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RESEARCH

The marginal value of public funds: a brief guide and application to tax policy

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Abstract

This paper provides a brief and accessible guide to the Marginal Value of Public Funds (*MVPF*) and offers some new perspectives on its application to the evaluation of tax policy. Specifically, the paper aims to: (i) bridge the gap between traditional uses of the Marginal Cost of Public Funds and the growing interest in the *MVPF* approach, (ii) highlight the crucial link between the *MVPF* and tax policy, (iii) critically discuss empirical quantification, particularly with respect to tax elasticities, and (iv) explore distributional considerations and their connection to the literature on optimal redistributive taxation.

Keywords Benefit-cost analysis · Marginal cost of public funds · Excess burden · Distortions · Public goods · Taxation

JEL Classification D61 · H41 · H53 · H21

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1 Introduction

A fundamental question in public economics that has been debated for decades is how the government should allocate resources to public goods. The classical answer, based on Samuelson (1954), is simple: provide public goods until the collective marginal willingness to pay equals the marginal cost of provision. However, this answer assumes that the government can tax and spend without any efficiency loss. In reality, taxation is distortionary and influences the behavior of individuals and firms. The literature on public goods provision in the presence of distortionary taxation, initiated by Pigou (1928), has explored how to adjust the Samuelsonian prescription under the real-world constraints imposed by distortionary tax financing. A key concept in this literature is the Marginal Cost of Public Funds (*MCPF*), which measures the economic cost of raising additional tax revenue to finance public spending.

The *MCPF* concept has been widely used in policy analysis, but it has also been subject to various interpretations and confusions,[1] As a result, its impact in applied economic research has not reached its full potential. Recently, however, it has undergone something of a "revolution" through its reintroduction into the literature by Hendren (2016), Hendren and Sprung-Keyser (2020), and Finkelstein and Hendren (2020) in the form of the Marginal Value of Public Funds (*MVPF*). The *MVPF* embodies Mayshar (1990)'s definition of the *MCPF* (see also (Ballard, 1990) and (Slemrod & Yitzhaki, 2001)), but through a pedagogical approach resolves some of the confusion in the earlier literature and extends the range of applications beyond taxation to a wide range of public expenditure programs, providing an accessible tool for empirical economists to perform welfare calculations.

The purpose of this paper is to provide a guide to the *MVPF* and to offer some new perspectives on evaluating tax policy using this metric. The paper has three specific objectives. First, the paper bridges the gap between traditional applications of the *MCPF* and the emerging interest in the *MVPF* approach, complementing previous accounts such as Hendren (2016). Second, the paper highlights the important link between the *MVPF* and fiscal policy, thereby refocusing attention on the tax side of the government budget, which has been somewhat neglected in recent *MVPF* discourses that focus more on the public expenditure side. In this context, the paper provides a detailed discussion of how the *MVPF* can be quantified using the elasticity of taxable income (ETI), while also discussing how the "sufficiency" of the ETI translates into the adequacy of the ETI for *MVPF* calculations. Third, the paper provides a detailed discussion of how distributional concerns are taken into account in the *MVPF* framework, illustrating the implications of viewing welfare weights as "sufficient statistics" and highlighting the relationship to the literature on optimal redistributive taxation.

[1] The complexity arises from the variety of tax instruments available for financing, the debate over whether the marginal provision of public goods should account for the costs associated with distortionary tax financing (Kaplow, 1996; Slemrod & Yitzhaki, 2001) and how distributional considerations should be integrated (Gahvari, 2006). Jacobs (2018) provides a detailed discussion of the complexities and confusions surrounding the *MCPF* in the earlier literature.

The *MVPF* is a benefit-cost ratio defined as the change in welfare in monetary terms of a policy divided by the change in net government expenditure. The numerator is the willingness to pay of those affected by the policy, while the denominator captures the mechanical change in government spending (holding behavior constant) due to the upfront costs of the project, plus any changes in tax revenues due to behavioral responses that follow the policy. The latter are referred to in the public finance literature as "fiscal externalities" and highlight the importance of accounting for the long-term costs and benefits of projects on future tax revenues in benefit-cost analysis.

In the context of fiscal policy, the *MVPF* for a tax increase captures how the tax change reduces individuals' disposable income, leads to a mechanical increase in tax revenues, and affects tax revenues through individuals' behavior. For a public spending project, the *MVPF* captures individuals' private willingness to pay for the project, the mechanical cost of the project, and the effect of the project on tax revenues through individuals' behavior. Historically, there has been an asymmetry in the sense that the traditional *MCPF* has emphasized the long-term costs due to behavioral responses to taxes, while the long-term effects of public spending projects on the government budget have played a more marginal role. The *MVPF* emphasizes that the welfare measure is the same for spending and tax policies, and they should be given equal weight in assessing the long-term consequences for the government budget.

The decision rule for benefit-cost analysis is simple. If it is proposed to increase spending on a public project P_1 by \$1, the first step is to compute $MVPF_{P_1}$, which describes the welfare effect of spending \$1 more on P_1. In a second step, $MVPF_{P_2}$ is computed, which reflects the welfare effect of raising a tax (or reducing spending on some other project P_2) by \$1 to raise the required revenue. The decision rule is that the policy reform (P_1, P_2) should be undertaken if $MVPF_{P_1} > MVPF_{P_2}$.

A key issue is how to empirically quantify the *MVPF* for different policy reforms, all of which lead to different *MVPF* measures. The *MVPF* for a small tax increase can be expressed in terms of elasticities estimated in the large empirical literature that studies how individuals respond to tax changes. For a proportional increase in the marginal tax rate on labor income that covers all income groups, the simple expression $\frac{1}{1-\frac{t}{1-t}\epsilon_{z,1-t}}$ can be derived, where $\epsilon_{z,1-t}$ is the uncompensated ETI with respect to the net of tax rate (one minus the tax rate) and t is the current tax rate level. Thus, to estimate the *MVPF* for a tax change, one can draw on a wide range of studies that use different identification and estimation strategies to estimate $\epsilon_{z,1-t}$, not just those studies that explicitly calculate the *MVPF*.

However, the translation between tax elasticities and the *MVPF* is not as straightforward as one might think. Therefore, a specific aim of this paper is to critically discuss the empirical quantification of the *MVPF* in the context of tax reforms. In particular, the distinction between compensated and uncompensated tax elasticities is examined. The uncompensated elasticity is relevant for calculating the *MVPF* for a tax reform that finances a public project (e.g., tax-financed infrastructure) because such tax reforms reduce household income. This income effect means that people have incentives to work more to maintain their consumption level, even though the tax increase at the margin makes it less profitable to work. Therefore, one needs to assess the extent to which the elasticity of taxable income captures these income effects. If it doesn't, one can use an external estimate of income effects, for example from recent studies of behavioral responses to lottery winnings.

The taxable income elasticity is often advocated as a "sufficient statistic" for the welfare effects of tax changes (Feldstein, 1995, 1999), but a large literature has qualified this statement, emphasizing the role of extensive margin responses, income shifting, multiple taxes, general equilibrium (price) effects, as well as externalities from components of the tax base, such as charitable contributions, or from the tax base itself, such as environmental impacts (see e.g., (Chetty, 2009; Saez et al., 2012)). These aspects determine whether the *MVPF*, as quantified by the ETI, captures the full range of welfare effects in the context of evaluating tax reforms. In the presence of externalities, one needs to broaden the focus beyond the ETI to include estimating the causal effects of policies on externalities and estimating the marginal willingness to pay for those externalities.

An important point is that only the total causal effect on the government budget is needed to calculate the *MVPF* for past reforms. However, knowledge of the underlying substitution and income effects, as well as the relative importance of the behavioral channels underlying the behavioral response, is important in calculating the *MVPF* for future reforms. Although reduced-form elasticities are local to the economy's current equilibrium (see, e.g., (Kleven, 2021)), being armed with the underlying elasticities (e.g., having access to separate estimates of the elasticity of labor and capital income, not just the sum of the two) allows better predictions of the behavioral effects of future tax reforms, which may be parameterized differently from past ones.

Distributional considerations are at the heart of public policy. How to deal with them in benefit-cost analysis is therefore an important issue. Because of the complexities involved, due to the reliance on social preferences for redistribution and the need to make interpersonal utility comparisons, a large literature has abstracted from distributional concerns altogether.[2] But they are also key to understanding the need for distortionary tax policy, because the reason governments use distortionary taxation is to redistribute income. If the distribution of income did not matter, the government could use a nondistortionary lump sum tax. In addition, many projects benefit one group and are paid for by another, requiring a method of aggregating the costs and benefits of projects that accrue to different taxpayers.

In the presence of distributional considerations, a policy should be implemented if the social value of the gains to those who benefit from the policy exceeds the social costs associated with the increased tax burden on those who must finance it. An appeal of the *MVPF* approach is that one can compute the *MVPF* without taking a position on social welfare weights, using the (unweighted) sum of the willingness to pay of individuals affected by each policy. For example, if the *MVPF* for changing the top tax rate is 1.85 and the *MVPF* for expanding the Earned Income Tax Credit for families with children (EITC) is 1.15, then the government should spend more

2 In fact, much of the early work, such as Mayshar (1990), focused on identical individuals.

on the EITC financed by higher top tax rates if it values \$1.15 for the poor more than \$1.85 for the rich, i.e., if $\eta_{\text{poor}} \cdot 1.15 > \eta_{\text{rich}} \cdot 1.85$, where the η's can be interpreted as welfare weights that can be used to determine whether a policy that has winners and losers should be implemented.

At the same time, it should be noted that these welfare weights depend on the government's preferences for redistribution, the tax instruments available, and how they are optimized. If the current tax system is optimal from a distributional point of view, distributional considerations do not really change the comparison of a project's benefits and costs, because the efficiency costs of a small tax increase are exactly equal to the distributional gains. However, if the current tax system is less redistributive than what the policymaker considers optimal, a small tax increase to finance a public good will generally have a distributional gain because it makes the overall tax system more redistributive.[3] Thus, the welfare weights used in the *MVPF* approach are endogenous and can be affected, for example, by major tax reforms or other policy or economic changes that significantly alter the distribution of welfare in the economy.[4]

The paper is organized as follows. In Sect. 2 I first provide some background by presenting the "traditional" definition of the *MCPF* associated with Stiglitz and Dasgupta (1971) and Atkinson and Stern (1974), clarify the relationship with the other classical welfare measure, the Marginal Excess Burden (*MEB*), and motivate the attractiveness of considering the new *MVPF* measure. In Sect. 3 I introduce the *MVPF* as defined in Hendren and Sprung-Keyser (2020). Section 4 discusses the *MVPF* in the presence of heterogeneous taxpayers and distributional considerations. Section 5 expresses the *MVPF* in terms of elasticities of taxable income, considering both proportional tax changes and changes in the tax rate on top earners. Section 6 discusses how empirical studies can be used to quantify the *MVPF*. Section 7 discusses some limitations of quantifying the *MVPF* for tax reforms using the ETI. Finally, Sect. 8 concludes. Appendix B describes other ways of presenting benefit-cost analysis and relates them to the *MVPF*.

2 Background: from the *MCPF* to the *MVPF*

Before turning to the *MVPF*, it is useful to provide some background on the *MCPF* as discussed by Stiglitz and Dasgupta (1971) and Atkinson and Stern (1974).[5]

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[3] If the current system is more redistributive than what the policymaker considers optimal, a small tax increase will have a distributional cost because it will make the tax system even more redistributive, moving the tax system further away from the policymaker's optimum.

