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MARGINAL EFFICIENCY COST CALCULATIONS FOR DIFFERENT TYPES OF GOVERNMENT EXPENDITURE: A REVIEW

by

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ABSTRACT

This paper reviews the burgeoning literature on the marginal cost of public funds (MCF, for exhaustive government expenditure) and marginal efficiency cost of redistribution (MECR). It is shown that much of the controversy in the MCF literature is caused by the use of different definitions. These definitional differences deal with income effects. Special attention is paid to the cases in which the MCF can be less than one. The MECR literature is also shown to be plagued by definitional differences, although these do no explain in full the difference between the results of different authors.

First of all, it should be recalled that the MECR for a wage subsidy program can be very small, and even negative. More importantly, these welfare cost measures are only one input into the decision about whether to expand government spending programs. The efficiency cost calculations say nothing about the benefits from such spending programs. They merely suggest that, in most cases, the out-of-pocket costs of a spending program are an understatement of the true economic costs, because of the distortionary effects of taxes. Depending on the concavity of the social welfare function (see Ballard (1988)), it would be entirely possible to approve additional redistribution through cash grants, and reject additional exhaustive projects, even though the relevant MECR outweighs the relevant MCF.

IV. Conclusion

In the last 20 years, economists have increasingly recognized that the revenue and expenditure sides of government are intimately connected, both in theory and in practice. If we are to decide whether to approve a new government spending project, we must consider not only the benefits and the out-of-pocket costs, but also the indirect costs that are due to the fact the project is financed with taxes. In most cases, these indirect costs make it less likely to approve projects. In the language of this paper, the MCF and MECR are usually greater than one. For some "average" configuration of tax increases, the MCF is probably something like 1.2 or 1.3 or 1.4.

However, it must be borne in mind that MCFs and MECRs can actually be less than one. In these cases (for Pigouvian taxes and wage subsidies, for example), the benefits of a proposed government expenditure can actually be less than the explicit non-tax costs, and yet the project can still be socially beneficial.

In this paper, I have attempted to clarify (for economists) the distinctions among various marginal efficiency cost calculations. Stepping back from technical details, the best thing to say is probably this: If we are clear about the relevant tax rates and elasticities, and about the experiment that is being undertaken, we will end up with a clearer understanding of the results and of their meaning. As the economics profession increases its understanding of these issues, it can move on toward sounder policy advice. Ultimately, our goal should be to design fiscal policy so that we select the correct level of expenditure, and so that we make maximum use of the revenue sources with the lowest efficiency costs.

notches that we observe in some transfer payment programs in the United States are at income levels that may affect very large numbers of people, so that the welfare effects may be very great. Nevertheless, we cannot rule out the possibility that the notch program would be superior. Explicit consideration of the welfare effects of the notches would be an interesting extension for future work.

Another policy considered by Ballard is a "wage subsidy", which is modeled as an increase in the net-of-tax wage rate for some of the low-income groups. This can be financed in a number of ways, but Ballard most often considers increases in the marginal income tax rates for all consumer groups. For Ballard's central case parameters, when the wage subsidy is available to the two lowest income classes, the MECR is 0.92. In other words, the gains to the winners actually exceed the losses to the upper-income groups. (The money income tradeoff is even more favorable, at 0.83. The critical value of r is 0.067.) These results point toward the need for further consideration of wage subsidies as a policy option.

Until this point, the MCF and MECR literatures have been treated as if they were completely separate. However, it is interesting to compare them. The best way to begin is to compare the MCF of additional tax-financed exhaustive expenditure with the MECR for a notch cash grant program. If the pattern of demands of the low-income groups and the government were identical, then the MECR for the notch program and the MCF should be very similar. So, the question is: How do the demands of the low-income households differ from the government demands? In a multi-sector model, it would be possible for the two groups to differ in the capital intensity of their exhaustive purchases. (The government buys missile systems and the poor buy consumer goods.) However, in a one-sector model, such as the one used by Ballard (1988), such effects have been ruled out, so that there is only one difference. When the government gets an extra dollar, in a MCF experiment, it spends the entire dollar on goods. The low-income consumer spends an extra dollar partly on goods and partly on leisure.

When a poor consumer's leisure increases as a result of the cash grant, he works less and pays less tax on his labour income. This reduces the tax base in a way that does not occur when we perform a MCF experiment, in which the additional revenues are spent on exhaustive government projects. This reduction in the tax base means that the tax rate increase is able to generate less additional revenue. Thus, while the increase in tax-induced distortion is the same in the two experiments (since Ballard holds constant the tax rate increase), the MCF experiment generates more "benefits", in terms of revenues that can be used for government expenditure, than does the MECR experiment. Thus, in the simple comparision where taxes on high-income groups can finance either notch cash grants or additional government exhaustive spending, we expect that the notch MECR will exceed the MCF. This result is borne out in Ballard (1990c).

We have already seen that the MECR for a demogrant will usually exceed the nothc MECR by a wide margin. Thus, it follows that the demogrant MECR will also exceed the MCF by a substantial margin.

The point of the preceding paragraphs has not been to suggest that redistribution is somehow less desirable than exhaustive expenditure, just because the MECRs for notch and demogrant redistribution exceed the MCFs.

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additive social welfare function of the type used by Stern, we can focus on the parameter r, which determines the curvature of the relationship between individual utilities and social welfare. When r is zero, then we have a Benthamite social welfare function: we simply add up the individual utilities without assigning any higher weight to the lower-income individuals. If r is positive, the social welfare function becomes concave, and we place greater weight on the utilities of the poor. In the extreme case of an infinite r, we have a Rawlsian (or maxi-min) social welfare function. For each simulation, it is possible to calculate a critical value of r. If society is believed to be characterized by a value of r that exceeds the critical value, then the marginal redistribution can be said to have been socially beneficial (even though it clearly is not a Pareto improvement). If society is believed to be characterized by a lower value of r, then the extra redistribution would be socially harmful.

For most of Ballard's simulations, the critical value of r is rather small. For his central case simulations, the critical value is 0.397. For many of Ballard's simulations, the critical value is even lower. The construction of an actual social welfare function has well-known problems. The point is that one need not be an extreme egalitarian to prefer more redistribution, even when the marginal efficiency costs seem high.

Browning and Johnson restrict their attention to demogrant-type programs. Ballard also calculates the efficiency costs of redistributing through two other schemes. One such scheme is a "notch cash grant" scheme, under which cash grants are increased only for the lowest-income groups, and taxes are increased only for the highest-income groups. In practice, a notch could have severe adverse efficiency effects. Ballard does not directly assess the efficiency cost of the program with the notch, since for any given consumer, he maintains a linear budget constraint. Nevertheless, the results are interesting because they indicate that the notch program may be more efficient than the demogrant program, if the notch can be placed in an area of the income distribution where its negative effects are minimized.

