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ABSTRACT

This paper discusses alternative ways of defining and measuring the marginal economic cost of public funds and reviews empirical cost estimates – including estimates for EU countries. Moreover, it illustrates how the economic cost of public funds should be accounted for in cost-benefit analyses of government expenditure, notably on public infrastructure, and how the cost-benefit assessment changes if user fees contribute to the financing of infrastructure services. The paper also clarifies why the economic cost of public funds must not be confused with the social discount rate, social opportunity cost, and the interest rate on government debt. In this context, the paper discusses how government borrowing – that is, taxing later in lieu of taxing now – affects the cost-benefit assessment.

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The economic cost of public funds in infrastructure investment

The art of taxation consists in so plucking the goose as to obtain the largest possible amount of feathers with the smallest amount of hissing.

Jean Baptiste Colbert

1. Introduction

To finance their expenditures, governments must raise taxes now – or later in case they borrow to pre-finance expenditures. Each euro raised imposes a burden of one euro on taxpayers as their opportunities to spend are cut by one euro. This burden constitutes an opportunity cost – a concept at the heart of economics, categorically expressed by Nobel laureate Kenneth Arrow (1974, p. 17) as “... this or that, not both. You can’t do both.”

But when funds are withdrawn from the private sector through taxation, there is more to consider than merely a one-to-one opportunity cost. Virtually all taxes – taxes on wage income, interest income, and consumption, for instance – are distortionary in the sense that they drive a wedge between the prices relevant for the supply side of markets and those relevant for the demand side. As a result, economic activity falls below the level that would materialize in the absence of distortionary taxation. This decline in activity constitutes an excess burden that comes on top of the burden of taxation, implying that the economic cost of raising one euro is larger than one euro. This has considerable implications for the cost-benefit comparison of government expenditure, effectively making less expenditure worthwhile compared to a situation without excess burden.

That said, spending tax revenue might have effects that work against this negative impact on government expenditure. To be clear, one should not think of effects related to the direct expenditure benefits. As for them, an intuitively reasonable expectation is that they should amount to at least one euro for each euro of tax revenue raised. Rather, government expenditure could have effects that essentially counterbalance the excess burden of taxation, that is, the reason why the economic cost of public funds is larger than one in the first place. More specifically, given the nature of the excess burden, one needs to think of effects that boost the economic activity hampered by distortionary taxes. For instance, consider an increase in wage taxes to raise finance for transport infrastructure. Better infrastructure might increase the supply of labour. If it does, it counters the decline in supply caused by an increase in distortionary wage taxes. Or, imagine a specific tax on TV sets is increased to finance a new public TV channel. The availability of an additional – presumably high-quality – channel might increase the demand for taxed TV sets, thereby boosting the production of TV sets – an activity curbed by the specific tax.

There are thus two opposing forces. On the one hand, distortionary taxes create an excess burden, raising the economic cost of public funds above the forgone opportunities due to transferring one euro from taxpayers to the government. Costs understood in this way depend on the type of tax since the excess burden is unlikely to be same for all taxes. On the other hand, the expenditure made possible by tax revenue might, in addition to generating direct benefits, boost activities that taxation reduces. One could consider this simply an indirect benefit that cost-benefit analyses of government expenditure need to account for. Alternatively, one could see this as a reason for redefining the economic cost of public funds. In this case, the economic cost of funds would depend not only on the type of tax imposed but on the type of expenditure, too, making the cost of funds expenditure specific – as the reference to infrastructure investment in the title of this paper suggests. Obviously, alternative ways of defining the economic cost of public funds do not change the economics of the expenditure examined. Yet, for applied expenditure and project appraisal there is a challenge: Analysts need to know whether the empirical estimate of the economic cost of public funds they use rests on the first (conventional) definition, considering just the excess burden of taxation, or the



Armin Riess

second (modified) definition, considering also indirect benefits of government expenditure. Not knowing this is a recipe for an erroneous appraisal.

The main purpose of this paper is to analyze these issues in a manner easily accessible to project appraisal practitioners and policymakers. Although demand-supply diagrams and equations will be used, they are simple compared to the welfare economics and public finance literature on which they draw, and their sole rationale is to support the narrative of the paper.

The economic cost of public funds can be defined in different ways, is kept in check by user fees, and must not be confused with the discount rate and interest rate on government debt.

Another objective of the paper is to discuss how user fees affect the economic cost of public funds. User fees aim at partly covering the cost of providing public goods and services and they thus reduce the need to raise tax revenue and, by extension, the excess burden of taxation and the economic cost of public funds. User fees might be charged for a variety of infrastructure services – in transport, health, and education, for instance. A salient feature of these services is that charging too much for them is economically inefficient. There is then a trade-off to consider: Charging user fees is welfare enhancing as it lowers the economic cost of public funds, but charging too much is welfare reducing as it prevents demand from reaching its socially optimal level.

The paper also clarifies the distinction between the economic cost of public funds and the social discount rate used in cost-benefit analyses. A key point to recall is that discounting is simply a method of aggregating costs and benefits occurring at different points in time. There are two broad approaches to determining the social discount rate. One is based on social time preference rates, the other on social opportunity costs. Although opportunity-cost based discount rates are often seen as representing the economic cost of funds, they do not. Rather, the economic cost of public funds and discount rates are two distinct concepts, although the latter might influence the former.

After everything else, the paper will shed light on whether government borrowing and, thus, taxing later might be better for society than taxing now. An intuitive reflex tells us that this depends on the interest rate on government debt and the social discount rate. Although not wrong, it is not exactly right either. The paper will conclude that without the excess burden of taxation, society would be indifferent between taxing now and taxing later – regardless of the interest rate on government debt and the discount rate. However, with the excess burden, differences between these rates matter. Although the literature on the link between the excess burden of taxation and government borrowing is still young, indications are that borrowing does not offer a cheap way out.