[4] This relates to the point made by Kaplow (1996) that standard welfare measures for evaluating public projects involve distributional considerations that are unrelated to the problem of public goods provision and may be better addressed by reforms of the nonlinear tax and transfer system.

[5] See Dahlby (2008) for a comprehensive textbook treatment.

2.1 The traditional *MCPF*

Traditionally, a large literature has focused on how the classical Samuelson (1954) public goods rule should be modified for the fact that public goods must be financed by distortionary taxes, emphasizing the *MCPF* in the following equation (see, for example, (Ballard & Fullerton, 1992), page 118):

$$\sum_i MRS^i = MCPF \cdot p. \tag{1}$$

Equation (1) describes that in a social optimum, a public good is supplied so that the economy's total private marginal willingness to pay for an additional unit (as measured by the sum of individuals' marginal rates of substitution between that good and the numeraire consumption good, $\sum_i MRS^i$) equals the marginal cost p, adjusted by the *MCPF*. The *MCPF* is widely used by practitioners who, after carefully estimating the effects of a policy, typically make a rough comparison of the benefits to the costs of the program, multiplying the latter by a factor, often thought to be in the range of 1 to 1.5, to capture the economic cost of raising the tax revenue needed to pay for the policy.

The *MCPF* is traditionally thought to reflects three things. First, it reflects the deadweight loss of using a distortionary tax instead of a lump-sum tax, which is usually referred to as the Marginal Excess Burden (*MEB*) (as emphasized by (Pigou, 1928)).[6] Second, it reflects the fact that a tax increase to finance a public good results in a loss of income that makes people poorer, leading to income effects on both labor supply and consumption choices. Third, it captures that a marginal expansion in the provision of public goods has effects on individual behavior that can increase (or decrease) the demand for taxed private goods and services in a way that increases (or decreases) tax revenue from other taxes (such as consumption and capital income taxes).[7]

The *MEB* reflects a thought experiment in which a tax is raised while each taxpayer receives hypothetical compensation in the form of a lump-sum transfer so that they can achieve the same level of utility as before the tax increase.[8] Instead, *MCPF* reflects a thought experiment in which a tax increase is used to finance a public good. In the context of the models studied by Stiglitz and Dasgupta (1971) and Atkinson and Stern (1974), *MEB* and *MCPF* are equivalent when the following two conditions hold: (i) there are no income effects of the tax change on labor supply or the demand for taxed private goods (which happens when there is an untaxed numéraire consumption good that enters the utility function in a linear fashion), and (ii) there are no interactions between the public good and demand for private

[6] In a simple labor supply model, *MEB* is determined by the compensated labor supply elasticity (although the concept has of course been applied much more broadly than just in labor supply models). Classical studies that have examined *MEB* are Harberger (1964, 1974), Browning (1976, 1987), and Hansson (1984).

[7] See Stiglitz and Dasgupta (1971) and Atkinson and Stern (1974).

[8] The *MEB* can be defined both in models with homogeneous individuals and in models with heterogeneous individuals, but in the latter case it relies on hypothetical *individualized* lump-sum taxes/transfers.

goods or labor supply (which happens when the utility function is separable between private goods and the public good).

2.2 Moving to the *MVPF*

The *MCPF* discussed above focuses on the effects of compound, budget-neutral reforms in which taxes and spending are adjusted simultaneously, often implicitly assuming that public spending is financed by adjusting a proportional tax on labor income. In practice, however, there are many ways to finance a public project, and each way will produce a different value of *MCPF*. This has led to *MCPF* being perceived as a confusing concept by academics and practitioners alike.

Traditionally, empirical researchers are instructed to conduct a cost-benefit analysis and "adjust for the MCPF" on the assumption that the *MCPF* reflects both the effects of distortionary tax financing and the effects of spending. However, the *MCPF* as used in practice rarely includes the effect of public spending and instead focuses only on the effect of tax increases. This omission has led to welfare analyses that neglect the effects of government spending,[9]

However, there is another definition of *MCPF* introduced by Mayshar (1990) and developed by Slemrod and Yitzhaki (1996, 2001) and Kleven and Kreiner (2006). This definition was recently revived by the contributions of Hendren (2016), Finkelstein and Hendren (2020), and Hendren and Sprung-Keyser (2020) with the new name *MVPF*. The reason for calling it the marginal "value" of public funds is to distinguish it from the *MCPF*, while also reflecting that it makes more sense to describe the welfare effects of many public spending projects as a "value" rather than a "cost" because they have expected positive effects on social welfare. Recent examples of papers calculating the *MVPF* in the context of public expenditure projects are Angrist et al. (2021), Katz et al. (2022), and Deshpande and Mueller-Smith (2022).

Some papers in the earlier literature, such as Slemrod and Yitzhaki (2001), used two concepts to deal with the complexity of labeling and the expected sign of the welfare effect: a "cost" measure for tax reforms with expected negative welfare effects, and a "benefit" measure for beneficial projects. However, the *MVPF* framework streamlines these into a single welfare metric, thereby simplifying the communication of policy effects. The emphasis on the "value" of projects rather than the "cost" in the *MVPF* framework reflects a focus on applications beyond taxation. However, in the context of tax increases, the term "cost" may still be appropriate.

The *MVPF* is consistent with the conceptual experiment that defines a causal effect of a policy, rather than the combined reforms that simultaneously change taxes and spending. The *MVPF* approach uses separate estimates of the effects of taxes and government spending on the tax base, and therefore gives equal attention to the behavioral effects of public spending projects on tax revenues as it does to the behavioral effects of tax changes on tax revenues. It also allows projects to be

[9] An example is Heckman's Perry Preschool ROI study (Heckman et al., 2010) which accounted for the welfare costs of increased tax revenues but overlooked the subsequent reduction in welfare costs due to the children's higher earnings later in life.

financed in any way, making it easier to compare different projects and to describe how one project is financed by reducing spending on another. The separation in the *MVPF* is particularly useful when spending and financing decisions are made at different times or by different branches of government.[10]

3 The marginal value of public funds (*MVPF*)

3.1 Definition

The *MVPF* is a benefit-cost ratio that reflects individuals' private willingness to pay for a project (or tax change) expressed in dollars, divided by the total cost to the government (including any effects of the project on net government expenditure). It is defined formally below:

$$MVPF = \frac{\text{Change in welfare in monetary terms}}{\text{Change in net government expenditure}}. \tag{2}$$

The *MVPF* can be related to a formal social optimization problem.[11] Consider an economy with n identical agents with utility V, so that social welfare is given by $W = nV$. Let R be net government expenditure (total spending minus total tax revenue). The Lagrangian is $\mathcal{L} = W - \mu R$, where μ is the Lagrange multiplier on the government's budget constraint. Consider a policy parameterized by P_1. The social optimality condition for P_1 is

$$\frac{d\mathcal{L}}{dP_1} = n \cdot \frac{dV}{dP_1} - \mu \frac{dR}{dP_1} = 0.$$

Solving for μ and dividing by the private marginal utility of lump-sum income, denoted by λ, gives

$$\frac{\mu}{\lambda} = \frac{1}{\lambda} \frac{n \cdot \frac{dV}{dP_1}}{\frac{dR}{dP_1}} = \frac{n \cdot WTP_{P_1}}{\frac{dR}{dP_1}} = MVPF_{P_1}, \tag{3}$$

where $WTP_{P_1} = \frac{dV}{dP_1} \Big/ \lambda$ is the willingness to pay out of one's own income for the policy change P_1.

In the literature, a common definition of the traditional *MCPF* in (1) and the Mayshar (1990) *MCPF* in (2) is μ/λ, that is, the ratio between the social marginal utility of income and the private marginal value of private funds. Equation (3) suggests that μ/λ could also be used as a definition of *MVPF*. However, defining the *MVPF* as in (2) is

[10] Appendix B describes other ways of presenting benefit-cost analysis and relates them to the *MVPF*, see also Hendren and Sprung-Keyser (2022).

[11] Note that expression (2) is identical to the *MCPF* defined in Mayshar (1990) (see also (Ballard, 1990)), which takes the form $MCPF = -\frac{\text{Change in welfare in monetary terms}}{\text{Change in net tax revenue}}$, since minus one times the change in net tax revenue equals the change in net government expenditure.

more general because it does not require that policies be optimal, nor does it impose any particular structure on the government's optimization problem or the set of available policy instruments (see also (Håkonsen, 1998), footnote 6).

As described above, the $MVPF$ does not consider budget neutral composite reforms. Instead, if it is proposed to increase spending on a public project G by \$1, the first step is to compute a welfare measure $MVPF_G$ that describes the welfare effect of spending \$1 more on G. In a second step, another welfare measure $MVPF_T$ is computed that reflects the welfare effect of raising a tax (or reducing spending on some other project) by \$1 to raise the required revenue. If the private marginal willingness to pay for G is \$2 and the project expansion increases tax revenue by 50 cents through behavioral responses, then $MVPF_G = \frac{2}{1-0.5} = 4$. Now consider a tax reform that finances the one-dollar cost. Such a tax reform results in a private welfare loss of one dollar, and if we assume that it also reduces tax revenue by 20 cents through behavioral responses, then $MVPF = \frac{-1}{0.2-1} = 1/0.8 = 1.25$. Since $MVPF_G > MVPF_T$, the implementation of the project with the proposed financing implies an increase in social welfare. This decision rule is shown formally below.

Derivation of decision rule To see where the decision rule comes from, consider two projects parameterized by P_1 and P_2, where we can think of P_1 as a spending project and P_2 as a "revenue raising" project. Suppose the government seeks to run a balanced budget given by $R(P_1, P_2) = \bar{R}$ for some constant $\bar{R} > 0$. The first-order welfare effect of changing P_1 by dP_1 and P_2 by dP_2 is:

$$\frac{d\mathcal{L}}{dP_1}dP_1 + \frac{d\mathcal{L}}{dP_2}dP_2 = \left(n\frac{dV}{dP_1} - \mu\frac{dR}{dP_1}\right)dP_1 + \left(n\frac{dV}{dP_2} - \mu\frac{dR}{dP_2}\right)dP_2 \tag{4}$$

$$= \frac{dR}{dP_1}\left(\frac{n\frac{dV}{dP_1}}{\frac{dR}{dP_1}} - \mu\right)dP_1 + \frac{dR}{dP_2}\left(\frac{n\frac{dV}{dP_2}}{\frac{dR}{dP_2}} - \mu\right)dP_2. \tag{5}$$

Normalizing by $\lambda\frac{dR}{dP_1}dP_1$, which is the private marginal value of the increased resource cost following the additional spending on project P_1, where λ is the private marginal utility of income, yields:

$$\frac{\frac{d\mathcal{L}}{dP_1}dP_1 + \frac{d\mathcal{L}}{dP_2}dP_2}{\lambda\frac{dR}{dP_1}dP_1} = \frac{1}{\lambda}\left[\left(\frac{n\frac{dV}{dP_1}}{\frac{dR}{dP_1}} - \mu\right) + \left(\frac{\frac{dR}{dP_2}}{\frac{dR}{dP_1}}\right)\left(\frac{n\frac{dV}{dP_2}}{\frac{dR}{dP_2}} - \mu\right)\frac{dP_2}{dP_1}\right] \tag{6}$$

$$= \frac{n}{\lambda}\left[\left(\frac{\frac{dV}{dP_1}}{\frac{dR}{dP_1}}\right) + \left(\frac{\frac{dR}{dP_2}}{\frac{dR}{dP_1}}\right)\frac{dP_2}{dP_1}\left(\frac{\frac{dV}{dP_2}}{\frac{dR}{dP_2}}\right)\right] - \frac{\mu}{\lambda}\left(1 + \left(\frac{\frac{dR}{dP_2}}{\frac{dR}{dP_1}}\right)\frac{dP_2}{dP_1}\right). \tag{7}$$