For his central case parameters, Ballard finds that the notch cash grant MECR is around 1.14 to 1.18, compared with an MECR for the demogrant plan of 1.80. Similarly large differences are found for other parameter combinations. An intuitive understanding of the wide difference between the MECRs for these two plans can be gained if we imagine that a tracking device could be attached to every dollar as it flows into and out of the Treasury. To the extent that some dollars are taxed away from the high-income groups to finance transfers for the low-income groups, there is an element of pure redistribution. This is indeed what occurs in the case of the notch program. However, under the tax-financed demogrant plan, some of the taxes raised from each group could be viewed as being paid back to the same group. This is wasteful: when a dollar is raised from an individual with distortionary taxes and paid back to the same individual in a lump sum, there is a welfare loss because of the substitution effect. Finally, at least some of the dollars raised in taxes from the poor under the demogrant could be viewed as being paid to the rich. This obviously is not an efficient way to redistribute from rich to poor.

It is interesting that the difference between the MECRs for the notch cash grant and the demogrant is so large. This suggests that, even in a model in which the efficiency effects of the notch were recognized explicitly, the notch plan still might be a superior means of redistribution. In fact, the computational general equilibrium model, in which there are 384 consumer groups, distinguished by household type, income class, and number of persons per household. Data for the various groups are taken from the Census and from Current Population Reports, for 1979.

Before comparing the results of BJ with those of Ballard, it is necessary to clarify a difference in the way in which results are reported. BJ report their results in terms of the number of dollars of loss for the higher-income groups, when the lower-income groups gain one dollar. Ballard reports results in terms of the excess loss of the higher-income groups, over and above the one dollar that would be sacrificed if there were no efficiency effect. Thus, it is necessary to add one to Ballard's numbers, or subtract one from the BJ numbers, in order to render the numbers comparable. In an attempt to avoid confusion, I will here adopt the BJ style of reporting these numbers.

Ballard chooses different labour supply elasticities for the different household types in his model. For his central case, the weighted average uncompensated elasticity is 0.161, and the weighted average compensated elasticity is 0.361. In this case, Ballard calculates an MECR of 1.80, compared with the 3.49 of BJ. The money income calculations are similarly divergent. (Ballard's money income tradeoff is 4.25, compared with 9.51 for BJ.)

In an effort to reconcile his numbers with those of BJ, Ballard made a number of modifications to his tax rates, labour supply elasticities, and elasticities of substitution in production, in order to mimic the BJ model as closely as possible. However, this only increased the MECR to 1.89. Thus, a very substantial gap remained.

Unfortunately, Ballard did not investigate another source of difference between his results and those of BJ. This source of difference is very similar to the difference between balanced-budget and differential MCF calculations. Ballard's welfare measure merely involves comparing the equivalent variations for the different consumer groups. The BJ measure is (for net taxpayers) the extra net tax paid plus the marginal excess burden, as measured using the compensated labour supply curve. For net transfer recipients, their measure is the extra transfers received, minus this differential-type marginal excess burden. Thus, in a sense, BJ are calculating the marginal efficiency cost of increasing failure to use lump-sum taxes for redistribution.

Recently, I re-calculated the MECR in my model, using all of the adjustments that I had made earlier to mimic BJ, and this time using their welfare measure. This raises the efficiency cost ratio from 1.89 to 2.49, but still falls well short of the 3.49 of BJ. It may not be surprising that a substantial portion of the difference remains unexplained. After all, the numbers for the money income tradeoff were substantially apart, and these are unaffected by any differences in the method of calculating welfare. Nevertheless, it is suggestive that this experiment closes the gap between the two results by about three-eighths. This suggests that, if Browning and Johnson were to adopt a more sensible approach to welfare measurement, their MECR numbers would decrease, probably by a substantial amount.

It was stated earlier that the MECR is not sufficient for determining whether additional redistribution is socially beneficial. Ballard supplements his MECR calculations with calculations involving an explicit social welfare function, following Nicholas Stern (1976). Assuming the existence of an

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I. Introduction

Economists have long been concerned with finding the correct level of public expenditure. The attempts to study this problem can be divided into two broad categories. The first deals with the optimal level of exhaustive government expenditure, such as expenditure on missiles, roads, schools, and sewers. The second deals with the optimal level of redistribution through transfer payments. In each case, it has increasingly been recognized in recent years that the analysis must account for the distortionary effects of the taxes that are necessary to finance the government spending. This recognition has given rise to a literature on the "marginal cost of public funds", which deals with the effects of taxes on cost-benefit analyses for exhaustive expenditures. It has also given rise to a literature on the "marginal efficiency cost of redistribution". The purpose of this paper is to review these two related literatures. Obviously, the distinction between these two categories is somewhat artificial, since exhaustive programs also may redistribute income and wealth. However, for most of this paper, the two categories will be treated as if they were completely unconnected. Note that the literature on the marginal cost of public funds is much more extensive than the literature on the marginal efficiency cost of redistribution. This is reflected in this paper, where I devote much more space to the marginal cost of public funds for exhaustive expenditure.

In each of these two strands of the literature, some of the work has proceeded within partial equilibrium frameworks, and some has proceeded within general equilibrium frameworks. Since my audience is accustomed to general equilibrium analysis, I will emphasize the contributions of authors who

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have used general equilibrium models. However, the partial equilibrium work is sufficiently important that it, too, will receive a substantial amount of attention.

II. The Marginal Cost of Public Funds for Exhaustive Projects

The classic statement of the problem of finding the optimal level of government exhaustive expenditure was given by Paul Samuelson (1954, 1955). He showed that the optimal level of a pure public good will occur where the sum of the marginal rates of substitution between public and private goods is equal to the marginal rate of transformation. If we apply this idea to the cost-benefit analysis of a particular public project, we see that we must add up the marginal benefits to all consumers, and compare them with the marginal costs.

However, Samuelson's formula assumed that the revenue that is needed to finance the project could be raised with lump-sum taxes. Since this is not generally possible, we need to modify the formula to account for the effects of the tax system. The necessary modification is commonly called the marginal cost of public funds (MCF). The MCF is the factor by which the explicit costs of the project for labour, materials, etc., must be multiplied before any comparison with the benefits can be made. In Samuelson's case, where government is entirely financed with lump-sum taxes, the MCF would be 1.00. In any context, the MCF can be calculated by taking the change in consumer welfare brought about by a tax change, and dividing it by the amount of additional tax revenue collected.

Several years before Samuelson wrote, A.C. Pigou (1947, pp. 33-34) discussed how the analysis of public spending might be affected by taxes. He identified two costs of the tax system. The first is the cost of administration and compliance. Although these costs are doubtless important, they have generally been ignored by the economists studying the MCF since the 1970s. I, too, will put administrative and compliance costs aside. The second of Pigou's costs of the tax system is the "...indirect damage (inflicted) on the taxpayers...over and above the loss they suffer in actual money payment." This indirect damage results, at least in part, from the fact that the tax system distorts relative prices. Essentially, Pigou's conjecture is that these costs cause the MCF to be greater than one.

Some recent articles on the relationship between taxes and exhaustive expenditure have focused on the formulas for the optimal level of overall spending, and some have looked at the formulas for the cost-benefit analysis of a particular public project. In virtually every case, however, the work boils down to an attempt to identify the MCF. In the next few sections, my goal is to review and clarify this recent literature. I begin with a discussion of the relevant theory, and then provide some numerical calculations in a simple, partial-equilibrium model. I then compare these results with others from the literature. Finally, I suggest the outlines of what I believe is an emerging consensus. Afterward, I will move on to the literature on the marginal efficiency cost of redistribution.