The remainder of the paper proceeds as follows. Section 2 explains the excess burden of taxation and presents the difference between the conventional and the modified approach to the economic cost of public funds. Section 3 discusses how the economic cost of public funds enters the cost-benefit analysis of infrastructure investment. In this context, it will become clear that both approaches are equivalent, in particular as to the question of whether or not the investment is economically viable. Section 4 turns to empirical estimates of the economic cost of public funds. Section 5 broadens the view by introducing user fees into the cost-benefit equation. Having merits in its own right, this extension opens, too, a fresh perspective on the privatization of public goods and services – outright or through public-private partnerships. Up to here, the analysis is cast in an atemporal, or one-period, framework. Section 6 brings in the intertemporal, or multi-period, dimension necessary to investigate the link between the economic cost of public funds, on the one hand, and discounting and government borrowing on the other hand. Section 7 concludes.

A few remarks should be made before plunging into a fascinating topic. With a few exceptions, this paper assumes individuals, or households, to be identical and treated equally by the government. With this assumption, distributional concerns are ignored. While this is a simplifying and crude

departure from reality, it allows getting to the core of the matter. Moreover, we will use the terms ‘government expenditure’, ‘public project’, and ‘infrastructure investment’ interchangeably. And then, what we simply call the ‘economic cost of public funds’ actually refers to the ‘marginal (economic) cost of public funds’ in the literature. With these clarifications made, we proceed.

2. The excess burden of taxation and the economic cost of public funds

2.1 Setting the scene

The excess burden of taxation and the economic cost of public funds date back to, and continue to rest on, the contributions of Pigou (1947), Harberger (1964), and Browning (1976). They will be sketched in this sub-section. Sub-section 2.2 elaborates on them under the heading the ‘conventional’ approach to the economic cost of public funds – a term coined by Jones (2005). Mention of a conventional approach suggests that there is another one. Borrowing again from Jones, this approach is discussed in Sub-section 2.3 under the heading the ‘modified’ approach to the economic cost of public funds. This approach rests on Diamond and Mirrlees (1971), Stiglitz and Dasgupta (1971), and Atkinson and Stern (1974) – to name but a few. Finally, Sub-section 2.4 summarizes and offers a few qualifying remarks.

To start with a very basic idea, the excess burden and the economic cost of public funds must be defined relative to a benchmark, that is, an economic outcome not influenced by taxation. To set such a benchmark, consider an economy that comprises firms and households but no government and, thus, no taxation.

Firms use labour and other factor inputs to produce goods and services and they might borrow and lend. They take input, output, and (net) borrowing decisions with a view to maximizing profits. Households – assumed to be identical – allocate their time between leisure and work; the wage income earned is used to purchase goods and services – in the present or the future.¹ Households take decisions as to the allocation of time between leisure and work, how much to consume of each good, and how much to consume now and in the future with a view to maximizing their utility.

In a perfectly competitive setting – that is, one characterized by the absence of public goods and other market failures (caused by economies of scale and externalities, for instance) – the interactions between profit-maximizing firms and utility-maximizing households result in a set of relative prices that ensures an efficient allocation of resources. Three key features characterize this allocation.

First, the structure of output – that is, how much is produced and consumed of each good – is such that the cost of the last unit produced of each good just equals households’ willingness to pay for it, and for each good, its cost and households’ willingness to pay equal its market price. As long as cost, willingness to pay, and price differ, profit-maximizing behaviour of firms and utility-maximizing behaviour of households jointly cause a change in the structure of output until these variables are equal. Once this is the case, further increasing the output of one good comes at a cost in excess of its market price and what households are willing to pay for it. Changing the structure of output nonetheless is inefficient and thus reduces welfare.

¹ This implies that households might save part of their present income and thereby earn interest income in the future; but households can borrow, too, if they wish to consume more than they currently earn. Note also that households’ income is augmented by firms’ profits, as households are the ultimate owners of firms.

The excess burden of taxation and the economic cost of public funds must be defined relative to an economic outcome not influenced by taxation.

Second, the intertemporal structure of consumption is such that the rate at which firms can transform present output (which could be consumed today) into future output just equals the rate at which households willingly forgo present consumption for an increase in future consumption, and both rates are linked by the market interest rate. The cost of substituting future consumption for present consumption (or *vice versa*) beyond this point outweighs its benefit. Changing nonetheless the intertemporal structure of consumption reduces welfare.

Third, households' choice between leisure and work is such that the (i) extra income households require to entice them to work more (and thus forgo leisure) matches the (ii) extra income firms can generate with more work, and this extra income equals the wage rate. In the terminology used from here on, the (i) marginal value of leisure forgone is equal to the (ii) marginal product of labour, and both are equal to the wage rate. Suppose the wage rate is equal to the marginal product of labour but exceeds the marginal value of leisure. In these circumstances, households can gain by reducing leisure and working more. Gains will have been fully exhausted once leisure has become so precious that its marginal value has risen to the level of the wage rate. Likewise, for a wage rate below the marginal value of leisure, households gain from working less and increasing leisure until the marginal value of leisure has dropped to the wage rate. Departing from the optimal work-leisure choice reduces welfare. Of particular importance for the theme of this paper are situations where households work less than they would in a perfectly competitive economy without government.

In sum, in a perfectly competitive economy without government, the interactions of households and firms give rise to a set of prices (of goods, capital, and labour) that make households and firms allocate and use resources so that no further improvement in economic efficiency is possible. It is a state of bliss, and in the absence of concerns about the distribution of income, it fully describes a social welfare optimum.

Most taxes are distortionary in that they drive a wedge between prices relevant for supply decisions and prices relevant for demand decisions...