Given that the budget must remain balanced, we have that $\frac{dR}{dP_1}dP_1 + \frac{dR}{dP_2}dP_2 = 0$. Then, $\left(\frac{dR}{dP_2}/\frac{dR}{dP_1}\right)dP_2 = -\frac{dP_1}{dP_2}dP_2 = -dP_1$. We thus have:

$$\frac{\frac{d\mathcal{L}}{dP_1}dP_1 + \frac{d\mathcal{L}}{dP_2}dP_2}{\lambda\frac{dR}{dP_1}dP_1} = \frac{\frac{n}{\lambda}\frac{dV}{dP_1}}{\frac{dR}{dP_1}} - \frac{\frac{n}{\lambda}\frac{dV}{dP_2}}{\frac{dR}{dP_2}} = MVPF_{P_1} - MVPF_{P_2}. \tag{8}$$

Note that if P_1 and P_2 are set optimally, the first order conditions of the government's Lagrangian optimization problem $\frac{\frac{n}{\lambda}\frac{dV}{dP_1}}{\frac{dR}{dP_1}} = \frac{\frac{n}{\lambda}\frac{dV}{dP_2}}{\frac{dR}{dP_2}} = \frac{\mu}{\lambda}$ imply that (8) is zero. This captures the fact that in an optimal tax and spending system, the *MVPF* is equal for all policy changes.

Empirically observed differences in the *MVPF* across policies Empirically, however, if we were to calculate the *MVPF* for various actual policy changes, we would find large differences. These differences can be explained in several ways. One explanation is that different policies affect different groups of individuals, and the government may assign different welfare weights to these groups. We will explore these distributional considerations further in Sect. 4. Alternatively, differences in *MVPF* may arise because the government does not always set policies optimally from a social welfare perspective. Thus, in practice, variations in *MVPF* across policies provide insights not only into the welfare effects of policies, but also into the political economy underlying these projects. For example, the *MVPF* approach emphasizes the long-term effects of public spending projects on government tax revenues. However, if these benefits accrue far in the future, they may not be taken into account by politicians who may have a more short-term perspective.[12]

3.2 The *MVPF* in a simple labor supply model

Let us now relate the *MVPF* to the standard static labor supply model studied extensively in labor economics and public finance (see, e.g., (Blundell & Macurdy, 1999)). We abstract from consumption taxes, and assume that leisure is a normal good (i.e., individuals demand more leisure as income increases, ceteris paribus). The economy consists of n identical individuals, each with an hourly wage w, who choose their labor supply h so as to maximize individual welfare. We postpone differences between individuals to Sect. 4. The production technology is linear (one hour of work increases the output of the economy by w units) and there is perfect competition.

We consider a small change in a proportional tax rate. Since the tax change is small, the direct welfare effect can be approximated by the reduction in disposable income. The tax change also affects individuals' labor supply, but since the tax change is small, this behavioral change will have a negligible effect on individuals' welfare. This follows from the envelope theorem.

Before the tax increase, each individual had an income of wh and the tax increase of dt therefore implies a reduction in disposable income of $wh \cdot dt$ and a welfare change

[12] In addition, in practice, it is desirable but difficult to capture the full range of costs associated with public projects, including crowding out of private investment, distortions of market competition, and inefficiencies in public procurement, which may be only partially captured by the impact on tax revenues (see the discussion in Sect. 7).

equal to $-wh \cdot dt$ in monetary terms. Turning to the denominator, the contribution of each individual to government tax revenue is twh and the change in net government expenditure is thus $-\frac{d(twh)}{dt} \cdot dt$. We can therefore write (2) in the following way:

$$MVPF_{\text{prop. tax}} = \frac{-wh \cdot dt}{-\frac{d(twh)}{dt} \cdot dt} = \frac{wh \cdot dt}{(wh + tw\frac{dh}{dt}) \cdot dt} = \frac{1}{1 + \frac{t}{h}\frac{dh}{dt}} = \frac{1}{1 + \epsilon_{h,t}}, \tag{9}$$

where in the last step we have expressed $MVPF$ in terms of an elasticity. It can be seen that $MVPF$ is a decreasing function of $\epsilon_{h,t}$, the uncompensated elasticity of labor supply with respect to t. Thus, whether $MVPF$ is greater or less than one depends on whether $\epsilon_{h,t}$ is negative or positive. A tax increase distorts labor supply, but at the same time has a positive income effect that increases tax revenues.

The $MVPF$ in (9) can also be formally derived from a social optimization problem. Suppose that individuals choose consumption (c) and labor supply (h) in order to maximize their utility $u(c, h, G)$, where utility also depends on the level of a public good G. The budget constraint is given by $y + p_w h - p_c c = 0$ where $p_w = (1-t)w$ is the after-tax wage and y is non-labor income (e.g. wealth or partner income). We normalize the price and tax of consumption to 1, i.e., $p_c = 1$. The indirect utility function $V(p_w, y, G)$ is the value function to the *individual* optimization problem with the following Lagrange function:

$$\mathcal{H} = u(c, h, G) + \lambda(y + p_w h - p_c c), \tag{10}$$

where λ is the shadow price (Lagrange multiplier) of the individual budget constraint. Let $h(p_w, y, G)$ denote the Marshallian demand for h (the uncompensated labor supply function). The government maximizes the welfare of individuals by choosing the tax rate t and the level of the public good G, subject to the government's budget constraint $R = p_G \cdot G - n \cdot twh(p_w, y, G)$, where the marginal production cost of the public good is assumed to be equal to p_G. This results in the following Lagrange function for the government optimization problem:

$$\mathcal{L} = n \cdot V(p_w, y, G) - \mu[p_G \cdot G - n \cdot twh(p_w, y, G)], \tag{11}$$

where μ denotes the shadow price (Lagrange multiplier) of the government budget constraint. By exploiting the individuals' Lagrange function (10) to compute $\frac{dV}{dp_w}$ while using the envelope theorem, we obtain that the first-order condition for the government optimization problem with respect to t is:

$$\frac{d\mathcal{L}}{dt} = \frac{dV}{dp_w}\frac{dp_w}{dt} + \mu\left[wh + tw\frac{dh}{dt}\right] = (\lambda h)(-w) + \mu\left[wh + tw\frac{dh}{dt}\right] = 0. \tag{12}$$

If we divide by λhw and rearrange, we get

$$\frac{\mu}{\lambda}\left[1 + \frac{t}{h}\frac{dh}{dt}\right] = 1 \quad \Longleftrightarrow \quad MVPF_{\text{opt. prop. tax}} = \frac{\mu}{\lambda} = \frac{1}{1 + \epsilon_{h,t}}, \tag{13}$$

which is the same expression that we found in (9). Thus, in this case, the *MVPF* in (2) and μ/λ is the same, but this will not always be the case (see the discussion in Sect. 3).

We can also derive the policy rule for the public good. By taking the first-order condition with respect to G in (11) we get:

$$\frac{d\mathcal{L}}{dG} = n\frac{dV}{dG} - \mu\left[p_G - n \cdot tw\frac{dh}{dG}\right] = 0.$$

By dividing by λ and rearranging we get:

$$n\frac{dV/dG}{\lambda} = \frac{\mu}{\lambda}\left[p_G - n \cdot tw\frac{dh}{dG}\right].$$

If we denote $MRS^i = \frac{dV/dG}{\lambda}$ and exploit the fact that, since G is optimally chosen, $MVPF = \frac{\mu}{\lambda}$ according to (3), we get:

$$\sum_i MRS^i = MVPF \cdot \left[p_G - n \cdot tw\frac{dh}{dG}\right]. \tag{14}$$

Expression (14), which coincides with equation (3) in Atkinson and Stern (1974), illustrates that, in the context of the simple labor supply model here, and assuming optimal policies, the *MVPF* is identical to the traditional *MCPF* in (1) if $\frac{dh}{dG} = 0$. A necessary and sufficient condition for this to hold is that the utility function u can be written in the form $u(c, h, G) = u(f(c, h), G)$ for any subutility function f (i.e., the utility function is weakly separable between G and other goods). When the utility function can be written in this form, the marginal rate of substitution between labor and consumption is independent of the public good.[13]

Note that the "traditional way" would be to consider a composite tax and spending reform and insert $MVPF = \frac{1}{1+\epsilon_{h,t}}$ into (14). However, the *MVPF* approach does not do this. Instead, a researcher or practitioner considering increased spending on a project G should construct $MVPF_G = \frac{\sum_i MRS^i}{p_G - n \cdot tw\frac{dh}{dG}}$ of that policy so that it can be compared to all possible ways of raising money for that project (e.g., the *MVPF* of a revenue-raising tax reform or any other policy for which spending can be reduced).

3.3 Other reforms

So far, we have discussed adjustments to the tax on labor income. Of course, it is also possible to find expressions for the *MVPF* for other reforms that can be used to raise funds to pay for public projects.

Consumption taxation One possibility is to close the budget constraint by increasing the consumption tax. In the context of the simple labor supply model considered in Sect. 3.2, we could alternatively have normalized the tax on labor income

[13] Note that in a richer model with different consumption goods and different commodity taxes, the effects of G on commodity tax revenues would also appear in (14), see Atkinson and Stern (1974).

to zero ($t = 0$) and set the price of consumption equal to $p_c = 1 + \tau_c$ and derived the *MVPF* for the ad valorem tax rate τ_c.[14] Using a derivation similar to Eq. (9), we get

$$MVPF_{\text{cons. tax}} = \frac{-c \cdot d\tau_c}{-\frac{d([1+\tau_c]c)}{d\tau_c} \cdot d\tau_c} = \frac{c}{c + \tau_c \frac{dc}{d\tau_c}} = \frac{1}{1 + \epsilon_{c,t}}, \tag{15}$$

where $\epsilon_{c,t}$ is the uncompensated elasticity of consumption c with respect to τ_c. Note that in general $\epsilon_{c,t} \neq \epsilon_{h,t}$, which means that the *MVPF* for the consumption tax is different from the *MVPF* for the labor income tax. For example, in the Cobb-Douglas case $\epsilon_{h,t} = 0$ while $\epsilon_{c,t} < 0$, see Håkonsen (1998). The sensitivity to the choice of normalization is well recognized in the literature. The intuition provided by Atkinson and Stern (1974) is that the income effect of taxation reduces the revenue from a consumption tax, given the normality of consumption, but increases the revenue from a labor income tax, given the normality of leisure.