A. Theoretical Background

Much of the recent work in this literature has built upon the work of Anthony Atkinson and Nicholas Stern (1974), who in turn built upon the pathbreaking work of Peter Diamond and James Mirrlees (1971) and Joseph Stiglitz and Partha Dasgupta (1971). Atkinson and Stern assume that the

move the economy closer to the optimal level of capital. In another dynamic model, Kenneth Judd (1987) shows that future taxes can increase the supply of productive factors in the present, and this can also generate MCFs less than one.

III. The Marginal Efficiency Cost of Redistribution

I should note at least two important differences between MCF calculations and calculations of the marginal efficiency cost of redistribution (MECR). First, although some MCF calculations emerge from multi-consumer models, it is perfectly acceptable to calculate the MCF within a one-consumer model. This is not possible for a MECR calculation. Second, the MCF is the only additional information that we need to evaluate a public project, once we have information on the benefits and non-tax costs. On the other hand, the MECR is not sufficient to tell us whether a given redistributive program is socially beneficial. Redistribution necessarily implies that different weights are attached to the utilities of different individuals, and a calculation of the MECR says nothing about how to choose the weights. Nevertheless, MECR calculations may be of some use. If the MECR appears to be exceptionally large, then we would need to exercise special caution before expanding redistributive programs. If the MECR is small or negative, such programs will appear more attractive.

The first well-known study of MECR is Browning and William Johnson (BJ, 1984), building on earlier work of Browning (1978). BJ perform calculations in a partial equilibrium setting, in that they hold gross-of-tax wage rates fixed. The model of BJ is a static one, in which the only distortion is to labour supply behavior. They use data from the March, 1975, Current Population Survey, updated and adjusted to 1976 levels.

Browning and Johnson undertake two types of calculation. First, they compare the loss in money income for the upper quintiles of the income distribution with the gain for the lower quintiles, when a demogrant-type system of income redistribution is increased by a small amount. Not surprisingly, the results depend on the labour supply elasticities. For the case preferred by BJ, in which the uncompensated elasticity is 0.20 and the compensated elasticity is 0.31, they find that the top three quintiles experience a loss that is 9.51 times as great as the gain of the bottom two quintiles. For every dollar of money income gained by the poorest 40% of the population, the richest 60% suffer a loss of $9.51.

BJ also attempt welfare calculations. For their favorite parameter values, BJ find that the welfare loss to the top quintiles is 3.49 times as great as the welfare gain to the bottom quintiles. For other combinations of parameters, the ratio of the losses to the quintiles that lose to the gains of the quintiles that gain ranges as high as 6.84 and as low as 2.29. It is not surprising that the tradeoff is less unfavorable when we consider welfare than when we merely consider money income. If we adopt a policy that encourages people to consume more leisure, and if they value that leisure, then calculations that concentrate only on money income (and ignore the leisure) are likely to make the policy look much less efficient.

More than four years after BJ published their study, Ballard (1988) presented new calculations. Once again, a static model was used, in which the central focus was on labour supply distortions. Ballard employs a

Table 3

Another Comparison of the Marginal Cost of Public Funds (MCF), for Different Portions of the United States Tax System

		Ballard–Shoven–Whalley (1985a)	Same, Except With Differential Analysis
GEMTAP Model	All Taxes	1.332	1.426
	Capital Taxes at Industry Level	1.463	1.576
	Labour Taxes at Industry Level	1.230	1.312
	Consumer Sales Taxes	1.388	1.491
	Sales Taxes on Commodities Other Than Alcohol, Tobacco, and Gasoline	1.115	1.185
	Income Taxes	1.314	1.406
	Output Taxes	1.279	1.369
Jorgenson and Yun (1990)	All Taxes		1.460
	Corporate Income Tax		1.838
	Capital Income Taxes, Individual & Corporate		1.924
	Property Taxes		1.174
	Labour Income Tax		1.482
	Sales Tax		1.256
	Individual Income Tax		1.598

All of the work reported so far has been based on single-country models. Even when the models have any foreign trade at all, the international aspects are not emphasized. One paper that runs counter to this trend is the one by Ramon Clarete and Whalley (1987), who use a CGE model of the Philippine economy to assess the effects of domestic taxes and trade taxes. They find that the MCFs of raising additional revenue from tariffs are much larger than the MCFs associated with domestic taxes.

Finally, let me mention some other recent studies that calculate MCFs less than one. We have already seen MCFs less than one in static models in which the labour supply elasticity is low, and in the Fullerton-Henderson model for a reduction in the investment tax credit. In a model with pollution, Ballard and Steven Medema (1990) show that a Pigouvian, externality-correcting tax can generate MCFs less than one. Raymond Batina (1990) shows that a tax on interest income imposes tax liability later in the life cycle than a tax on labour income, so that it may increase capital accumulation and

government seeks to maximize the utility of a group of identical consumers, subject to the constraint that the revenue must be raised by a set of commodity taxes. They use a static model, so that the effects of the tax system on the accumulation of capital are not considered. They also assume that the net-of-tax producer prices are constant.

Atkinson and Stern derive a condition for the optimal provision of a public good, where the public good is separable in utility (i.e., the public good does not affect the utility derived from consumption and leisure).

$$MRT = \left\{ 1 - \sum_{i=1}^{n} t_i \frac{\delta X_i}{\delta I} + \sum_{i=1}^{n} t_i (S_{ik} / X_k) \right\} \sum MRS + \frac{\delta}{\delta_e} \left[\sum_{i=1}^{n} t_i X_i \right], \qquad (1)$$

where MRT and MRS are the marginal rates of transformation and substitution, the t's are the tax rates, the X's are uncompensated commodity demands, I is the consumer's exogenous income, the S's are elements of the Slutsky substitution matrix, and e is the supply of public goods.

This condition of Atkinson and Stern deviates from the Samuelson condition in some important respects. The first is what they call the "distortionary effect", which is the portion of the righthand side of equation (1) that involves substitution effects. Atkinson and Stern show that this always works in the direction of making government projects less attractive, so that the optimal level of government spending will be lower because of this effect. In other words, the distortionary effect tends to raise the MCF to values higher than one. This is probably what Pigou had in mind when he made his conjecture.

A second part of the MCF is the "revenue effect", which is the portion of the righthand side of equation (1) that involves income derivatives. When taxes change, they generate income effects as well as substitution effects. If the income effects reduce the amount of revenue collected by the government, they will reinforce the substitution effects. When this happens, the income effects will work in the direction of Pigou's conjecture, so that the MCF is all the more likely to be greater than one.

However, as is well known from the labour supply literature, changes in the net-of-tax wage rate lead to income effects and substitution effects that go in opposite directions. Since the income effect of wage taxation actually increases the government revenue, it works toward a lower MCF.

Thus, Pigou's conjecture was on the mark regarding sales or excise taxes on normal consumption commodities, since the distortionary and revenue effects reinforce each other. However, in the case of wage taxes, the distortionary and revenue effects run counter to each other, so that Pigou's conjecture may not be correct. In this case, if the income effect is large enough that the uncompensated labour supply elasticity is negative, the MCF may be less than one.