Against this benchmark, let us broaden the perspective by introducing the government as an economic agent in addition to firms and households. To finance its expenditure, the government levies taxes. In the economy considered here, it could impose a tax on specific goods, a general tax on consumption, a tax on labour income, and a tax on interest income. Besides, the government could levy a so-called lump-sum tax. The defining property of such a tax is that it is not levied on an economic activity and that it is the same for all households. Whatever the tax, the tax revenue is an involuntary transfer from the private sector to the government and this constitutes the burden of taxation. In the parlance of economics, the opportunity cost of transferring, say, one euro from the private sector to the government is one euro.

But what, then, is the excess burden of taxation and what causes it? To start with the cause, except for a lump-sum tax, taxes distort the set of prices that entice firms and household to make efficient choices. As a result of this distortion, firms and households allocate resources in a way that is inefficient compared to the benchmark presented above. This efficiency or welfare loss is the excess burden of taxation, coming on top of the burden of taxation. Thus, the cost to society of transferring one euro from the private sector to the government exceeds one euro.

To illustrate, consider the first tax mentioned above – a tax on one particular good, that is, a specific tax. The equilibrium between demand and supply that ensues after firms and households have adjusted to the tax is characterized by a lower level of output of the taxed good. More important, it is characterized by a tax wedge between the gross price households must pay (the so-called consumer price) and the net price firms obtain (the so-called producer price). But since the consumer price measures the marginal value of this good to households and the producer price measures its marginal cost, this wedge indicates that society would benefit from an increase in output and, by

extension, it suffers from the tax-induced decline in output. Note that this excess burden of taxation remains even if the government were to return the tax revenue to households.

A general tax on consumption, while not distorting the choice between goods, drives a wedge between wages and the purchasing power of wages. The former guides firms' demand for labour and they choose the input of labour so that the wage equals the marginal product of labour. The latter guides households' supply of labour and it measures the marginal value of forgone leisure. But a positive gap between these two measures indicates unexploited scope for a welfare-enhancing increase in hours worked and, thus, output. Again, this excess burden remains even if tax revenue were to flow back to households.

A tax on labour income creates an excess burden for similar reasons – only that the wedge between the marginal product of labour and the marginal value of forgone leisure manifests itself in the difference between gross (before-tax) wages and net (after-tax) wages rather than operating indirectly *via* a decline in the purchasing power of wages. The similarity between the excess burden of a general consumption tax and that of a wage tax is because although households' choice is between leisure and income-generating work, it is ultimately a choice between leisure and consumption made possible by income.

To complete the illustration, consider the excess burden resulting from a tax on interest income. Such a tax drives a wedge between net (after-tax) and gross (before-tax) interest rates. It follows that a tax on interest income makes the rate at which households are willing to forgo current consumption in favour of future consumption lower than the rate at which firms can transform current consumption into future consumption. But this implies that welfare-enhancing possibilities for increasing future consumption remain untapped. In other words, a tax on interest income makes household consume more today compared to a situation where their choice between consuming now and in the future is exclusively determined by their time preference.

In sum, except for a lump-sum tax, taxes drive a wedge between the price relevant for the supply side of the firm-household interaction and the demand side of that interaction. This creates an excess burden that comes in addition to the burden of the revenue transfer itself. But this implies that the cost of transferring tax revenue of one euro from the private sector to the government is larger than one euro. In essence, this is the fundamental result following from the conventional approach to the excess burden of taxation and the economic cost of public funds. The next subsections express this result in simple algebraic shorthand and illustrate it graphically. The shorthand is essential for following the remainder of the paper; the graphical illustrations and the explanations coming with them will be presented in text boxes that can be skipped without harm.

... making the cost of transferring one euro from the private sector to the government larger than one euro.

2.2 Conventional approach to the economic cost of public funds

The notion that the economic cost of public funds is larger than one can be put as

$$(1) \quad \text{Economic cost of public funds} = a^c = 1 + \beta^c \quad \text{with } \beta^c \geq 0 \text{ and, hence, } a^c \geq 1.$$

In Equation (1), a^c stands for the 'conventional' economic cost of public funds. It is expressed per unit of tax revenue raised. The first term on the right-hand side simply states that the opportunity cost of transferring one euro from taxpayers to the government is one euro. The second term, β^c , is the 'conventional' excess burden expressed per unit of revenue raised; as (1) suggests, it might be zero ($\beta^c = 0$), but – unless explicitly stated – we focus on situations where it is strictly positive ($\beta^c > 0$); by extension, we focus on situations where the economic cost of public funds is strictly larger than one ($a^c > 1$).

The economic significance of $\alpha^c > 1$ is that tax revenues of one euro reduce households' consumption possibilities by more than one euro as the excess burden of taxation β^c adds an element to the economic cost of public funds that cannot be seen in the government budget – but which is a cost to the economy nonetheless. To illustrate, $\beta^c = 0.2$ would mean that one euro of tax revenue raised comes with an additional cost to society of 20 euro cents, resulting in economic cost of public funds of EUR 1.2 per euro raised. Arguably, there is political significance, too, as taxpayers surrender more to the government than they think they do.

Identified and described by Pigou (1947) and Harberger (1964), Browning (1976) called α^c the marginal cost of public funds. As pointed out in the introduction, we call it the economic cost of public funds. But it is useful to bear in mind that it refers to the marginal cost of raising additional revenue through an increase in tax rates although we will omit the 'marginal' most of the time for convenience.

Box 1 illustrates graphically the economics leading to Equation (1). Only some of it is crucial to follow the plot. First, the illustration is for a tax on labour income – wage tax, for short. Focussing on a wage tax is more than choosing an example, however. Many taxes – as argued with respect to a general consumption tax above – are eventually borne by labour, and most of the empirical work on the economic cost of public funds has been carried out for wage taxes.

The excess burden of taxation is due to a decline in economic activity whose social benefit exceeds its social cost.