It may seem strange that the *MVPF* for the labor income tax and the consumption tax are different, even though these policy instruments are equivalent from a social welfare perspective. In the context of the model examined in Sect. 3.2, we would get the same allocation and the same level of social welfare whether we taxed consumption with an ad valorem rate of τ_c or whether we taxed labor income with a rate of $1 - \frac{1}{1-\tau_c}$.[15] However, the usefulness of the *MVPF* derives from its ability to evaluate reforms to existing suboptimal tax systems (in an optimal tax system, the *MVPF* are equal for all tax reforms, recall the discussion following Eq. 8 on page 9). In the context of suboptimal tax systems, the welfare effect of a tax change depends on which tax is changed and how all other pre-existing taxes are set.

Here, we have limited our attention to a uniform consumption tax (such as a change in the standard VAT rate). Alternatively, we could have examined a multi-commodity framework and considered a change in a specific commodity tax, such as an increase in the excise tax on children's toys. However, it is questionable whether it is a good idea to finance public projects with individual commodity taxes, since this creates distortions in people's consumption patterns, unless there are negative externalities that one wants to counter at the same time (such as in the case of excise taxes on alcohol or carbon dioxide emissions).

Capital taxation Another possibility is to adjust taxes on capital, such as the capital income tax or the corporate income tax. In this case, other models are needed to study the *MVPF* (taking into account dynamic aspects such as savings behavior). I do not discuss such models here, but note that in such approaches the *MVPF* would include other elasticities for which we have limited empirical knowledge.

Reduced spending on other projects To close the budget constraint, one must not only consider tax policy, but can also think about financing a public project by reducing public spending. Hendren and Sprung-Keyser (2020) present over 100 estimates of the *MVPF* for various methods of spending and raising revenue, compiled

[14] Note that without normalizing one of the tax instruments, the social optimization problem would not be well defined because there would be a redundancy of tax instruments.

[15] See Bastani and Koehne (2024) for details and further discussion of the equivalence between labor and consumption taxation.

in their "policy impacts" library for historical policy changes in the United States (https://policyimpacts.org/policy-impacts-library). They point out the desirability of broadening the empirical goal from thinking only about estimating "the MVPF" to creating a library of estimates that allows researchers to think about raising revenue from different sources.

3.4 The *MVPF* and open economy issues

The standard MVPF calculation applies to a single national government operating in a closed economy. This ignores two issues: (i) that the *MVPF* may be different for local and federal policies, and (ii) strategic competition between governments for mobile tax bases.

Local vs. federal policy Agrawal et al. (2023) present a framework for assessing the welfare implications of local government policies that have effects transcending local boundaries in the form of mobility, cross-jurisdictional fiscal externalities, and spillovers—effects typically overlooked by the local governments implementing the policies (see (Agrawal et al., 2022) for a recent review of research on local government policy choices). The authors propose the concept of a Marginal Corrective Transfer (MCT), a fiscal mechanism designed to incentivize local governments to consider the cross-jurisdictional effects of their policies. It is calculated by determining the discrepancy between a "local" *MVPF* and an "external" *MVPF*.[16] The authors find that local policies such as property tax reductions and investments in education tend to produce positive MCT figures, suggesting that they should be financially supported by the federal government. In contrast, property tax cuts and competitive business incentives tend to create a harmful "race to the bottom," as reflected in their negative MCT scores, and instead warrant federal discouragement.

International tax competition A substantial body of work discusses how governments strategically compete with tax policy for a mobile tax base. In the context of optimal tax policy, this has been studied by Gordon and Cullen (2012) and Lehmann et al. (2014). This line of research suggests that when a national government considers changing a tax rate, it should consider how other countries will react to that tax change. An interesting area for future research is to incorporate such considerations into *MVPF* calculations. Note that the standard *MVPF* framework integrates mobility/migration margins by including these responses as part of the overall behavioral response to a tax change (see Sect. 7.4), but it does not account for potential strategic interactions between governments. Welfare calculations in this context typically require assumptions about how a national government values the welfare of citizens and non-citizens.

[16] The local *MVPF* measures the willingness to pay of local residents and the impact on the budget of the jurisdiction itself, while the external *MVPF* reflects the willingness to pay and the financial impact on neighboring jurisdictions when a competing jurisdiction changes its policies. For example, while spending on education may benefit people from outside the jurisdiction, it may also cause population shifts from nearby areas, which can affect the prices and costs associated with providing public services in those areas.

4 Distributional considerations

So far, we have focused on economies with identical individuals. This means that we have neglected the distributional effects of tax changes or public spending projects. In principle, the general definition in (2) allows for differences between individuals, although it makes no reference to the fact that the social welfare function may assign different weights to the welfare of different individuals. We now want to make these considerations explicit. In Sect. 4.1, we first discuss the most common way to define the traditional *MCPF* in the presence of distributional concerns in the prior literature. This is helpful in understanding how distributional concerns can be easily incorporated into the *MVPF* framework, which is the subject of Sect. 4.2.

4.1 Background: the traditional *MCPF* with distributional concerns

The most common way to define the traditional *MCPF* in the presence of distributional aspects is a generalization of (3) as follows (see, for example, (Johansson-Stenman, 2005; Gahvari, 2006), and (Kleven & Kreiner, 2006)):

$$MCPF = \frac{\mu}{\sum \pi^i \lambda^i}. \tag{16}$$

In the numerator we have the social marginal value of public funds, and in the denominator we have the marginal utility λ^i of different individuals in the economy, weighted by each individual's importance in the social welfare function, π^i.[17]

The social marginal value of public funds μ is derived from a social optimization problem that includes distributional considerations (hence it is different from the μ in Eq. 3). Let $W = \sum_i \pi^i V^i$ denote social welfare, where V^i is the indirect utility of individual i, and let R denote net government spending (spending minus taxes). Then consider a small change in policy, captured by the parameter P (reflecting, for example, a change in public spending on a project or a change in the tax-transfer system). Taking the first-order condition of the Lagrangian expression $\mathcal{L} = W - \mu R$ w.r.t. P yields:

$$\mu = \frac{\frac{dW}{dP}}{\frac{dR}{dP}} = \frac{\sum_i \pi^i \frac{dV^i}{dP}}{\frac{dR}{dP}} = \frac{\sum_i \pi^i \lambda^i \left(\frac{dV^i}{dP} \Big/ \lambda^i\right)}{\frac{dR}{dP}} = \frac{\sum_i \pi^i \lambda^i WTP_P^i}{\frac{dR}{dP}}, \tag{17}$$

where $WTP_P^i = \frac{dV^i}{dP} \Big/ \lambda^i$. Insertion into (16), yields:

$$MCPF = \frac{\sum_i \pi^i \lambda^i WTP_P^i}{\frac{dR}{dP} \cdot \left(\sum_i \pi^i \lambda^i\right)}. \tag{18}$$

Note that in a setting where individuals are heterogeneous, the willingness to pay WTP_P^i for a policy change will vary from person to person. For example, a

[17] See Jacobs (2018) for an alternative definition.

proportional labor income tax increase would result in a heavier tax burden for those with higher incomes than for those with lower incomes. It's also important to note that both the numerator and the denominator of (18) depend on π^i and λ^i. Consequently, the *MCPF*, as defined in the context of heterogeneous agents, depends not only on the redistributive goals of policymakers, but also on the available tax instruments. Appendix A provides a brief survey of the optimal tax literature that has calculated *MCPF* in the presence of distributional concerns, showing that *MCPF* defined in this way can generally be both less than and greater than one.

4.2 Distributional concerns in the *MVPF* framework

In the presence of heterogeneous individuals and distributional concerns, the *MVPF* is still defined as in (2), but the change in welfare in the numerator refers to the total (unweighted) willingness to pay of the affected individuals $\sum_i WTP^i$:

$$MVPF_P = \frac{\sum_i WTP^i_P}{\frac{dR}{dP}}, \tag{19}$$

where P denotes the policy being implemented, and the denominator is, as before, the change in net government spending, denoted by $\frac{dR}{dP}$. Apart from the normalization by $\sum_i \pi^i \lambda^i$, the difference between *MCPF* in (18) and *MVPF* in (19) is that the willingness to pay in the numerator of (19) is unweighted and does not include the distributional weights $\pi^i \lambda^i$. Thus, the *MVPF* is defined without taking a position on the social welfare weights.

To see where the distributional weights come into play in the *MVPF* framework, note that Eq. (17) can be rewritten as follows:

$$\begin{aligned} \mu = \frac{\frac{dW}{dP}}{\frac{dR}{dP}} = & \frac{\sum_i \pi^i \lambda^i WTP^i_P}{\frac{dR}{dP}} \cdot \frac{\sum_i WTP^i_P}{\sum_i WTP^i_P} = \sum_i \pi^i \lambda^i \frac{WTP^i_P}{\sum_i WTP^i_P} \cdot \frac{\sum_i WTP^i_P}{\frac{dR}{dP}} \\ = & \eta \cdot MVPF_P, \end{aligned} \tag{20}$$

where

$$\eta = \sum_i \pi^i \lambda^i \frac{WTP^i_P}{\sum_i WTP^i_P}, \tag{21}$$

is the average social marginal utility of private income weighted by the economic incidence $\frac{WTP^i_P}{\sum_i WTP^i_P}$ of policy P.

Equation (20) shows that the (unweighted) *MVPF* in (19) can be multiplied by η to convert from units of recipient income (i.e., the willingness to pay of those targeted by the policy) to units of social welfare. For example, suppose the *MVPF* for changing the top tax rate is 1.85 and the *MVPF* for expanding the Earned Income Tax Credit for families with children (EITC) is 1.15. This means that the government should spend more on the EITC financed by higher top tax rates if it values \$1.15 for the poor more than \$1.85 for the rich, i.e., if $\eta_{\text{poor}} \cdot 1.15 > \eta_{\text{rich}} \cdot 1.85$.

Conversely, if we observe that a government expands the EITC financed by increases in top tax rates, we can infer that $\frac{\eta_{\text{poor}}}{\eta_{\text{rich}}} > \frac{1.85}{1.15}$. In this way, the *MVPF* framework is related to the "inverse optimal tax" literature which attempts to derive the social weights that would rationalize the current tax schedule as optimal.[18] In a social optimum, $\frac{MVPF_{P_A}}{MVPF_{P_B}} = \frac{\eta_{P_A}}{\eta_{P_B}}$ for any policies P_A and P_B targeting income groups A and B, respectively. Thus, the *MVPF* allows capturing the key insight of the Mirrlees (1971) framework that redistribution is costly and that the costs of redistribution differ along the income distribution.

4.3 The endogenous nature of η

Equation (20) shows that $\eta = \sum_i \pi^i \lambda^i \theta^i$ is a factor that translates the willingness to pay of those affected by a policy into units of social welfare, where the economic incidence is denoted by $\theta^i = \frac{WTP^i}{\sum_i WTP^i}$. It is important to note, however, that while the weights η can be inferred from observed policy choices, they are not structural parameters. Rather, they are "sufficient statistics" since η depends on three things: (i) social preferences for redistribution, captured by π^i, (ii) the distribution of private marginal utility, captured by λ^i, and (iii) the economic incidence of the policy, captured by θ^i.

To illustrate, it is useful to consider an example. Suppose we consider an increase in spending on a public good G, financed by an increase in a proportional tax on labor income t. In the *MVPF* framework (with distributional concerns), the decision rule for engaging in the provision of such a public good, using the proposed financing scheme, is as follows:

$$\eta_G MVPF_G > \eta_t MVPF_t. \tag{22}$$

One appeal of the *MVPF* approach is that one can compute $MVPF_G$ and $MVPF_t$ using Eq. (19) without taking a position on social welfare weights. After computing these distribution-free quantities, one can use (22) to apply the corresponding weights η_G and η_t, which capture the weight the social planner attaches to the beneficiaries of the project G and to those affected by the tax increase used to finance it. However, it is useful to expand the inequality (22) in terms of its underlying components.