In the simple case of a static, one-period model with fixed producer prices, where the government spending is separable in utility from the consumption-leisure choice, the theorem reads like this: If the only existing distortion in the economy is a wage tax, and if labour supply does not change in response to changes in the consumer's budget constraint, then the MCF is exactly 1.0. If labour supply increases, then the MCF is actually less than one. This possibility is empirically important, since many studies have found negative labour supply elasticities, especially among prime-age males. Pigou's conjecture (that the MCF exceeds one) may well be correct for a model such as this. But it will only be correct if labour supply goes down in response to the increase in the wage tax that is necessary to finance additional government spending.

This point is illustrated in Figure 1, for the consumer with perfectly inelastic labour supply. Point A is the consumer's initial, pre-tax choice. The consumer's nonlabour income is given by RS. If a wage tax is imposed, the consumer chooses B, and the government collects revenue of AB. The calculation of an MCF involves an analysis of a change from an already-distorted point like B. If the rate of proportional wage taxation is increased, the consumer will now choose point C. The additional revenue collected by the government will be BC. In order to calculate the MCF, we must compare this revenue gain for the government with the consumer's loss of utility. If we measure the consumer's loss by the equivalent variation, we get BD. The MCF will then be BD/BC. For large discrete changes away from the first distorted equilibrium, this MCF will exceed one. However, for small changes, it will be 1.0.

Thus, in a static model, the MCF of additional government exhaustive spending financed by a proportional tax on inelastic labour is 1.0. This may strike many economists as odd. After all, we are used to thinking of wage taxes as being worse than lump-sum taxes. Many of us would have guessed that the MCF of additional spending financed by a lump-sum tax would be 1.0. However, this latter guess turns out to be incorrect, as shown in Figure 2. There, the revenue collected from an initial wage tax is EF. If a lump-sum tax is imposed on top of the wage tax, the consumer's new choice will be G. This yields additional government revenue of GH. However, the consumer's utility only drops by GJ. Thus, the MCF will be less than one. In a simple model such as this, the MCF of additional spending financed by a lump-sum tax will only be 1.0 if the existing taxes are also lump sums. If the initial tax is a wage tax, then the MCF of adding a lump-sum tax will be less than one.

B. Numerical Calculations from a Simple Model

In order to put some numerical flesh on these ideas, I now present some MCF calculations from a simple, partial-equilibrium model in which labour supply is the consumer's only decision, and labour income taxes are the only distortions. For simplicity, I use a linear labour supply function suggested by Jerry Hausman (1981), along with Hausman's figures for wage rates and nonlabour income. In most cases, I start with a progressive tax system where the average tax rate is 27 percent and the marginal rate is 43 percent. I focus on the case of a separable public good, highlighted above.

The results are shown in Table 1. In the top panel of this table, I present results for the special case of a zero uncompensated labour supply elasticity. As suggested above, for a proportional increase in labour taxes, this gives a MCF of exactly 1.0. This means that, if a public project were to be financed by this type of tax, the project would be socially beneficial if its benefits exceed its explicit (non-tax) costs by any amount. For a lump-sum

increasing failure to use lump-sum taxes, rather than the marginal efficiency effects of additional government spending. Thus, their results are only relevant for project analysis if the exhaustive government expenditures under consideration are close substitutes for cash. In addition, the results of Jorgenson-Yun are not directly comparable with those of BSW or Fullerton-Henderson.

Since Jorgenson and Yun employ the techniques of differential analysis, it is not surprising that their estimated marginal efficiency costs are higher than those of BSW. In order to provide a clearer comparison between the two studies, I have used the same GEMTAP model that was used by BSW, along with all of the same parameters, but with lump-sum taxes to provide equal revenue yield. Thus, these calculations are in the tradition of differential incidence analysis, and may be compared with the results of Jorgenson and Yun.

In Table 3, I include the information from Table 4 of Jorgenson and Yun, along with additional results from the differential calculations using the GEMTAP model. Once we use the same type of conceptual experiment, it becomes possible to explain much of the apparent difference between BSW (1985a) and Jorgenson and Yun (1990). For example, when all taxes are incremented, BSW report a MCF of 1.332 when their standard elasticity values are used, and Jorgenson-Yun report a MCF of 1.460. When differential techniques are used, the GEMTAP model of BSW produces a MCF of 1.426. Thus, when the same type of conceptual experiment is used, approximately three-fourths of the apparent difference disappears. This suggests that, if Jorgenson and Yun were to employ the techniques of balanced-budget analysis (which, I have argued, is the best way to go if we desire to produce calculations that are useful for project analysis), their marginal efficiency cost numbers would be noticeably lower.

Another possible source of the difference is in the specification of consumer dynamics. Both BSW and Fullerton-Henderson employ the GEMTAP model of consumer behavior. Despite its problems (some of which are discussed by Jorgenson and Yun), this model has the advantage that it can be calibrated precisely to any desired degree of intertemporal responsiveness on the part of consumers. Jorgenson and Yun employ an infinite-horizon utility functional. They do not provide a report on the degree of intertemporal responsiveness that their model implies. However, as shown by Ballard (1990b), the infinite-horizon formulation often results in extremely large savings elasticities. Thus, another possible explanation for the difference is that Jorgenson and Yun may employ a much more elastic model. As we have seen repeatedly, higher elasticities tend to lead to higher MCFs.

Jorgenson and Yun attribute the difference in results between their paper and BSW (1985a) to "...the greater precision we employ in representing the U.S. tax structure." Because they carry out a different type of experiment, and possibly because of differences in elasticities, this is a precarious statement.

Table 2

The Marginal Cost of Public Funds (MCF) for Different Portions of the United States Tax System, From Two Recent Studiesa[a]

		Fullerton–Henderson (1989b)	Ballard–Shoven–Whalley (1985a)
A.	Investment Tax Credit	0.624	
B.	Depreciation Allowances		
	1. Lifetimes	0.812	
	2. Declining Balance Rates	1.081	
C.	Corporate Income Tax Rate	1.310	
D.	Corporate and Noncorporate Income Tax Rates	1.252	
E.	Personal Income Tax Rates		
	1. Capital Gains	1.202	
	2. Dividends	1.036	
	3. Interest Income	1.028	
F.	Labour Tax Rates at Industry Level	1.169	1.230
G.	Personal Income Tax Rates	1.247	1.314

a. Both studies employ a value of 0.15 for the uncompensated labour supply elasticity, and 0.4 for the elasticity of saving with respect to the net rate of return.

The most striking feature of the Fullerton-Henderson results is the wide variation among the MCFs for different capital tax instruments. Also striking is the MCF for increasing revenue by reducing the investment tax credit. This MCF is substantially less than one. As Fullerton and Henderson put it, this result "...arises because the values for effective tax rates on equipment are lowest in our baseline. The gain from lowering the dispersion of effective tax rates in this manner more than offsets the loss on the intertemporal margin."