Second, the wage tax interferes with households' work-leisure choices, making them work and produce less than they would in the absence of the tax, or without increasing the tax rate. But it is not simply the decline in hours worked and output that matters. Rather, it is that the value of output forgone is larger than the avoided economic cost of producing that output – and the difference between the two is the excess burden (β^c) of taxation. The general conclusion is that the excess burden comes in the form of a decline in economic activity and as this activity benefits society more than it costs, there is a welfare loss.

Third, it surely did not go unnoticed that we introduced the government and taxation into an apparently perfect economy without specifying what they are for. The conventional approach to the excess burden of taxation (and the economic cost of public funds) assumes that tax revenues finance a unique government expenditure, namely lump-sum income transfers to households. A defining property of such transfers is that each household receives the same amount and that they do not distort prices. Thus, a crucial assumption underlying the conventional approach is that the government raises revenues through distortionary taxes and hands them back to households in the form of lump-sum transfers. This round-tripping of funds makes households worse off, and the excess burden measures this welfare loss. Equation (1) captures all this per unit of tax revenue: The economic cost of raising funds through distortionary taxes is $1 + \beta^c$ euros; one euro is returned to households, leaving a net loss to society of β^c euros.

This raises two questions. First, why think of a government that imposes a wage tax only to hand back the tax revenue to households? There are at least two answers. For one thing, taxing labour income to finance lump-sum transfers is a means of redistributing income if the transfer to some households is higher (lower) than the taxes they have paid. In these circumstances, the efficiency loss measured by the excess burden is the cost of redistributing income. For another, assuming that tax revenues are returned lump-sum to households is an analytical device to separate the welfare effect of financing government expenditure from the welfare effect of such expenditure itself.

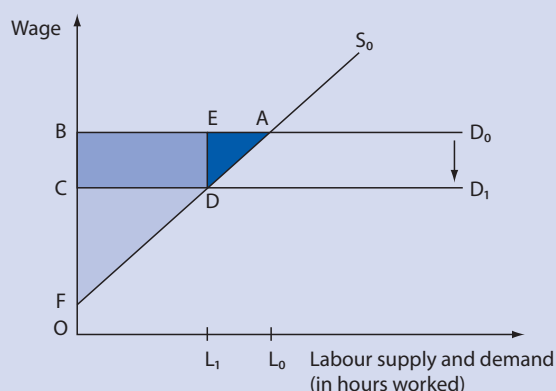
Second, what if revenues are not handed back as lump-sum transfers but, more realistically, finance expenditure such as public infrastructure investment? Answering that question takes us straight to the modified approach to the economic cost of public funds.

Box 1. Burden and excess burden of taxation – conventional approach

Figure B1 illustrates graphically the burden and the excess burden of taxation for a wage tax. It pictures the demand for and supply of labour – measured in hours worked – as a function of the wage rate. To be precise, D_0 shows firms' demand for labour when there is no wage tax. For simplicity, the demand schedule is assumed to be flat rather than downward sloping. This implies that the marginal product of labour, which sets the wage firms are willing to pay, does not fall when firms use more labour. S_0 shows households' supply of labour. A change in the supply of labour reflects a change in the hours worked by households already working (intensive labour-supply response) and a change in the labour force participation rate (extensive labour-supply response). The link between wages and labour supply is positive for two related reasons. First, working more comes at the expense of leisure and, second, the marginal value of leisure forgone rises with successive cuts in leisure. Thus, the wage households require for working more and cutting leisure rises with an increase in the amount of time allocated to working, or – equivalently – as wages go up, households wish to allocate more of their time to work and less to leisure. The labour-supply curve might be steeper or flatter than the one shown in the diagram. In fact, it might be backward-bending. These issues will be taken up in Box 3 of Section 4.

The labour-market equilibrium resulting from the interactions between firms and households yields a wage of BO , hours worked of L_0 and, thus, labour income equivalent to the area OL_0AB . As the labour-demand schedule represents the marginal product of labour, this area also represents workers' contribution to the value of output, and with constant returns to scale and in the absence of other factor inputs it equals the value of output. This value can be readily compared with the economic cost of producing it. This cost is given by the total value of leisure forgone, which equals the area OL_0AF under the labour-supply schedule. With the value of output (OL_0AB) exceeding the economic cost of generating it (OL_0AF), there is thus a labour-supply surplus of FAB . How does introducing a wage tax change this surplus and how does this change relate to the burden and the excess burden of taxation?

Figure B1. Burden and excess burden of taxation – conventional approach



A neat way of illustrating the impact of a wage tax assumes that firms make the tax payments to the government. But as they do not want to foot the bill, they offer households a lower net (after-tax) wage, and as firms demand for labour is completely elastic, they succeed in passing

on the tax burden to households. In Figure B1, D_1 shows the reduced wage offer of firms, that is, the demand for labour as perceived by households. The vertical difference between D_0 and D_1 (BC) is the tax per hour worked (that is, the difference between the gross wage and the net wage) and BC/BO is the tax rate. As a result of introducing a wage tax and, thus, reducing households take-home pay, labour supply and the number of hours worked fall from L_0 to L_1 . The value of output, which continues to be measured by the area under D_0 , falls to OL_1EB . It is shared between households – receiving (net) labour income of OL_1DC – and the government, which collects tax revenue $CDEB$. For obvious reasons, these revenues constitute the burden of taxation: In the absence of taxation, this part of the output value would have accrued to households for working L_1 hours.

This leaves the excess burden to explain. One way of doing this is to measure the value of output forgone due to taxation and to compare this value to the avoided economic cost of producing it. The value of output forgone is L_1L_0AE . Its economic cost equals the value of leisure households would have had to give up to produce it. Given the explanation of the labour-supply curve given above, this value is pictured by the L_1L_0AD . The difference between the value of output forgone and the avoided economic cost of producing it is the excess burden of taxation DAE .