We have by (20), assuming no behavioral effects of G, that

$$\eta_G MVPF_G = \frac{\sum_i \pi^i \lambda^i WTP^i_G}{\frac{dR}{dG}} = \frac{\sum_i \pi^i \lambda^i WTP^i_G}{p_G}, \tag{23}$$

[18] For contributions to the inverse optimal tax literature, see, for example, Christiansen and Jansen (1978), Bourguignon and Spadaro (2012), Bargain et al. (2014), Lockwood and Weinzierl (2016), Jacobs et al. (2017), Bastani and Lundberg (2017), and Hendren (2020).

$$\eta_t MVPF_t = \frac{\sum_i \pi^i \lambda^i WTP_t^i}{\frac{dR}{dt}} = \frac{-\sum_i \pi^i \lambda^i w^i h^i}{-\frac{d}{dt}[t \sum_i w^i h^i]} = \frac{\sum_i \pi^i \lambda^i w^i h^i}{\sum_i w^i h^i [1 + \frac{t}{h^i} \frac{dh^i}{dt}]}$$
$$= \frac{\sum_i \pi^i \lambda^i w^i h^i}{\sum_i w^i h^i [1 + \epsilon_{h^i,t}]}, \tag{24}$$

where $\epsilon_{h^i,t} = \frac{t}{h^i} \frac{dh^i}{dt}$. The decision-rule (22) can thus be written:

$$\sum_i \pi^i \lambda^i WTP_G^i > p_G \frac{\sum_i \pi^i \lambda^i w^i h^i}{\sum_i w^i h^i [1 + \epsilon_{h^i,t}]}. \tag{25}$$

Note that in a homogeneous agent setting we would have $\pi^i = \pi$, $\lambda_i = \lambda$, and $w^i = w$, implying that (25) would simplify to $\sum_i WTP_G^i > p_G \frac{1}{1+\epsilon_{h,t}}$, which is identical to the policy rule for public good provision derived in Eq. (14), if we apply the expression for the *MVPF* for a proportional tax derived in Eq. (9). However, in a heterogeneous agent setting, as shown in (25), the distributional effects of G and the distributional effects of the financing tax reform play an important role due to the weighting by $\pi^i \lambda^i$ on both the LHS and RHS.

To illustrate (25), suppose there are two groups, "disabled" and "non-disabled", with market productivities $w^1 = 0$ and $w^2 > 0$, respectively, and $WTP_G^1 > 0$ and $WTP_G^2 = 0$ (disabled agents earn no income but value the public good, while non-disabled agents earn positive income but derive no utility from the public good). Suppose further that the social welfare function is utilitarian, $\pi^1 = \pi^2 = 1$. Then we can write (25) as:

$$WTP_G^1 \cdot \underbrace{\frac{\lambda^1}{\lambda^2}}_{\text{distributional gain}} > p_G \cdot \underbrace{\frac{1}{1 + \epsilon_{h^2,t}}}_{\text{efficiency cost}}. \tag{26}$$

In an optimal tax (and expenditure) system, (26) holds as an equality (since in an optimal tax system, any proportional tax change combined with public good adjustments cannot increase social welfare). In the presence of an optimal nonlinear tax on labor income, as shown by e.g., Boadway and Keen (1993) and Gauthier and Laroque (2009), optimal public goods provision under the above separability assumption implies $WTP_G^1 = p_G$. This implies $\frac{\lambda^1}{\lambda^2} = \frac{1}{1+\epsilon_{h^2,t}}$. However, if the income tax is not optimal, distributional considerations will affect the benefit-cost rule. Based on the above analysis, three cases can be distinguished for a small tax increase to finance a public good:

1. If the current tax system is optimal, the efficiency cost of the tax change is exactly equal to the distributional gain ($\frac{\lambda^1}{\lambda^2} = \frac{1}{1+\epsilon_{h^2,t}}$ and $WTP_G^1 = p_G$).
2. If the current tax system is less redistributive than what the policymaker considers optimal, the distributional gain from the tax change exceeds the efficiency cost ($\frac{\lambda^1}{\lambda^2} > \frac{1}{1+\epsilon_{h^2,t}}$ and $WTP_G^1 < p_G$).

3. If the current system is more redistributive than what the decision maker considers optimal, the tax change will have a distributional cost (the redistributive efficiency of the tax system moves even further away from the decision maker's optimum), which is added to the efficiency cost of the tax change ($\frac{\lambda^1}{\lambda^2} < \frac{1}{1+\epsilon_{h^2,t}}$ and and $WTP^1_G > p_G$).

Consequently, the welfare weights applied in the *MVPF* framework are not fixed; they are endogenous and subject to the influence of policy changes, such as tax reforms, or economic events that redistribute welfare across the economy. This relates to a criticism made by Kaplow (1996), building on the work of Hylland and Zeckhauser (1979), that the approach discussed above runs the risk of assigning a role to distributional considerations that is unrelated to the problem of public goods provision, but can instead be addressed by reforms to the flexible nonlinear tax and transfer system. The endogenous nature of welfare weights is also related to Slemrod and Kopczuk (2002b), who note that taxable income elasticities are not exogenous but rather endogenous and partly under the control of the government, as well as to the general discussion in Kleven (2021) about the endgeonous nature of the determinants of optimal tax formulas based on the sufficient statistics approach.

4.4 Policies that pay for themselves and Pareto improvements

Since there may be disagreement about the appropriate welfare weights for different policy contexts, it is useful to identify policies that are self-financing or offer Pareto improvements. Hendren and Sprung-Keyser (2020) define the *MVPF*, based on (19), as infinite for any policy where the total willingness to pay is positive and the net cost to the government is negative. In this case, the policy pays for itself; positive fiscal externalities from behavioral responses generate revenues that exceed the mechanical cost of the policy. Note that when the total willingness to pay is positive, the winners could in principle compensate the losers through individualized lump-sum transfers, consistent with the concept of Kaldor-Hicks improvement (Kaldor, 1939; Hicks, 1939).

If one additionally assumes that each individual has a non-negative willingness to pay (with at least one individual having a strictly positive willingness to pay), then a policy with an infinite *MVPF* provides a Pareto improvement. For example, this is typically thought to be the case for a self-financing income tax cut (if the current tax rate is above the peak of the Laffer curve). Finally, note that if the net cost to the government is negative, additional resources are created. These resources could be redistributed to agents through uniform lump-sum transfers, helping to achieve Pareto improvements. However, as discussed earlier, the *MVPF* does not consider budget-neutral policy experiments.[19]

[19] Bierbrauer et al. (2023) develop a framework for finding Pareto improvements in nonlinear tax-transfer systems, focusing on budget-neutral one- or two-bracket tax reforms.

5 Expressing the *MVPF* in terms of the ETI

We now turn to expressing the *MVPF* for tax changes in terms of the elasticity of taxable income (ETI), which is often estimated in empirical work (Saez et al., 2012). In Sects. 5.1 and 5.2 I derive expressions for the *MVPF* for two types of tax reforms that can be used to raise tax revenue to finance public projects, involving either a change in a proportional tax rate or a tax on top earners.

5.1 A proportional tax change

To relate the *MVPF* to modern estimates of behavioral responses to taxation, it is useful to express (2) in terms of the elasticity of taxable income $z = wh$ with respect to one minus the marginal tax rate (the net-of-tax rate). We see that:

$$MVPF = \frac{-z \cdot dt}{-\left(z - t\frac{dz}{d(1-t)}\right) \cdot dt} = \frac{1}{1 - \frac{(1-t)}{(1-t)}\frac{t}{z}\frac{dz}{d(1-t)}} = \frac{1}{1 - \frac{t}{1-t}\epsilon_{z,1-t}}. \tag{27}$$

Note that above I have considered a marginal increase in income tax (which applies to everyone) and the elasticity $\epsilon_{z,1-t} = \frac{1-t}{z}\frac{dz}{d(1-t)}$ should be interpreted as the average elasticity of taxable income in the working population. However, one can consider a tax change only for a particular income group, and then a different measure of *MVPF* is obtained. In Sect. 5.2 below, I derive *MVPF* for an increase in the tax on labor income for high-income (top) earners. As discussed earlier (see Sect. 3.1), only in an optimal tax system is *MVPF* the same for different sources of marginal financing.

5.2 A change in the tax on top earners

Suppose that agents are heterogeneous in terms of their income and we increase the marginal tax rate by dt only above a certain income level $\bar{z}$. We assume that in the initial situation everyone faces the same tax rate t so that the result of the reform is a piece-wise linear tax schedule where taxpayers face tax rate t up to the income level $\bar{z}$ and face tax rate $t + dt$ above that (for $z > \bar{z}$). Such a reform has exactly the same effects on individuals with incomes $z \geq \bar{z}$ as a two-part reform with two components: (i) a marginal tax increase of dt on incomes from $z = 0$ to $z = \infty$, and, (ii) a lump-sum compensation with size $\bar{z}dt$. The second component is necessary because a tax increase that covers only a portion of income does not make individuals as much poorer as a tax increase that covers all income. Saez (2001) shows how the income change to this reform for an individual with initial income z can be written as

$$dz = \frac{\partial z}{\partial(1-t)}dt + \frac{\partial z}{\partial y}\bar{z}dt = -(\epsilon_{z,1-t}z - \zeta\bar{z})\frac{dt}{1-t},$$

and that the total reduction in tax revenue can be written (where $\mathbf{E}_{z>\bar{z}}$ means that we take an average over all individuals with income higher than $\bar{z}$)

$$\mathbf{E}_{z>\bar{z}}[t \cdot dz] = -t \cdot (\bar{\epsilon}_{1-t} z_m - \bar{\zeta}\bar{z}) \frac{dt}{1-t},$$

where z_m is the average income among top income earners, $\bar{\epsilon}_{1-t}$ is the average uncompensated elasticity among top income earners, and $\bar{\zeta}$ is the average income effect for individuals with incomes higher than $\bar{z}$. We can use this to derive an expression equivalent to (27) but which applies to a tax increase dt only for individuals with incomes above $\bar{z}$:

$$\begin{aligned} MVPF_{\text{opt. top tax rate}} &= \frac{(z_m - \bar{z}) \cdot dt}{(z_m - \bar{z}) \cdot dt - t \cdot (\bar{\epsilon}_{1-t} z_m - \bar{\zeta}\bar{z}) \frac{dt}{1-t}} \\ &= \frac{1}{1 - \frac{t}{1-t} \cdot (\bar{\epsilon}_{1-t} \cdot a - \bar{\zeta} \cdot b)}, \end{aligned} \tag{28}$$

where $a = \frac{z_m}{z_m - \bar{z}}$ is the so-called "Pareto parameter" which is a measure of how "thin" the distribution of high incomes is above a certain level $\bar{z}$ (which is the level of income above which the tax is raised) and $b = \frac{\bar{z}}{z_m - \bar{z}}$ reflects how much of the total income is not subject to the tax increase (how much of the income is infra-marginal to the tax increase). Note that if $\bar{z} = 0$ so that the tax reform covers all income, $a = 1$ and $b = 0$ which means that (28) becomes identical to (27).[20]

Bastani and Lundberg (2017) study the distribution of income in Sweden locally over a limit $\bar{z} = 3 \cdot z_{avg}$ where z_{avg} is the average labor income in the economy. They find that a ranged between 3 and 4 over the period 1971–2012. If we set $a = 3$, it necessarily follows that $z_m = 4.5 \cdot z_{avg}$. This in turn implies that $b = \frac{3 \cdot z_{avg}}{4.5 \cdot z_{avg} - 3 \cdot z_{avg}} = 2$. However, for a country with a much thicker tail of the income distribution, such as the US, the results would be different (for the US, a common estimate of the Pareto parameter is 1.5, see (Lundberg, 2024) for a cross-country comparison of Pareto parameters at the top of the income distribution). Thus, just as elasticities can vary across countries, so can other parameters, with implications for the magnitude of the *MVPF* for tax changes.