Another recent paper that uses a large-scale, dynamic model is the paper by Dale Jorgenson and Kun-Young Yun (1990). Like Fullerton and Henderson, they calculate effective marginal tax rates on capital using a cost-of-capital approach. However, unlike either Fullerton-Henderson or BSW, Jorgenson and Yun only perform differential analysis. Whenever they alter a distortionary tax, they always hold government expenditure constant by altering a lump-sum tax. Consequently, Jorgenson and Yun are in the tradition of Browning: They calculate the marginal efficiency effects of

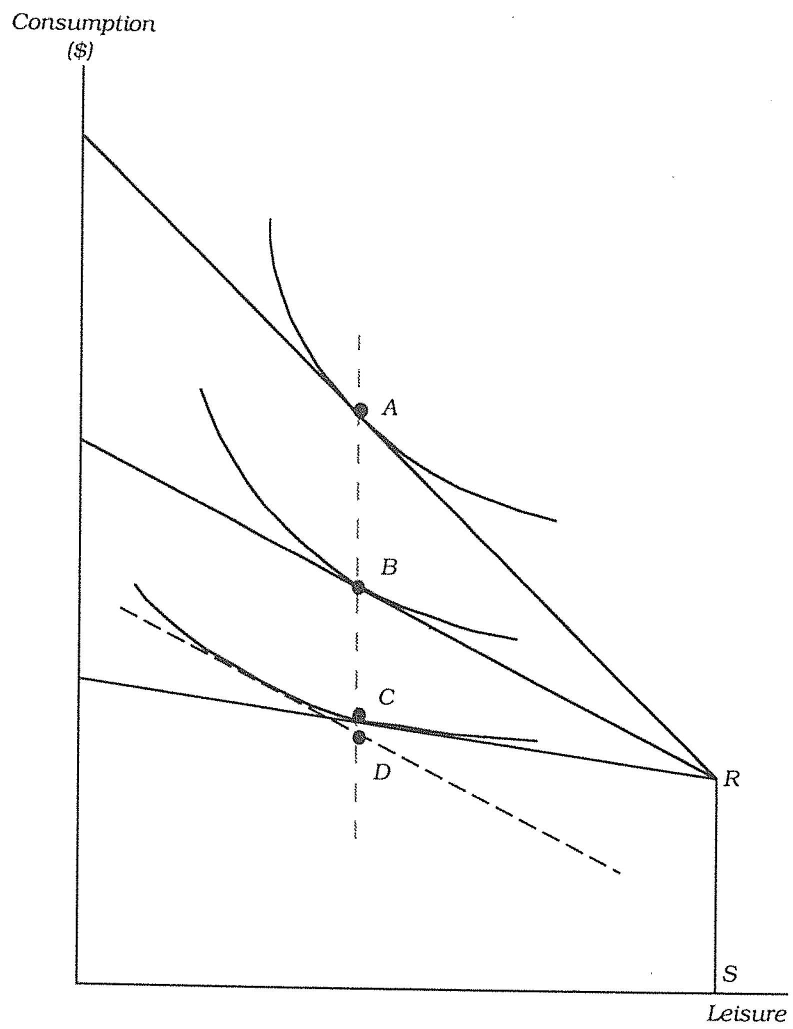

Figure 1 Effects of a Marginal Increase in the Labour Income Tax, when Labour Supply is Perfectly Inelastic

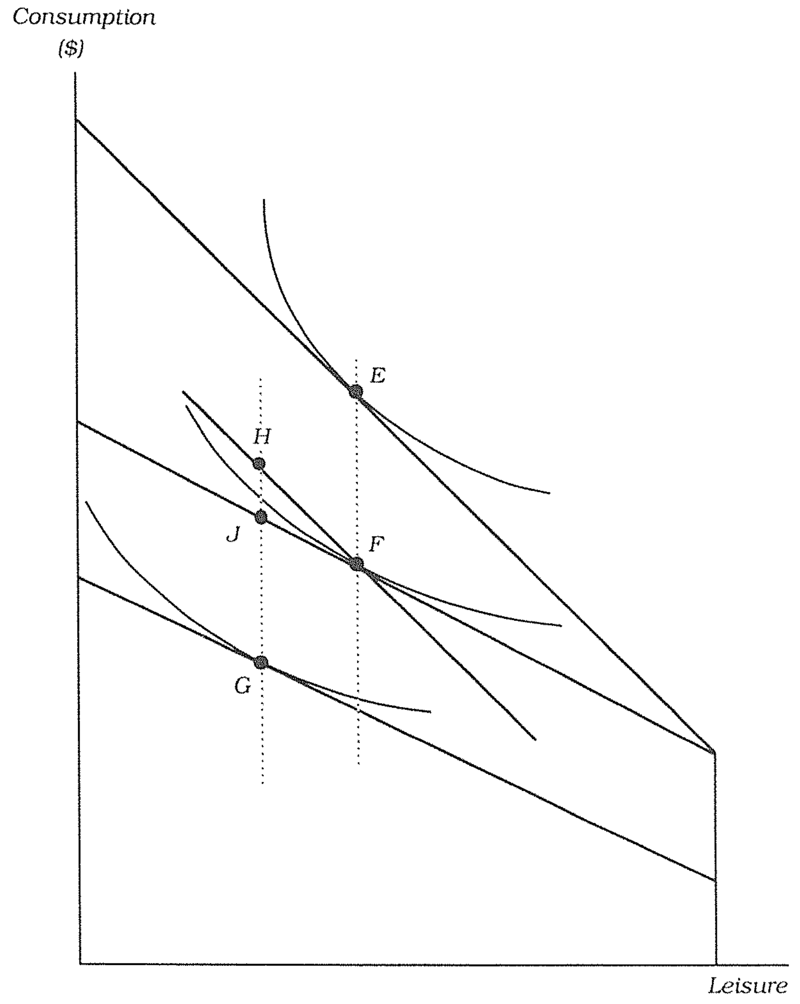

Figure 2 Effects of a Marginal Lump-Sum Tax, Applied in the Presence of a Pre-Existing Labour Income Tax

burden (MCF-1) from the balanced-budget experiments exceeds the average excess burden from the differential experiments. However, it is crucial to emphasize that these marginal excess burdens cannot be computed by taking small changes in the average excess burdens, since the two come from different experiments.

Ballard, Shoven, and Whalley analyze the sensitivity of their results with respect to the uncompensated labour supply elasticities, but they do not discuss the role of compensated elasticities. Sensitivity analysis with respect to the compensated elasticities provides some interesting results, which were reported in Ballard (1990a). In their central case, BSW use an uncompensated elasticity of 0.15 for each of the 12 consumer groups in their model. The weighted average of the compensated elasticities is rather high, at 0.479. In this case, BSW calculate an overall balanced-budget MCF (for simultaneous increases, in all tax rates) of 1.332. If we increase the compensated elasticities while holding constant the uncompensated elasticity, the MCF actually decreases slightly. For an average compensated elasticity of 0.55, the MCF is 1.31. For an average compensated elasticity of 0.20, the MCF is 1.41. Similar patterns are observed when MCFs are calculated for increases in payroll taxes or income taxes only.

This effect is one that could only arise in a general equilibrium model. With a positive uncompensated labour supply elasticity, the increased labour tax leads to a reduction in labour supply. This raises the relative price of labour services, and lowers the relative price of capital services. Thus, the consumer's nonlabour income falls. The decrease in nonlabour income increases labour supply, *ceteris paribus*. Therefore, the initial decline in labour supply is offset partially. The extent of this effect grows as the compensated elasticity grows.