Another way of looking at things is to examine the change in the labour-supply surplus, amounting to FAB without taxation. Introducing the tax reduces this surplus to FDC . The decline in the surplus $CDAB$ exceeds the tax revenue $CDEB$ by an amount equivalent to the triangle DAE , which is the excess burden of taxation. For the wage tax considered here, it is thus the difference between the decline in the labour-supply surplus ($CDAB$) and the government's tax take ($CDEB$). For distorting taxes in general, it is the difference between the decline in the private surplus and the government's tax take.

This excess burden ($CDAB - CDEB = DAE$) is commonly expressed per unit of tax revenue:

$$(B1) \quad \text{Excess burden} = \frac{\text{decline in private surplus} - \text{tax revenue}}{\text{tax revenue}}$$

$$= \frac{CDAB - CDEB}{CDEB} = \frac{DAE}{CDEB}$$

So far, the story was about introducing a tax where there was none before. Clearly, it is more realistic to consider an increase in the tax rate of an existing tax, giving rise to a marginal burden and a marginal excess burden of taxation. It is straightforward to develop a diagram similar to the one above for an increase in the tax rate. In such a diagram the areas representing the decline in the private surplus and the additional tax revenue get only slightly more complicated. Suffice it to change definition (B1) to

$$(B2) \quad \text{Marginal excess burden} = \frac{\text{decline in private surplus} - \text{additional tax revenue}}{\text{additional tax revenue}}$$

$$= \frac{\text{decline in private surplus}}{\text{additional tax revenue}} - 1 = \beta^c$$

Let us now establish the link between the (marginal) excess burden and the (marginal) economic cost of public funds. As set out in the main text, the excess burden makes the cost of transferring tax revenue of one euro from the private sector to the government larger than one euro. In fact, the cost of transferring one euro from the private sector to the government equals the decline in the private surplus per unit of additional tax revenue. Using the symbol α^c for this ratio and accounting for (B2) yields:

$$(B3) \quad \text{Economic cost of public funds} = \frac{\text{decline in private surplus}}{\text{additional tax revenue (conventional)}} = \alpha^c = 1 + \beta^c$$

This relation is identical to Equation (1) in the main text, with the term in the middle emphasizing that the economic cost of public funds equals the decline in the private surplus per unit of additional tax revenue raised. In Figure B1, α^c can be expressed as $1 + DAE/CDEB$ or as $CDAB/CDEB$.

2.3 Modified approach to the economic cost of public funds

Public expenditure financed with the income tax revenue can be thought of as having direct and indirect welfare effects. Consider a road-safety improvement project, for example. The direct benefit of this project is a decline in road accidents and, thus, the damages that usually come with them – deaths, injuries, material damages, and so on. For ease of exposition, assume that direct benefits equal the tax revenue raised for the project. Thus far, the change in welfare is the same as in the case of returning the tax revenue to households: The direct benefits of the project exactly compensate for the tax burden, leaving the excess burden of taxation as the net welfare loss of the road-safety improvement project. And then, the view that the cost of public funds (per euro transferred from the private sector to the government) is $1 + \beta^c$ would continue to hold.

Diamond and Mirrlees (1971), Stiglitz and Dasgupta (1971), and Atkinson and Stern (1974) – among others – argue for a modification of this view because indirect benefits might partly or fully offset the outcome of distorting taxation. To illustrate, safer roads might entice households to allocate more of their time to work (and less to leisure). This could be, for instance, if the hazards of travelling to work deterred some households – or some members of a household – to take up work. With safer roads, there might thus be an increase in the supply of labour. This increase in labour supply – more generally, the boost to an economic activity hampered by distorting taxes – has been called the spending effect of the expenditure (Snow and Warren 1996).

The welfare implications of this are analyzed in Box 2. The main insight is as follows. The induced increase in labour supply boosts output. Because of the tax distortion, the economic value of this additional output is larger than its cost and, thus, there is a welfare gain. A measure of this gain is the extra income tax revenue accruing to the government, which comes on top of the additional revenue following from raising the tax rate to finance the project. In essence, the extra tax revenue reduces the net financing requirement of the project.

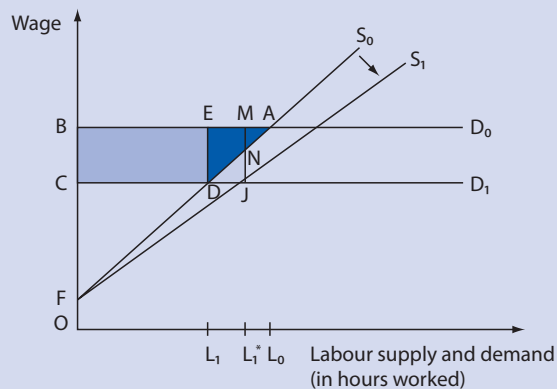
All in all, if the initial tax revenues are used to finance government expenditure, rather than handing them back to households as lump-sum transfers, and if these expenditure boost the activity that taxation curbs, there is an indirect welfare gain. This is because the spending effect of expenditure counteracts the departure from an efficient allocation of resources caused by distorting taxes.

If government expenditure boosts the economic activity that taxation curbs, there is an indirect welfare gain that counteracts the excess burden of taxation.

Box 2. Burden and excess burden of taxation – modified approach

The diagram below replicates Figure B1, but shows a rightward swivel of the labour supply curve to S_1 , indicating the increase in time households allocate to work because of the spending effect of expenditure such as the road-safety improvement project considered here. As a result of this induced rise in labour supply, hours worked increase from L_1 to L_1^* , while the gross wage and the net wage remain unchanged at BO and CO , respectively. With an increase in hours worked, output rises too.