6 Empirical quantification using the ETI

Let us now turn to the empirical quantification of the *MVPF* in the context of financing tax reforms and the elasticity of taxable income (ETI). Section 6.1 discusses empirical estimates of the ETI, Sect. 6.2 discusses income effects on labor supply, and Sect. 6.3 discusses implications.

Note that if we are interested in calculating the *MVPF* for a tax reform that has already taken place, there is no need to decompose into income and substitution effects, since the denominator of the *MVPF* is determined by the causal effect of the

[20] Saez et al. (2012), page 8, calculate *MCPF* for a tax increase on top incomes without taking into account income effects and finds that $MCPF^{\text{top}} = \frac{1}{1 - \frac{t}{1-t} \cdot a \cdot e}$ where e is the compensated elasticity of taxable income. We get exactly the same expression if we put $\zeta = 0$ and $\bar{\epsilon}_{1-t} = e$ in Eq. (28).

policy on the tax base. However, if we are interested in a public spending project and are considering a new tax reform to finance it, we need to carefully analyze which income groups are affected and to what extent the financing tax reform involves changes in marginal incentives to earn income (substitution effects) and to what extent the financing tax reform involves non-marginal changes that lead to changes in disposable income (i.e., changes in "virtual income") and thus income effects on the decision to earn income. This is a fundamental difference between calculating *MVPF* for public expenditure projects and calculating *MVPF* for tax changes. The provision of a public good does not change an agent's disposable income and therefore has no income effects, whereas tax changes do.[21]

6.1 Elasticities of taxable income

Formula (27) and (28) contain the ETI. There is a large empirical literature estimating this parameter, and an introduction to this literature is provided by Saez et al. (2012). In general, elasticities of taxable income differ across studies, depending on the nature of the tax reform, the estimation approach used, the country studied, and the income groups affected. A meta-analysis of recent studies is provided by Neisser (2021).[22] For example, based on Swedish, Danish and Finnish tax reforms that affected broad groups of taxpayers, an elasticity of 0.2 could be deemed as reasonable.[23]

In the current context, it is important to note that what goes into (27) is the elasticity resulting from a thought experiment where the marginal tax rate is increased in a proportional tax system without compensating households in the form of increased (monetary) transfers. Such a reform has a negative substitution effect that is counteracted by a positive income effect (under the reasonable assumption that individuals demand less leisure and more work when income falls). Thus, when interpreting elasticities estimated using tax reforms, it is important to keep in mind that different tax reforms differ both in which income groups are affected and in the relative importance of income and substitution effects. For example, armed with an elasticity estimated using a reform that affected broad groups of taxpayers, one should use the formula (27), whereas if the reform involved tax changes only for high-income earners, then the formula (28) should be used instead. For more complex reforms, other formulas would need to be derived.

One complicating factor, of course, is the progressive (nonlinear) income tax system. Suppose we are studying high-income earners who are at the beginning of the second segment of a piecewise linear tax schedule, and the tax change under consideration is a lower marginal tax on low incomes combined with an increase

[21] The importance of distinguishing between substitution and income effects when considering the impact of different types of tax changes is also discussed by Keane (2011).

[22] See also Aronsson et al. (2022) for an overview and evaluation of different methods of estimating the ETI.

[23] See Blomquist and Selin (2010) that studied the major tax changes that occurred in Sweden from 1981 to 1991, Kleven and Schultz (2014) that studied the 1987 Danish reform, and Matikka (2018) that studied changes in Finnish municipal taxes from 1995 to 2007.

in the marginal tax on high incomes. The overall response of high-income earners will reflect both an increase in their marginal tax rate (a substitution effect leading to lower labor supply) and a reduction in the average tax rate due to the tax cut on low incomes (an income effect also leading to lower labor supply). Admittedly, the tax increase on the second segment makes high-income earners poorer (an income effect leading to higher labor supply), but for high-income earners who are just at the beginning of the second segment, this income effect will be negligible. For low earners, however, the substitution and income effects run in opposite directions.

Income effects in empirical studies can be both positive and negative depending on whether individuals are poorer or richer overall as a result of the tax form being studied. It is therefore quite possible that studies finding different elasticities are consistent with the same magnitude of substitution effects but different magnitudes of income effects. Unfortunately, few studies are able to shed credible light on the role of income effects (see the discussion in the next section). Many studies therefore ignore the distinction altogether by starting from models where the utility function is linear in consumption, which means that the estimated elasticity is interpreted as a *compensated* elasticity that reflects substitution effects only.

One type of study where income effects tend to play a less significant role is so-called bunching studies (Saez, 2010) where elasticities are estimated by locally analyzing behavior around kink points in the tax system (income thresholds where marginal income tax rates discontinuously change).[24] An example of such a study is Bastani and Selin (2014) who study the first central government income tax kink in Sweden (located in the upper middle part of the income distribution) and find an elasticity of zero for wage earners, which they interpret as an estimate of the compensated elasticity. At the same time, the authors point out that if individuals accept a utility loss of not optimizing at the cut-off point of on average one percent of disposable income, the compensated elasticity could be substantially larger.[25]

That elasticities may be underestimated due to optimization frictions does not only apply to bunching studies, but to most empirical studies of how individuals react to taxation. In the labor market, there are several adjustment costs and frictions, for example regarding the possibilities to change one's working hours, change jobs, etc., combined with the fact that it takes time and energy for people to get to know how the tax system works and to understand which tax rates apply.[26] This usually means that: (i) changes in behavior only occur in the longer term, and, (ii) changes only occur if the benefits of changing one's behavior are sufficiently large.[27] However, the vast majority of empirical studies are only able to study responses in the relatively short term. The problem is compounded by the fact that there are

[24] See Kleven (2016) for an overview of bunching studies.

[25] In their study, compensated elasticities above 0.39 can be ruled out based on the empirical estimates for 1998 and compensated elasticities beyond 0.7 can only be ruled out based on the estimates for 1999–2005.

[26] Bastani and Waldenström (2021) present recent bunching evidence showing that conditional on income, the responses are larger among those with high cognitive ability.

[27] This is discussed in Chetty (2012), Chetty et al. (2011), Bastani and Selin (2014), Kleven and Schultz (2014), Kostøl and Myhre (2021), and Labanca and Pozzoli (2022), among others.

responses to taxes that can in principle only be measured in the long run (such as educational choices) and responses that can hardly be measured at all, such as how much effort people put into their workplace in order to get a higher wage, and which are only reflected in labor income after a long time (and which are difficult to attribute to tax changes as income changes over time for many reasons unrelated to taxes).[28]

6.2 Studies of income effects

As discussed several times above, a key component of the *MVPF* for a tax change is the income effects that arise. But how important are they empirically? In the context of the taxable income model studied in Sect. 3.2, the total response to a change in the net-of-tax rate $(1-t)$ can be decomposed using the well-known Slutsky equation as follows:

$$\epsilon_{z,1-t} = \epsilon^{c}_{z,1-t} + \zeta, \tag{29}$$

where $\epsilon^{c}_{z,1-t}$ is the compensated elasticity of taxable income that describes substitution effects and ζ is a parameter that captures income effects.[29] The parameter ζ is defined as:

$$\zeta = (1-t)\frac{dz}{dy}, \tag{30}$$

where $\frac{dz}{dy}$ is the marginal propensity to increase one's labor income in response to a marginal increase in non-labor income y. If leisure is a normal good (i.e., the demand for leisure never decreases as income increases), then $\frac{dz}{dy} \leq 0$.

Income effects can be estimated in basically two ways. Either structural labor supply models estimated using data on labor income/hours (z/h), wages (w), taxes (t) and various "other" incomes (y) (such as partner income) are used. One problem with these studies is that they rely on strong assumptions and rarely have access to credible exogenous variation in y. For example, individuals with a strong preference for work relative to leisure will simultaneously work more hours and have more financial assets and therefore greater non-work income, creating a spurious correlation between non-work income and labor supply.

Another way is to use some natural experiment that offers exogenous variation in non-labor income. An important branch of these studies is that which has used lottery winnings. Using lottery winnings offers many advantages over other natural experiments, such as studies based on inheritance (where the question arises to what extent such inheritance is expected or unexpected, and inheritance coincides with the death of a parent which in itself may affect labor supply). One challenge with

[28] Kleven et al. (2023) is a recent attempt to estimate long-run elasticities by focusing on job changers.

[29] The compensated elasticity is derived from the compensated supply function that describes labor supply adjustments to taxes when individuals are compensated so that they always achieve the same utility level u, see for example Saez (2001) for details.

lottery studies is that they require assumptions about how individuals choose to distribute lottery winnings over the remaining part of the life cycle.[30]

An early study of the effects of lottery winnings on labor supply is Imbens et al. (2001). These authors use data in the United States in the 1980s and find a marginal propensity to increase labor income in response to an income increase of about −0.11, which should be interpreted as an increase in income of 1000 dollars leads to a decrease in labor income of 110 dollars. Cesarini et al. (2017) use Swedish lottery winnings and find a marginal propensity to increase labor income in response to an income increase of between −0.036 (at age 60) to −0.168 (at age 20).[31] This could justify a ζ of about −0.1.[32]

Golosov et al. (2023) find larger income effects on US data. They find a marginal propensity to increase labor income in response to an income increase of as much as −0.52 (see their Table 4.1), which could easily justify a ζ of around −0.2. This means that with a value of the compensated elasticity of $\epsilon^c_{z,1-t} = 0.2$, Eq. (29) yields a value of the uncompensated elasticity that is around zero.[33] Of course, one should be cautious about extrapolating values between countries, as there could also be cross-country differences in compensated elasticities.

6.3 Illustration: the role of income effects for the *MVPF*

Suppose that a government agrees on a given value of the elasticity of taxable income for small tax changes affecting broad groups of taxpayers, and suppose that this value is ϵ. If ϵ is interpreted as the uncompensated elasticity of taxable income, this implies that $\epsilon_{z,1-t} = \epsilon$, and we obtain a value of *MVPF* in (27) (assuming $t = 0.5$) of $MVPF_{\text{prop.tax}} = \frac{1}{1-\epsilon}$. However, if instead ϵ is interpreted as the compensated elasticity, we need to add the income effect to get the uncompensated elasticity (see Sect. 6.2 and Eq. 29). In this case, we get $MVPF_{\text{prop.tax}} = \frac{1}{1-[\epsilon+\zeta]}$. Figure 1 illustrates the latter expression for different values of ϵ and ζ. What we see from the figure is that assumptions about income effects can have a significant impact on the size of the *MVPF* for this tax change. In particular, for empirically relevant and modest values of ϵ, assumptions about the size of the income effects determine whether the *MVPF* is smaller or larger than unity. We can also calculate the point at which a tax cut would pay for itself. This happens when $\epsilon + \zeta = 1$ or $\epsilon = 1 - \zeta$,

[30] Another convincing way to identify income effects on labor supply is to exploit the random allocation of scholarships, see Braga and Malkova (2023).