For a period of several years, the BSW paper was the only one that presented MCF calculations based on a large-scale computational model with a large variety of tax instruments. Recently, other authors have presented such calculations, as well. Don Fullerton and Yolanda Henderson (1989b) use a version of the dynamic, multi-sector GEMTAP model that bears a great many similarities to the model of BSW (1985a). Like BSW, Fullerton and Henderson also concentrate on balanced-budget experiments. The one major difference is in their model of capital taxes. BSW calculate the average tax rate on capital for each sector, and then assume that the marginal tax rate is equal to the average tax rate. They also put all capital taxes (including corporate income and franchise taxes and property taxes) into a single vector of capital tax rates. Thus, an increase in capital tax rates in the BSW model does not correspond to any real-world tax policy proposal. Fullerton and Henderson improve upon this by adopting a cost-of-capital approach, in the tradition of Robert Hall and Dale Jorgenson (1967). This allows them to distinguish among a variety of detailed provisions of the tax code, each of which has its own distinct effect on marginal effective capital tax rates.

In Table 2, I reproduce the central results of Fullerton and Henderson, from their Table 1. I also present the corresponding MCFs from BSW, for the two experiments for which a comparison is possible. In these two cases, the results of Fullerton-Henderson and BSW are certainly not identical, but they are moderately close to each other.

model was calibrated around a 1973 data set. It includes taxes on labour, capital, outputs, sales, income, and intermediate input purchases. Details of the model, including its dynamic structure, can be found in Ballard, Fullerton, Shoven, and Whalley (1985). Unlike the papers by Stuart and by Ballard, BSW only consider the case of separable exhaustive expenditure. They do not consider the case in which the additional government revenues are rebated to consumers in cash form. Thus, some of the calculations of BSW are directly comparable with some of the calculations of Stuart and of Ballard, but none of the calculations of BSW is directly comparable with any of the calculations of Browning. BSW found MCFs of 1.11 for labour taxes when the uncompensated labour supply elasticities were zero, even though they use proportional taxes. These MCFs exceed one because of the interactions among tax instruments. (See the discussion of Ballard (1990a), above, for some comments on the effects of interactions across tax instruments.) For an uncompensated elasticity of 0.15, the labour taxes yield an MCF of 1.23. For capital taxes, their MCFs range from 1.18 to 1.46, depending on elasticity values.

In addition to the calculations for capital and labour taxes, BSW also calculate MCFs for sales taxes, income taxes, output taxes, and the entire tax system. For the entire tax system, the MCFs range from 1.17 to 1.56, depending on elasticity values. Thus, BSW suggest that "...a project must produce marginal benefits of more than $1.17 per dollar of cost if it is to be welfare improving. This suggests that many projects accepted by government agencies on the basis of cost-benefit ratios exceeding unity might have been rejected if the additional effects of distortionary taxes had been taken into account."

All of the MCFs calculated by BSW exceed 1.0. This suggests that, in a model such as that used by BSW, the interactions among tax instruments would make it less likely for the MCF to be less than one, as it was for several of the calculations reported in Table 1.

The other most striking results of BSW are the wide disparities among the MCFs for the various tax instruments. For a labour supply elasticity of 0.15 and a savings elasticity of 0.4, the MCFs range from 1.12 for certain sales taxes to 1.46 for capital taxes. In an optimal tax system, we would want the MCFs to be equalized across tax instruments. This indicates the existence of many important opportunities for welfare-improving tax reforms.

Unfortunately, BSW did not discuss the conceptual similarity between their measures and those of Stuart, or the conceptual differences between their measures and those of Browning (1976).

In comparing his results with those of Stuart and Ballard-Shoven-Whalley, Browning states (p. 11) that "...almost all of the differences in results can be traced to different assumptions about key parameter values." Several authors, including especially Fullerton (1991) have shown that this statement is incorrect. Instead, the differences in MCFs stem primarily from conceptual differences.

It is interesting to compare these MCF results of Ballard, Shoven, and Whalley with some differential calculations that they performed using the same model. Whereas BSW (1985a) report on the MCFs that come from balanced-budget changes in government spending and taxation, BSW (1985b) report on the average excess burdens that come from replacing portions of the tax system with lump-sum taxes. In most cases, the marginal excess

tax, we get MCFs less than one. Thus, if the MCF for a lump-sum-tax-financed project were 0.93, the project could be socially beneficial even if its benefits fell short of its non-tax costs by nearly seven percent. The greater is the income effect on labour supply, the smaller is the MCF for a lump-sum tax.

If we simulate progressive increases in the labour taxes, the MCFs can exceed one, even in this case with a zero uncompensated labour supply elasticity. In this case, the increase in the marginal tax rate increases "virtual income". The associated income effect decreases the actual labour supply, even when the uncompensated elasticity is zero.

Under a progressive tax system, when the marginal and average tax rates rise by the same percentage, it is necessary for the inframarginal tax rates to rise. An increase in inframarginal wage taxes is effectively a lump-sum tax. It has no first-order distortionary effect. Consequently, when both marginal and average rates rise, the MCF is substantially lower than when only the marginal rate rises. In fact, when the marginal rate applies only to a small fraction of labour income, and when only the marginal rate rises, tax revenue actually decreases.

The bottom panel of Table 1 shows MCF calculations for different combinations of compensated and uncompensated labour supply elasticities. These elasticities are taken from Burtless's (1987) survey of the labour supply literature. The largest MCF occurs when only the marginal rates rise, for the labour supply elasticities corresponding to Burtless's survey of 38 studies of the labour supply behavior of wives. In this case, the MCF is 1.989. This means that a government project financed in this way would need to have benefits nearly twice as great as its non-tax costs, in order to be socially beneficial. If this project only had benefits that were 1.5 times as great as its non-tax costs, it would be erroneous to approve the project.

The results shown in Table 1 reinforce the main points made so far with respect to static models: (1) For negative uncompensated labour supply elasticities, the MCF of a proportional tax increase is less than one. (2) The MCF for a lump-sum tax assessed on top of an existing wage tax is less than one. (3) The income elasticity of labour supply is important in determining the deviation of the lump-sum MCF from one, and in determining the size of the MCF for progressive tax changes.

It appears that many economists have had difficulty in reconciling results (1) and (2), in the preceding paragraph, with their intuition. The problem is that the intuitions of recent generations of public finance economists have been nurtured by the work of Frank Ramsey (1927) and Arnold Harberger (1964). The 24-year-old Ramsey developed the formula for the optimal configuration of commodity taxes, assuming that the level of government spending is fixed. Harberger also assumed that the level of spending is fixed, and developed the formula for the welfare cost of any given tax.

Table 1

The Marginal Cost of Public Funds (MCF) For Small Tax Changes, with a Pre-existing Wage Tax[a] *as a Function of Labour Supply Elasticities*[b]

		Tax change that generates MCF			
				Progressive wage tax:	
Uncompen-sated labour supply elasticity	Compen-sated labour supply elasticity	Proportional wage tax	Lump sum tax	marginal & average rates rise by same proportion	only marginal rate rises
0.000	0.100	1.000	0.930	1.047	1.179
0.000	0.200	1.000	0.870	1.099	1.434
0.000	0.300	1.000	0.816	1.156	1.834
-0.105c	0.284c	0.936	0.774	1.052	1.540
-0.022d	0.090d	0.984	0.922	1.025	1.136
0.173e	0.243e	1.147	0.950	1.315	1.989

a The initial marginal tax rate is 43%, and the initial average tax rate is 27%. In the case of a proportional tax, both marginal and average tax rates are initially 43%. Many studies have shown that the difference between a calculated MCF and 1.0 will increase as the pre-existing tax rate increases.

b The public project does not affect the consumer's uncompensated demand curves for leisure and consumption.

c. Elasticities are from Burtless's (1987) survey of nonexperimental studies of male labour supply behavior.

d. Elasticities are from Burtless's (1987) survey of studies of the effect of the negative income tax experiments on male labour supply behavior.

e. Elasticities are from Burtless's (1987) survey of 38 studies of the effect of the negative income tax experiments on the labour supply of wives.