Figure B2. Burden and excess burden of taxation – modified approach



In analyzing the welfare effect of the induced increase in output, there are two equally useful perspectives. One is to compare the benefit and cost of the additional output resulting from an increase in hours worked from L_1 to L_1^* . As the labour demand curve D_0 continues to indicate the (constant) marginal product of labour, the economic benefit of the extra output is $L_1 L_1^* ME$. The economic cost to households of producing this output, measured at the after-tax wage CO , is $L_1 L_1^* JD$. Hence, the net benefit associated with the increase in hours worked is $DJME$. The other perspective follows from simply measuring the extra income tax revenue, which is $DJME$. They accrue to the government, but can be thought of as flowing back to households or – which is the same thing – reducing the net financing needed to carry out public expenditure.

The area $DJME$ pictures the positive welfare effect that needs to be compared to the negative welfare effect associated with the excess burden, which is DAE . Thus, the net welfare effect is the difference between DJN and NAM . Although Figure B2 suggests a positive net effect, it must be stressed that this is merely because the rotation of the labour-supply curve has been drawn with a view to keeping the graphical exposition traceable. In other words, in contrast to what the diagram suggests, the labour-supply curve might swivel very little, making the area DJN (NAM) much smaller (larger) than in Figure B2. In any case, simple graphical illustrations of what are general equilibrium effects have their limitations. That said, a positive net welfare effect is possible.

In Figure B2, the difference between the conventional excess burden DAE and the additional tax revenue $DJME$ pictures the modified excess burden. This difference equals $NAM - DJN$, which is smaller than the conventional burden DAE . What is more, because of the spending effect and the increase in hours worked induced by it, modified tax revenues amount to $CDEB + DJME$ rather than $CDEB$. Hence, when expressing the excess burden and the cost of funds per unit of tax revenue, both are set relative to higher tax revenue than under the conventional approach. More specifically, using Figure B2 and definition (B3) from Box 1 yields

$$(B4) \quad \alpha^M = \frac{\text{decline in private surplus}}{\text{additional tax revenue (modified)}} = \frac{CDEB + DAE}{CDEB + DJME} = 1 + \frac{NAM - DJN}{CDEB + DJME} > 1.$$

This compares with

$$(B5) \quad \alpha^C = \frac{\text{decline in private surplus}}{\text{additional tax revenue (conventional)}} = \frac{CDEB + DAE}{CDEB} = 1 + \frac{DAE}{CDEB} > 1$$

for the conventional approach. Comparing the conventional approach with the modified approach can thus be summarized as:

$$(B6) \quad \alpha^C = 1 + \beta^C > 1 + \beta^M = \alpha^M,$$

with $DAE/CDEB = \beta^C > 0$

whereas $(NAM - DJN)/(CDEB + DJME) = \beta^M > 0$.

Strictly speaking, we have illustrated the case of introducing a tax rather than raising the tax rate of an existing tax. It is straightforward to develop a diagram similar to the one above for an increase in the tax rate.

What does all this mean for the excess burden of taxation and, thus, the cost of public funds? Clearly, there is a positive welfare effect that needs to be compared to the negative welfare effect associated with the excess burden. The net welfare effect might be negative, zero, or positive – in which case the indirect project benefits, triggered by the spending effect, would outweigh the excess burden of taxation as defined so far. One could stop here.

But one can go further. The modified approach does not simply compare the excess burden as defined so far – that is, the conventional excess burden – with indirect benefits that might counterbalance this burden. Rather – as Jones (2005) has worked out in an exemplary manner – it modifies the very definition of the excess burden and the economic cost of public funds. A stripped-down version of this modification is

$$(2) \quad \text{Economic cost of public funds} = \alpha^M = 1 + \beta^M \text{ with } \alpha^M > 1 \text{ if } \beta^M > 0$$

The structure of Equation (2) is identical to that of (1). However, because of indirect project benefits, the modified excess burden and cost of funds are smaller than their conventional siblings ($\beta^M \leq \beta^C$ and $\alpha^M \leq \alpha^C$). What is more, the modified excess burden might be negative ($\beta^M < 0$), implying that the cost of raising one euro might be less than one euro ($\alpha^M < 1$). This is in sharp contrast to the conventional approach where the excess burden of a distorting tax β^C is always positive and the economic cost of raising one euro is always greater than one euro.²

An observation of utmost importance is due: Modifying the definition of the excess burden and the cost of funds does not change the difference between the benefits and the costs of the project financed by a distorting tax. Rather, with the modified definition, indirect project benefits are counted as cost-reducing factors in the cost-benefit equation whereas with the conventional definition they are counted as benefits. This will be made explicit in Section 3 where it will become clear, too, that the practical implication of this difference is less innocuous than it appears. But before getting there, a few conclusions, extensions, and caveats should be noted.

Modifying the definition of the excess burden and the cost of funds does not change the net benefits of the project financed by a distorting tax.

² More precisely, the conventional excess burden is always non-negative and the conventional economic cost of raising one euro is always at least one euro. The conventional excess burden might be zero and the conventional economic cost might be one euro if taxation does not affect the taxed activity. For a wage tax, this would be the case for a vertical labour-supply curve.

2.4 Summing up and glimpsing at extensions and caveats

The main point to take away from this section is that while distorting taxes lead to a welfare-reducing decline in taxed activities, spending tax revenue might indirectly boost the very same activities. Thus, considering the distorting effect of taxes without considering, too, indirect spending effects gives an incomplete assessment of tax-financed expenditure. To illustrate this point, this section has used the example of a wage tax and a road-safety improvement project that was assumed to positively affect the supply of labour – the activity curbed by taxation.

The welfare increase operating through an increase in taxed activities is of a more general nature. Suppose there is not only a wage tax but a petrol tax, too, which for simplicity is assumed to be levied for purely fiscal reasons, not because of environmental or other externalities. Assuming that the demand for traffic is price elastic, the petrol tax reduces traffic below its optimal level. If safer roads foster traffic, road-safety improvements come with a welfare-enhancing spending effect in addition to the one resulting from an increase in the supply of labour. This welfare effect reveals itself in additional petrol tax revenue – at a constant petrol tax rate – thereby reducing the modified cost of funds associated with an increase in the wage tax.