[31] See Cesarini et al. (2017), Table 5, Panel C. The authors also report an uncompensated (Marshallian) elasticity of close to zero, 0.009, within their calibrated life-cycle model, see Cesarini et al. (2017), Table 5, Panel D.

[32] Similar results have been found on Dutch data by Picchio et al. (2018) who estimate an average marginal propensity to increase labor income in response to an income increase of −0.056 in the same year that the lottery winnings were received.

[33] This conclusion is consistent with the early studies of labor supply among men that were done in the 1960s, 1970s, and 1980s, see Pencavel (1986) for a review. Early studies found significantly higher elasticities for women (Killingsworth & Heckman, 1986) but these elasticities have declined sharply as labor force participation among women has increased, see for example Heim (2007).

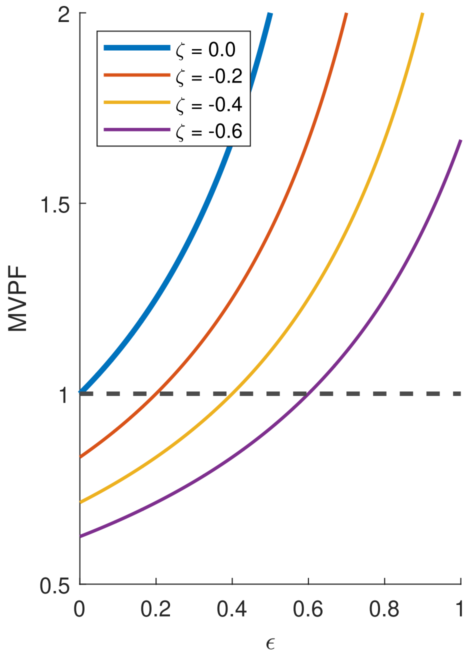

Fig. 1 Illustration of the *MVPF* for a proportional tax change. *Note*: The figure plots $MVPF_{\text{prop.tax}} = \frac{1}{1-[\epsilon+\zeta]}$ for different values of the compensated ETI ϵ and the income effect parameter ζ. The study by Golosov et al. (2023) suggests a value of $\zeta = -0.20$, although higher values can be justified based on their estimates

where $\zeta \leq 0$. Thus, the larger the income effect parameter in absolute terms, the higher the compensated elasticity associated with a self-financing tax cut.

7 Limitations of using the ETI

In this section, I describe some of the limitations of using the ETI to quantify the *MVPF* of tax changes, discussing externalities, general equilibrium effects, the extensive margin (labor force participation and migration), and the dependence of the ETI on the definition of the tax base.

7.1 Externalities

The *MVPF* focuses on marginal policy changes, which, according to the envelope theorem, implies that behavioral responses have no direct effect on utility. Therefore, it is sufficient to calculate the willingness to pay of the affected individuals for the policy change and, if the government is the only distortion in the economy, the causal effect of the policy on the government budget. The reason is that taxes drive a wedge between private prices and social costs. With a non-zero tax rate, a change in the tax base due to behavioral responses will have an effect on the government budget that is not accounted for by individuals. This is called a fiscal externality. In the simplest case, when there is only a single tax on labor income, the effect on the government budget is fully captured by the elasticity of taxable labor earnings. This is the motivation for quantifying the *MVPF* in terms of the ETI, as we have done.[34]

The attractiveness of the ETI as a measure for evaluating tax policy stems from the point made by Feldstein (1999), who showed that if taxable income is the result of a combination of different economic activities, then from the perspective of economic efficiency it is irrelevant what the mechanisms are that underlie the change in the ETI. In other words, the ETI is sufficient to compute deadweight loss even in the presence of multiple channels of adjustment. This result extends to welfare calculations using the *MVPF*. The logic underlying the result is that if individuals optimally choose how much to engage in each activity that affects their taxable income, then the marginal social cost of each activity is the same in the individual's optimal allocation.[35]

However, there are several caveats to the sufficiency of the ETI. For example, Chetty (2009) emphasizes two types of transfer costs that are important to consider: transfers to the government (revenue offsets) and transfers to other agents in the private sector. Transfers to the government can take several forms. The most important case of transfers to the government occurs when there are multiple taxes (such as labor income, capital income, and consumption taxes). If part of the behavioral response is a shift of income between tax bases, this means that the reduction in income is not entirely a social cost, but implies an increase in tax revenue from another tax base.[36] The most common type of income shift is between the labor and capital tax bases, triggered by the fact that taxes on capital income are often lower than marginal tax rates on labor income in progressive tax systems. If capital income is taxed at a different rate than labor income, the causal effects on both the labor and capital tax bases, weighted by their respective tax rates, would be needed to calculate the fiscal externality.[37]

Another type of transfer to the government occurs when tax evaders are fined by the tax authorities. These fines partially offset the loss of tax revenue due to evasion and imply that the private and social costs of evasion differ (see (Slemrod, 1995;

[34] The *MVPF* for a tax change should be the causal effect of that tax change on the government budget. Thus, it is not usually necessary to decompose it into income and substitution effects. However, as argued above, if we are to calculate the *MVPF* for hypothetical future tax changes, we must take into account the specific nature of the reform and use a weighted average of the compensated and uncompensated elasticities.

[35] To see this, consider a simplified version of the model in Chetty (2009), where an individual chooses both earnings z and how much income e to shelter in order to maximize $u = (1 - t)(z - e) + e - \phi(z) - g(e)$, where ϕ captures the disutility of earning income and g is the cost of sheltering. Then the first-order conditions imply $\phi'(z) = 1 - t$ and $g'(e) = t$. Thus, the social value (in terms of social resource costs) of a \$1 marginal increase in z is $1 - \phi'(z)$, and the social value of a \$1 marginal decrease in e is $g'(t)$. In other words, from a social welfare perspective, it does not matter whether the individual increases his/her taxable income by earning more or by sheltering less.

[36] See, for example, Slemrod (1998) and Saez (2004).

[37] When conducting an ex post evaluation of the welfare effects of a policy using the *MVPF*, it would be sufficient to calculate the effect of the policy on total tax revenue. However, we are often interested in making ex ante predictions about the effects of tax reforms, and if individuals engage in income shifting, then separate knowledge of how labor and capital income respond to the policy change allows for better predictions of the fiscal externality.

Slemrod & Yitzhaki, 2002; Chetty, 2009)). There are also important cases where the taxable income response implies transfers to the *private* sector. For example, many countries incentivize charitable giving through deductions in the tax code. If the behavioral response behind the ETI represents charitable giving, then one would need to count the welfare effects of these transfers to other agents in the private sector.

Transfer externalities are only a small subset of all externalities resulting from behavioral responses to taxation. There are also many traditional types of externalities. For example, deductions in the tax code may not only create transfers between individuals, but may also create an externality similar to a public good when, for example, charitable donations go to charities that fund medical research (Kaplow, 2023). Increased labor supply may be associated with increased pollution, or people who work long hours may impose externalities on the well-being of their children (effects that may not be fully considered by parents). There are also self-imposed externalities (so-called internalities), which arise when individuals do not fully consider the effects of their consumption on their own well-being. Taking these considerations into account requires broadening the focus beyond ETI to include the causal effects of policies on externalities and estimating the marginal willingness to pay for these externalities.

7.2 General equilibrium effects

The basic *MVPF* calculation for a tax change based on the ETI does not take into account general equilibrium effects. For example, if people reduce their labor supply in response to a tax increase, the reduced availability of labor could raise wages. Conversely, if a tax cut leads to more people entering the labor force, the increased labor supply could lower wage rates. The social value of such changes depends on who gains and who loses from these wage adjustments. Thus, when calculating the *MVPF* for a tax change that has general equilibrium effects on wages, one would need to use estimates of the causal effects of policy changes on wages. For example, Rothstein (2010) estimated that $1 of EITC spending increases after-tax income by only $0.73. In this case, the *MVPF* would be a weighted average of $0.73 for EITC recipients and $0.27 for others, presumably those who benefit from increased firm profits.[38]

7.3 The labor force participation margin

So far, we have mostly discussed "intensive" adjustments (changes in working hours) among individuals who are already working. We have not explicitly included extensive responses, i.e. decisions to work or not to work, or migration decisions. The participation margin is particularly relevant for tax changes affecting low-income individuals. While the ETI reflects the participation margin to some extent,

[38] From an optimal tax perspective, these trickle-down effects have been studied by Rothschild and Scheuer (2013, 2014), Ales et al. (2015), Sachs et al. (2020), and Schulz et al. (2023).

the link to *MVPF* is more complicated because the value of work is controlled by the average tax rather than the marginal tax. Kleven and Kreiner (2006) show that in the presence of both the intensive labor supply margin and the extensive participation margin, the denominator in the *MVPF* (Mayshar, 1990)'s *MCPF*) consists of an intensive elasticity weighted by marginal tax rates and a participation elasticity weighted by average tax rates. Note that if the participation elasticity is positive, the *MVPF* for a tax increase is greater than one, even if the uncompensated elasticity of taxable income is zero.

A decomposition into intensive and extensive margin elasticities is not necessary when evaluating past projects, since it is sufficient to know the causal effect of the tax reform on the government budget. However, the formula derived by Kleven and Kreiner (2006) is helpful for evaluating future projects, because it allows to weight the intensive and extensive margin elasticities appropriately, depending on how much the planned tax reform affects average tax rates (relevant for participation responses) and marginal incentives (relevant for intensive margin decisions). However, the usefulness of using estimated participation elasticities to evaluate future reforms should not be overstated. The reason is that these elasticities are highly context-dependent, as they are determined by how many people in the labor force are indifferent at the margin between working and not working, and whose decision to work is affected by a small change in the average tax rate induced by a small change in the marginal tax rate.[39]

7.4 The mobility (migration) margin

The estimation of the ETI is based on the taxpayer population recorded in the dataset for a given country over the study period. However, this does not take into account the cross-country migration margin, which can be an important behavioral response to tax changes, especially for high-income earners. Similar to participation responses, migration responses are driven by average tax rates, and the the people who choose to migrate in response to a small tax increase are those who are indifferent at the margin between staying in the country and moving abroad. A small increase in a marginal tax rate affects the number of domestic taxpayers at a given income level through the income-specific migration elasticity with respect to domestic disposable income.[40] This migration elasticity would have to be added to

[39] Bastani et al. (2021) is a recent study that presents quasi-experimental evidence on labor supply responses along the extensive margin to changes in participation tax rates, using a reform of the housing allowance in Sweden in the late 1990s. They find an average participation elasticity of about 0.13 for their study population of married women with relatively low income levels, but that elasticities decline sharply with income.