2. In the same model, with the same assumptions, suppose a public project with production costs (MRT) of $1, and benefits (ä MRS) of slightly more than $1, could be funded by a 1% increase in the wage tax. Would this be desirable?

yes ________ no ________

Most economists would probably answer "yes" to question 1, since the wage tax leaves the consumer worse off than a lump-sum tax that raises the same revenue. In fact, 18 of the 22 usable responses indicated "yes" to question 1.

I hope that this paper has made clear that "yes" is also the correct answer to question 2. With inelastic labour supply, the MCF is exactly 1.0. Since the ä MRS exceeds the MRT, it follows that the project is beneficial. However, 16 of the 22 respondents answsered "no" to question 2. This indicates that, at least as of late 1988, the issues discussed in this paper were not well understood, even by many leading public finance economists.

In the last two years, several papers dealing more clearly with these questions have been either published or accepted for publication. These include Fullerton (1989, 1991), Mayshar (1990, 1991), and Ballard (1990a). It is to be hoped that these papers will help to speed up the slow diffusion of knowledge in this area.

Although dissenting voices remain, I believe that a consensus may finally be emerging. Among the key points for this consensus are the following: (1) For separable public projects, when labour taxes are the only distortion in a static model, the MCF of additional spending financed by additional labour taxes is exactly 1.0 if labour supply does not change. In such a situation, the MCF for lump-sum taxes is less than one. (2) MCFs depend critically on the specific nature of the spending project being undertaken. If the project is a close substitute for cash, its MCF for labour taxes or lump-sum taxes will be higher than for a separable project. (3) The MCF is what is needed by the cost-benefit analyst. Much of the literature in the past was couched in terms of "marginal excess burdens" (which often were calculated as MCF - 1). In the future, this literature will probably concentrate on the MCF as the most important and simplest concept to use. (4) Lump-sum taxes are not the only ones for which the MCF may be less than one. In fact, although the MCFs can be very large in some contexts, there are now several papers that present MCFs that are less than one. (Some examples are given below.)

What is needed now is for this emerging consensus to coalesce more fully. In order for that to happen, it will be necessary for the points made here to become a standard part of graduate courses in public finance. Perhaps Mayshar (1990) will become the standard work on graduate reading lists. If we are able to teach the distinctions mentioned here to future generations of public finance economists, we will have moved closer to the goal of being able to give consistently sound policy advice regarding the marginal cost of public funds.

D. Discussion of Related Literature for Larger and Dynamic Models

Ballard, Shoven, Whalley (BSW,1985a), was the first study of MCFs to have a very wide range of tax instruments. BSW use the GEMTAP model of the United States economy and tax system. At the time that they wrote, the

Stuart study. Once again, a small-scale computational model is used, with emphasis on labour supply distortions.

Hansson and Stuart use the central assumption that the uncompensated labour supply elasticity is 0.10, with a compensated elasticity of 0.25. With these elasticities, when the initial tax rate is 40 percent, the MCF is 1.07 for separable projects and 1.16 for projects that are equivalent to cash. These values for the MCF are quite similar to the values calculated by Stuart in his 1984 paper, because the parameters used are very similar. However, Hansson and Stuart suggest that Swedish tax rates were around 70 percent in the early 1980s. At this level of initial tax rate, the MCFs become 1.69 and 2.29. When the initial tax rate rises to 80 percent, the MCFs rise to 7.1 and 32.7. For initial tax rates higher than 81 percent, both MCFs are effectively infinite, since the economy is beyond its tax-revenue-maximizing level of tax rates.

Another small-scale CGE model is that of Ballard (1990a). He uses proportional taxes, so that the MCF is exactly 1.0 when the uncompensated labour supply elasticity is zero and when labour taxes are the only taxes set to positive values. His model, like Stuart's, has only a single consumer. However, whereas Stuart has only one produced commodity and considers labour taxes only, Ballard has two produced commodities and includes sales taxes. For some of his calculations, he sets the labour tax rate to zero and considers a tax on one of the consumption goods. In this case, Ballard never gets MCFs less than 1.0, since income and substitution effects always reinforce each other for normal consumption goods. With a compensated elasticity of -0.5 for the taxed good, the MWC rises from 1.148 for an uncompensated elasticity of -0.75 to 1.307 for an uncompensated elasticity of -1.35.

Ballard also considers the case where both the labour tax and sales tax have positive values. In this case, the MCF is no longer exactly 1.0 when the uncompensated labour supply elasticity is zero. Instead, the MCFs tend to be several percent higher, for comparable elasticity values. The reason for this is as follows. When the labour tax rate is augmented, the consumer's net income declines. Less money is available to be spent on consumer goods, and the sales tax revenue goes down. As a result, the overall change in revenue is smaller than it would be if there were no sales taxes in the model. The MCF is larger as a result.

Although some economists have understood some of the relationships described here for some time, the diffusion of knowledge appears to have been slow. Some evidence on the slow speed of the diffusion comes from the responses to a survey conducted by Don Fullerton in 1988. The survey was sent to the invited participants of a taxation conference at the National Bureau of Economic Research in November, 1988. The survey was not scientific, but it probably did reflect the current understanding of many who teach graduate public finance at leading institutions. The survey involved the following two questions:

> 1. Consider a single aggregate individual facing a constant gross wage and a flat 50% wage tax, with Cobb-Douglas utility over leisure and a single consumption good, such that the uncompensated labour supply elasticity is zero and the compensated labour supply elasticity is positive. Is this wage tax distortionary?
>
> yes ________ no ________

Each of these classic works deals intelligently with its own problem. But neither Ramsey nor Harberger is concerned with the problem of selecting the optimal level of government expenditure. Thus, in general, neither is relevant for the calculation of the MCF.

As Harberger (1964, p. 61) puts it, his assumptions "...have the effect of setting first-order income effects...to one side." Thus, it is not surprising that Harberger's formula only includes substitution effects, since income effects have been assumed away entirely. Since Harberger is concerned with the efficiency effects of taxes, given the level of government spending, he is comparing the effects of a distortionary tax with the effects of an equal-revenue lump-sum tax. Since the comparison is with a lump-sum tax, and since even lump-sum taxes have income effects, the income effects disappear from the formula.

Harberger's approach is echoed in the work of Diamond and Daniel McFadden (1974) and Alan Auerbach (1985). These authors suggest that the additional government revenue that is relevant for calculating the MCF should be calculated after compensation returns the consumer to his original utility level. However, this is clearly inappropriate for analyzing the actual effects of a tax-financed increase in government spending.