One could think of other expenditures that indirectly boost the supply of labour. For instance, expenditures that successfully improve public health – itself beneficial – might tilt households' choice in favour of work, thus increasing the supply of labour. And then, government research might succeed in improving occupational safety, triggering an increase in labour supply.

While distorting taxes lead to a welfare-reducing decline in taxed activities, spending tax revenue might boost the same activities – but it could also further reduce them.

That said, it is easy enough to imagine indirect spending effects of all these expenditure that reduce rather than increase the supply of labour. Consider the road-safety improvement project again. Maybe it concerns a road that links a region where households live and work with a region where they can pursue leisure activities, say, enjoying a beach or a forest. The choice between work and leisure might then change in favour of leisure, thus cutting the supply of labour. Contrary to the situation described in Sub-section 2.3, this would make the modified excess burden and cost of funds larger than their conventional siblings ($\beta^M \geq \beta^C$ and $\alpha^M \geq \alpha^C$). Likewise, environmental expenditures that make beaches and forests more enjoyable might well reduce the supply of labour. More generally, whether indirect spending effects are positive or negative depends on whether public expenditures complement or substitute for taxed activities (Ballard and Fullerton 1992). All this highlights the challenges in properly assessing the welfare implications of tax-financed expenditure, an issue Section 3 will elaborate on.

After everything else, two questions are worth mentioning briefly. First, given the negative welfare implications of distorting taxes, why not impose lump-sum taxes instead? Obviously, lump-sum taxes militate against the notion of fairness as they tax the poor as much as the rich. Second, are the costs of administering taxes, monitoring tax payments, and enforcing compliance not far more important than the excess burden of taxation? Arguably, such costs are important and they add to the total cost of taxation. However, in contrast to the excess burden of taxation, they probably change little when increasing tax rates to finance additional expenditure.

3. The economic cost of public funds in cost-benefit analyses

To start with an extreme benchmark, consider again a perfectly competitive economy. In such an environment, the allocation of resources resulting from the market interactions of firms and households is efficient and, thus, no public project – however financed – can improve the allocation of resources. This is a classic result of welfare economics, and it is succinctly presented in Dinwiddie

and Teal (1996), for instance. In fact, a cost-benefit analysis of a public project in such an environment would show that its cost exceeds its benefit.

Moving on to a more pertinent benchmark, let us introduce public goods, that is, goods and services the market fails to supply or supplies in insufficient quantities. In these circumstances, markets do not allocate resources efficiently, and government provision of public goods can make society better off. More specifically, increasing the supply of public goods enhances welfare as long as their marginal benefits exceed their marginal costs. Assuming that marginal benefits fall with an increase in public goods (and/or that marginal costs rise), the optimal level of spending on public goods is found when marginal benefits equal marginal costs. In the absence of market failures other than the public-goods market failure and with lump-sum taxes financing the provision of public goods, the condition for the optimal provision of public goods is

$$(3) \quad B = C,$$

with B indicating the direct marginal benefits of public goods and C the marginal costs of producing them.³ As in Section 2, a road-safety improvement project is used from here on as an example for the provision of a public good, with B and C indicating the project's direct benefits and its costs, respectively.

How does the cost-benefit comparison change relative to benchmark (3) if the real-world situation differs from the perfectly competitive setting not only because of the public-goods market failure but because distortionary taxes are used to finance the project? The conventional approach to the economic cost of public funds suggests that project costs need to be scaled up by the factor $\alpha^C > 1$ because the economic cost of one euro raised with distorting taxes is larger than one euro. This changes the cost-benefit rule to

$$(4) \quad B = \alpha^C C \quad \text{with} \quad \alpha^C = 1 + \beta^C \quad \text{and} \quad \beta^C \geq 0.$$

Thus, due to the excess burden of taxation ($\beta^C > 0$), the economic cost of the project becomes $\alpha^C C > C$. It follows that the cost-benefit rule (4) requires $B > C$, that is, for a project to be economically viable its direct benefit must be larger than its cost to make good for the excess burden of taxation.

To illustrate, for $\alpha^C = 1.2$, direct project benefits must exceed direct costs by 20 percent to ensure the economic viability of the project. To put it differently, a road-safety improvement project costing EUR 100 million would need to generate direct benefits of EUR 120 million. Section 4 will review empirical estimates of the parameter α^C .

Let us then consider indirect project benefits, more specifically, spending effects that boost economic activity hampered by distorting taxes. For the wage tax and the road-safety improvement project, the spending effect increases the supply of labour, output, and wage tax revenue. Induced tax revenues, which measure the welfare impact of the spending effect, accrue to the government and reduce the financing requirement for the project to $C - R$, with R representing the extra tax revenue due to the spending effect. As a result, the scaling factor α^C needs to be applied to project cost and induced tax revenue, that is, the net budgetary impact of the project. The optimality condition then becomes:

³ In essence, (3) is the Samuelson condition for the optimal provision of a public good, with B representing the aggregate marginal willingness to pay for the public good and C representing its marginal production costs.

The conventional approach to the economic cost of public funds suggests that for a project to be economically viable its direct benefits must be larger than its direct costs.

$$(5) \quad B = \alpha^C (C - R)$$

Showing the indirect benefits R with a negative sign on the right-hand side of (5) is a matter of choice. But it helps emphasize that the indirect benefits accrue as income tax revenue to the government, thereby reducing the finance needed for the project. Alternatively, the indirect benefits could be shown as $\alpha^C R$ on the left-hand side of (5).

The modified approach suggests that a project might be welfare enhancing even if its direct benefits are smaller than its direct costs.

Depending on the relative size of the economic cost of public funds (α^C), indirect project benefits (R), and direct project costs (C), a project can be viable with $B \geq C$. To illustrate, suppose indirect benefits (R) of the road-safety investment amount to EUR 25 million. With project cost of EUR 100 million and $\alpha^C = 1.2$, the investment is worthwhile even if its direct benefits amount to only EUR 90 million.