[40] The size of the change in domestic disposable income depends on the size of the change in disposable income induced by the tax change. For example, if we consider a change in the top bracket in a two-bracket piece-wise linear income tax system, those just to the right of the kink will experience a small change in their disposable income, while those further to the right will experience a larger change. For very high earners, the change in the average tax rate can be approximated by the change in the marginal tax rate in the top bracket, which is why empirical researchers have estimated the effect of top tax rates on migration.

the traditional ETI to capture the overall impact of a tax change on the government budget. See Kleven et al. (2020) for an overview of the empirical literature on tax-induced migration decisions, and Kalin et al. (2022) and Muñoz (2023) for two recent contributions.

7.5 The definition of the tax base

The ETI offers a significant advantage due to the extensive availability of tax data, in particular through comprehensive administrative records. However, this advantage is accompanied by a notable challenge: the definition of the tax base strongly influences ETI estimates (Slemrod & Kopczuk, 2002a; Kopczuk, 2005). For example, a tax system with more available deductions is likely to yield a higher ETI. In addition, the rules that determine tax jurisdiction—whether taxes are levied based on the location of the employer or the taxpayer's residence—also affect the ETI. This issue has gained prominence with the rise of remote work.[41] Taken together, these complexities underscore the need to consider the details of the tax code, such as tax rates, tax bases, audit policies, and sourcing rules, which vary from country to country and are subject to government control. These are additional reasons to analyze the responsiveness of individual components of taxable income, rather than simply focusing on the aggregate, when using *MVPF* calculations to forecast the impact of future tax changes or when applying results across countries or jurisdictions.

8 Concluding remarks

The purpose of this paper was to provide an accessible guide to the *MVPF* (Mayshar, 1990's *MCPF*) as introduced into the literature by Hendren (2016), Hendren and Sprung-Keyser (2020), and Finkelstein and Hendren (2020). I have discussed how the *MVPF* can be used to evaluate the welfare effects of public projects, with an explicit focus on tax reform. I have also explained the relationship to the traditional *MCPF* as defined by Stiglitz and Dasgupta (1971) and Atkinson and Stern (1974) and the concept of deadweight loss/excess burden.

The paper emphasizes the link between *MVPF* and tax policy, a link that has been somewhat overlooked in the recent *MVPF* discourse, which has been predominantly concerned with public spending. I have undertaken an in-depth exploration of taxable income elasticities and provided a critical examination of how the *MVPF* is empirically quantified through these elasticities. I have also highlighted a difference between the analysis conducted by researchers evaluating past projects and the frameworks used by practitioners to develop benefit-cost rules for ongoing or future projects. In particular, when evaluating past projects, only the total causal effect on the government budget is needed. In contrast, when calculating the *MVPF* for future projects, separate knowledge of income and substitution effects or the elasticities of different tax bases is helpful because it allows

[41] See, for example, Agrawal and Tester (2024), which documents significant variations in these rules among U.S. states.

tailoring the *MVPF* measure to the specific nature of the planned tax reform, thereby improving the prediction of welfare effects.

The paper has also explored the *MVPF* approach to addressing distributional issues, positioning it within the broader discourse on optimal redistributive taxation and its practical implications for policymaking. In particular, I have emphasized that the weights that a policymaker assigns to different groups of taxpayers are endogenous to the tax and transfer system and depend not only on the government's inherent preferences for redistribution, but also on the economic incidence and distribution of income in the economy's current equilibrium. Thus, the welfare weights used in the *MVPF* approach, similar to behavioral elasticities that capture behavioral responses to tax policy (e.g., (Slemrod & Kopczuk, 2002b)), are endogenous and can be affected, for example, by major economic changes that significantly alter the distribution of income in the economy.

Appendix A: Public goods provision in the optimal tax literature

A large literature in public finance has analyzed the optimal provision of public goods under the assumption that the government redistributes among individuals with different abilities to earn income using an optimal nonlinear income tax. This is the starting point of modern tax research, which assumes that the fundamental constraint on tax policy is asymmetric information about individuals' abilities, see Mirrlees (1971). Few of these studies, however, explicitly discuss the *MCPF*. Those that do tend to focus on the definition of the traditional *MCPF* in (16).

Christiansen (1981), Boadway and Keen (1993), and Gauthier and Laroque (2009) show that in a setting with optimal nonlinear income taxation the policy rule for a public good is the same as in a first-best setting (the Samuelson rule) without any adjustment for the cost of raising tax revenue.[42] One way to understand this result is that the nonlinear income tax $T(z)$ includes a lump-sum transfer $T(0)$ that can be reduced to finance the public good at no efficiency cost. Such an adjustment has distributional effects, but these can be neutralized by adjustments in the nonlinear income tax so that all individuals achieve the same welfare as before. Kaplow (1996, 2004) argues that the first-best Samuelson rule is relevant even if the tax system is not optimal, as long as the introduction of the public good and its financing can be done in a distributionally neutral way.

It is tempting to interpret that the *MCPF* in (16) is equal to one under optimal nonlinear taxation. However, Gahvari (2006) shows that it is actually less than one in the model of Boadway and Keen (1993). So the *MCPF* can be less than one even though the public good in the optimum is provided neither "under" nor "above" the

[42] The result is based on a model in which preferences for labor supply are separable from other goods, including the public good. If preferences are not separable, a "modified" Samuelson rule applies instead, which takes into account the effects of the public good on income redistribution (through the so-called self-selection constraints) as well as the tax revenue from commodity taxes. See, for example, Edwards et al. (1994) and Aronsson et al. (2024). While these effects depend on the tax wedge, they are not very meaningful to relate to the *MCPF*.

Samuelson rule.[43] In a more general model, Gahvari (2006) shows that it can also be greater than one. Thus, there is no "definitive" value of the *MCPF* in (16) in models of nonlinear income taxation.

Some research has studied *MCPF* in (16) under restricted tax systems. Sandmo (1998) studies the policy rule for public goods under an optimal *linear* income tax (proportional taxation of labor income combined with a uniform lump-sum transfer) and shows that the *MCPF* in this case is less than one. The reason is that the public good can be financed at the margin without efficiency cost by reducing the lump-sum transfer. As this reduction makes people poorer, tax revenues increase through income effects while distributional effects are zero since the tax system is assumed to be optimal from the outset. Sandmo (1998) further finds that the *MCPF* is the same whether the marginal financing is done through a reduction in lump sum transfer or through the distortionary income tax rate. However, the lack of flexibility in the income tax (due to the linear rather than non-linear nature of the income tax) gives rise to a distribution factor linked to the public good in the policy rule, but this is included on the "revenue" side and not on the cost side. With optimal non-linear taxation, this generally does not arise because distributional issues can be dealt with entirely by income taxation (under certain separability assumptions)

Jacobs (2018) builds on Sandmo (1998) and proposes a modified measure of *MCPF* based on Diamond (1975). With this measure, the income effects of tax financing are included in the social value of private funds (see also (Lundholm, 2005)) and $MCPF = 1$ under both the optimal linear tax system and under an optimal non-linear income tax, see Bos et al. (2019) for a discussion of the policy implications. Building on Håkonsen (1998), Jacobs (2018) argues that the alternative definition addresses three well-known issues in the literature: (i) the standard definition of the *MCPF* is sensitive to the choice of the untaxed numeraire (a point first identified by (Atkinson & Stern, 1974)), (ii) the *MCPF* of a distortionary tax (in the absence of distributional concerns) cannot be directly related to the marginal excess burden of taxation, (iii) the MCPF for lump-sum taxes is typically not equal to one under the standard definition.

Appendix B: Net social benefit and benefit-cost ratios

It is instructive to briefly outline other ways of conducting benefit-cost analysis and relate them to the *MVPF*. Admittedly, this is not easy to do because, in practice, benefit-cost analysis distinguishes between small and large projects, whereas the marginal analysis underlying the (standard) application of the *MVPF* makes no such distinction.

A classical way of evaluating projects, at least since Feldstein (1964), is to calculate the net benefits of a project. García and Heckman (2022a) define Net Social Benefit (NSB) in the following way (see also (García & Heckman, 2022b)):

$$NSB = B - D(1 + \phi) + \Omega(1 + \phi), \tag{B1}$$

[43] Note, however, that the level of the public good can be both higher and lower in second-best compared to first-best.

where B is the direct welfare effect, D is the direct cost, and Ω is the benefit to society at large and $\phi = MEB$. Here, Ω may capture, for example, that part of the project cost is recovered in the long run through cost savings. The multiplication by $1 + MEB$ is justified by the fact that one dollar in the hands of the government is valued at $1 + MEB$ because the marginal source of financing is assumed to have a welfare loss amounting to MEB.

An advantage of calculating net social benefits over benefit-cost ratios is that the former concept takes into account the scale of social benefits and avoids the arbitrariness of what to include in the denominator or numerator. One problem, however, is that large projects tend to be ranked highest and the measure is sensitive to project delineation (lumping together two projects with positive but low NSB results in a new project with higher NSB).

When calculating NSB, it is also common to calculate the net benefit *per dollar* (NBD):

$$NBD = \frac{NSB}{D} = \frac{B}{D} - (1 + \phi) + \frac{\Omega}{D}(1 + \phi). \tag{B2}$$

If not all profitable projects can be implemented, it is important to look at both NSB and NBD. To see this, assume that the project benefit can be described as $B = (1 + \phi)D + \gamma$ for $\gamma \geq 0$ and that $\Omega = 0$. This means that $NSB = \gamma$ and $NBD = \frac{\gamma}{D}$. Suppose we have two types of projects, a large project with $D = 100$ and $\gamma = 1000$, and a smaller project with $D = 8$ and $\gamma = 100$. The large project has $NSB = 1000$ and $NBD = 10$. The smaller project has $NSB = 100$ and $NBD = 12.5$. The smaller project thus has lower NSB but higher NBD. Since the smaller project has a higher NBD, it means that if we have a budget of 100, and can implement 12 projects of the smaller project type, we get a total NSB of 1200 which is higher NSB than the large project.

How does NSB relate to the classical benefit-cost ratio (BCR) defined in, for example, Boardman et al. (2018)? Using the notation above, BCR becomes the following:

$$BCR = \frac{B + \Omega(1 + \phi)}{D(1 + \phi)}. \tag{B3}$$

The BCR quotient is thus created by "moving" the cost $D(1 + \phi)$ to the denominator. Note that $NSB > 0$ if and only if $BCR > 1$. Therefore, exactly the same projects are judged to be socially desirable under NSB and BCR. However, the choice of metric affects the distance between projects, which matters if not all projects with positive net benefits can be implemented. If we also "move" $\Omega(1 + \phi)$ to the denominator (in the form of a reduced cost), we get:

$$BCR' = \frac{B}{D(1 + \phi) - \Omega(1 + \phi)}. \tag{B4}$$

Again, this manipulation does not affect which projects are deemed profitable, but does affect the ranking. If we assume that we have D dollars to spend, and avoid making an assumption about how D is financed, we can set $\phi = 0$ and get:

$$BCR'' = \frac{B}{D - \Omega}. \tag{B5}$$

The above expression is equal to *MVPF* if we restrict Ω to represent the long-term behavioral effects of the project on *tax revenue* (and allow other positive welfare effects to be included in B). For example, we see that if $\Omega \to D$ (the project almost pays for itself) then $BCR'' \to \infty$ holds regardless of the size of $B > 0$. In future studies, numerical calculations illustrating the ranking of projects under different definitions of benefit-cost criteria would be useful to understand the practical significance of different assumptions.

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