The MCF formulas that are relevant for cost-benefit analysis will generally involve income effects. Here, the problem involves finding the optimal level of government spending. Consequently, the thought experiment must allow the level of government spending to vary. The taxes necessary to generate additional government spending will have income effects, in general. Stuart (1984) emphasizes that the alternative being considered is a lower level of taxation, rather than an equal-revenue lump-sum tax. Ballard (1990a) characterizes the difference in terms of the distinction drawn by Musgrave (1959) between "differential incidence" experiments and "balanced-budget incidence" experiments. In a differential experiment, we compare alternative means of financing the same amount of government spending. In a balanced-budget experiment, the level of expenditure is altered, and the tax system is changed simultaneously in order to finance the spending change. Calculations of the Harberger type are in the tradition of differential analysis. Calculations of MCFs are in the tradition of balanced-budget analysis. It is probably not surprising that many of those who have attempted to clarify this point are applied general equilibrium modellers. In a Harberger-type analysis, such as those of Browning (1976, 1987), income effects are ignored. However, this is extremely difficult for the applied general equilibrium modeller, since setting aside the income effects will usually mean that Walras's Law is not satisfied.

There is a special case in which the income effects wash out. This is the case in which the government expenditure is a cash transfer, or a perfect substitute for cash. In this case, we do get back to formulas in which the compensated elasticities are most important. Thus, ultimately, the MCF depends on the nature of the proposed spending. David Wildasin (1979, 1984) was the first to emphasize this point. Wildasin makes clear that Atkinson and Stern assume that the additional government spending does not change the ordinary, uncompensated demand curves. Wildasin uses the phrase "ordinary independents" to describe the case analyzed by Atkinson and Stern. Harberger-type analyses can be used if we assume that the additional spending does not change the compensated demand curves.

Thus, if a public project is to be financed from labour income taxes, and if the project is separable from the consumer's choices over leisure and consumption, the appropriate MCF formulas will depend primarily on uncompensated labour supply responses. My own judgment is that this case is considerably closer to the truth than the other extreme case studied by Harberger, Browning, and others. However, if the government's spending involves cash transfers, or if the spending can be viewed as a close substitute for cash, then the income effects will once again disappear. In this case, the appropriate MCF formulas will depend primarily upon compensated elasticities.

Over the last decade or so, this point has become clear to more and more economists. The appropriate formula will depend on what is being done with the money. Different formulas can be used, so long as we are clear about the nature of the analyses in which they will be used. Problems arise when a calculation is applied to a question for which it is inappropriate.

C. Discussion of Calculations from Small-Scale, Static Models

The first calculation of MCFs was by Harry Campbell (1975), who found an MCF of about 1.24 for Canadian sales taxes. Edgar Browning (1976) followed with estimated MCFs of between 1.09 and 1.16 for labour taxes. Unfortunately, both of these papers used Harberger formulas, without making clear that the calculations were thus applicable only for cash transfers or for government expenditures that substitute perfectly for cash. In 1987, Browning published new estimates. He used a modification of the Harberger-type formula of his 1976 paper, and once again did not make clear the special assumptions underlying the methodology. The MCFs cover a wide range, depending on parameters. In his 1987 paper, Browning prefers parameters that yield MCFs from 1.32 to 1.47.

Wildasin (1984) and Stuart (1984) were the first to provide MCFs calculated like those reported in Table 1, in which the public good does not affect the uncompensated labour-leisure choice. Unfortunately, Stuart did not emphasize the distinction between his calculations and those of Browning. The distinction comes through more clearly in Wildasin's paper, but it does not appear to have received the attention it deserved. (Evidence will be presented, below, indicating that large numbers of prominent public finance economists did not understand the distinction, even as of several years later.)

Stuart uses a very small-scale computational general equilibrium (CGE) model, in which a single household allocates its time between a taxed and an untaxed sector. In the case of a zero uncompensated labour supply elasticity and a compensated elasticity of 0.2, combined with an initial marginal tax rate of 42.7 percent, Stuart calculates an MCF of 1.072 for separable government exhaustive spending. When the assumed initial tax rate rises to 46 percent, the MCF rises to 1.09. Stuart's results are fairly sensitive to the uncompensated labour supply elasticity. (Stuart always uses a value of 0.2 for the difference between the uncompensated and compensated elasticities.) With an uncompensated elasticity of 0.318, the MCF rises to 1.427 for an initial marginal tax rate of 42.7 percent, and to 1.533 for an initial tax rate of 46 percent.

Stuart also calculates the MCF associated with additional government spending in the form of cash grants (or in some other form that the consumer takes to be equivalent to a cash grant). In this case, the income effects really do wash out, and Stuart's results in this case really are comparable with those of Browning. Not surprisingly, Stuart gets higher MCFs in this case. In the case with a zero uncompensated elasticity, the MCF is 1.207 for an initial tax rate of 42.7 percent, and 1.244 for an initial tax rate of 46 percent.

In considering the cases of (1) separable government exhaustive expenditure and (2) government spending that is equivalent to cash, Stuart considers two popular cases. It may be that consumers consider many types of spending to be partial, imperfect substitutes for cash. Econometric estimates of this type of substitutability are provided by Roger Kormendi (1983) and David Aschauer (1985). Their estimates may be taken to indicate that a dollar of government purchases is perceived by consumers as substituting for 30 cents of private consumption. Thus, the "true" MCF for a model like Stuart's might be 30 percent of the way between Stuart's 1.072 for exhaustive expenditure and his 1.207 for cash grants. This would give an MCF of about 1.11. If the 30 percent figure is correct, then models like that of Stuart will understate the true MCF by a small amount, and models like those of Browning will overstate the true MCF by a more substantial amount.

It is important to note that Stuart's MCF calculations for cash grants are not the same as calculations of the marginal efficiency cost of redistribution. Stuart uses a one-consumer model. By definition, it is impossible to consider the marginal efficiency cost of redistribution without having at least two consumers. I will return to the marginal efficiency cost of redistribution in a later section.

Stuart's model is sufficiently small in scale that it may be wondered whether computational techniques are really required. In fact, Mayshar (1991) is able to provide analytical expressions for a model that is very similar to Stuart's. For a somewhat more general model, Mayshar shows that the formula for the MCF for a separable government project is

$$MCF = 1 + \frac{\eta^c dm/dt - (\eta^c - \eta)}{(1 - m) / m + \eta^c [(1 - \alpha)(1 - m) / m - \alpha(t/m)(dm/dt)] + (\eta^c - \eta)} \quad (2)$$

where à is the elasticity of output with respect to labour, nc and n are the compensated and uncompensated labour supply elasticities, m and t are the marginal and average tax rates on labour income, and dm/dt is the ratio of the differential changes in these rates in the tax reform that generates the marginal tax revenue. For a project that is considered by the consumer to be equivalent to cash, the formula is

$$MCF = 1 + \frac{\eta^c dm/dt}{(1 - m) m + \eta^c [(1 - \alpha)(1 - m) / m - \alpha(t/m)(dm/dt)] + (\eta^c - \eta)} \quad (3)$$

For the case of à = 1 and and a proportional tax with t = m (so that dm/dt = 1), these formulas simplify considerably. The excellent discussion in Mayshar's paper is recommended highly.

So far, I have put the greatest emphasis on the role of elasticities in determining MCFs. However, the initial tax rates are also very important. This is seen most clearly in Hansson and Stuart (1985), which focuses on the Swedish economy. Since tax rates are so high in Sweden, sensitivity analysis with respect to initial tax rates became a natural centerpiece of the Hansson-