The possibility that a public project might be welfare enhancing even if its direct costs exceed its direct benefits ($B < C$) and the economic cost of raising one euro is larger than one euro ($\alpha^C > 1$) has been first pointed out by Diamond and Mirrlees (1971) and Stiglitz and Dasgupta (1971).

Clearly, the view that economically viable projects require $B > C$ is the more likely to hold the greater the economic cost of funds (α^C) and the smaller indirect project benefits (R). And then, there is a combination of α^C , R , and C that requires an economically viable project to merely generate direct benefits equal to its costs ($B = C$), as cost-benefit rule (3) demands. This combination is:⁴

$$(6) \quad R = \frac{\alpha^C - 1}{\alpha^C} C.$$

If this relation holds, a worthwhile project simply requires $B = C$. But if the left-hand side is smaller (greater) than the right-hand side, $B > C$ ($B < C$).

More important than this rather mechanical interpretation are the economics that make (5) simplify to $B = C$. Recall that the marginal excess burden of taxation β^C (which is the reason for $\alpha^C > 1$) is because raising a distorting tax results in a further decline in hours worked and output compared to the optimal level ensuing in a setting that is perfect apart from the public-goods market failure. Remember, too, that the indirect benefits R result from an increase in hours worked and output triggered by the spending effect of the road-safety improvement project. Intuition then suggests that the marginal excess burden and the indirect benefits exactly offset each other if the negative output effect associated with the former is just as big as the positive output effect of the latter, that is, if the net output effect of the project and its financing is zero. Ballard and Fullerton (1992) and Jones (2005) show that this is indeed the case. It follows that if the drop in output associated with the excess burden is smaller than the rise in output due to the spending effect, the project might be welfare enhancing even when its direct benefits fall short of its costs ($B < C$). And *vice versa*: The direct project benefits must surpass costs ($B > C$) if the fall in output caused by the tax distortion is larger than the increase in output triggered by the spending effect. This is also true, of course, if the project comes with a negative spending effect ($R < 0$), that is, if the spending reduces labour supply, hours worked, and output.

Thus far, the discussion has been cast in terms of the conventional cost of public funds α^C although the cost-benefit rule (5) incorporates indirect benefits of the spending effect, which has been presented in Section 2 as a salient feature of the modified approach to the economic cost of public funds. To recall, the definition of α^C assumes that the extra revenue resulting from raising the rate of a distorting tax is handed back to households in the form of lump-sum transfers. Clearly, this does

⁴ Mathematically, it can be found by searching for the combination of α^C , R , and C that makes α^C and R disappear from (5).

not happen when the extra revenue is used to finance public projects. As pointed out in Section 2, retaining that assumption nonetheless is a useful analytical device to isolate project-financing effects (α^C and C) from project-spending effects (B and R).

With this in mind, we follow Jones (2005) and rewrite the cost-benefit rule (5) so that it becomes

$$(7) \quad B = \alpha^M C \quad \text{with} \quad \alpha^M = \alpha^C \left(1 - \frac{R}{C} \right).$$

In (7), α^M indicates the modified cost of public funds. It rests on the conventional cost of funds α^C coincides with α^C for $R = 0$ (that is, when there is no spending effect), is smaller than α^C for $R > 0$, and exceeds α^C for $R < 0$. And then, for distortionary taxes, α^C is always larger than one whereas α^M can be smaller than one for $R > 0$ depending on the relative size of α^C , R , and C . To illustrate this, let us return to our numerical example: With indirect benefits (R) of EUR 25 million, direct project costs (C) of EUR 100 million, and $\alpha^C = 1.2$, we get $\alpha^M = 0.9$. Thus, the road-safety improvement is worthwhile even if its direct benefits (B) amount to only EUR 90 million, thus covering only 90 percent of its costs.

Obviously, (5) and (7) should lead to the same decision. That said, the cost of public funds α^C depends only on the marginal excess burden of taxation *à la* Pigou-Harberger-Browning and, thus, depends only on the tax used to finance the project.⁵ By contrast, the modified cost of public funds α^M depends not only on the tax but also the type of project. This makes α^M a project-specific parameter unless, that is, the spending effect *à la* Diamond-Mirrlees-Stiglitz-Dasgupta is the same for all projects. This difference between α^C and α^M has considerable practical implications.

For one thing, when using (5), project appraisal practitioners can consider α^C an exogenously determined economy-wide parameter – established, for instance, by the ministry of finance. They could then focus on appraising project-specific aspects, notably B , C , and R . In essence, such an approach is well aligned with the separation of responsibilities between the ministry of finance and other branches of government or, for that matter, between a general economics department and the project appraisal department in international finance institutions.

For another, project appraisal practitioners need to know whether the cost-of-funds estimate they use reflects α^C or α^M . To illustrate, practitioners might work with an estimate of α^M without being aware that it incorporates indirect spending effects (of the specific public expenditure underlying that estimate). If they then account for indirect spending effects associated with the project they appraise, they double count and overstate the net benefits of the project. Such concerns would be largely irrelevant if it were clear from the literature whether it offers an estimate of α^C or α^M and, in the case of α^M , how important the spending effect of that α^M is relative to the spending effect of the project appraised. Alas, this is not so, and there is more to it than the distinction between the conventional and the modified approach to the cost of public funds – as the next section will argue.

But before turning to that, two concluding comments are worth making. The cost-benefit rule presented here rests on a number of simplifying assumptions and certainly does not capture all possible general equilibrium effects following from raising funds and spending them on projects. For instance, projects might put upward pressure on wages. In a perfectly competitive setting, this would be immaterial as price and wage changes net out if prices and wages adjust so as to clear markets (see Johansson 1993, for instance). In a tax-distorted economy, this is no longer the case, and – as Jones (2005) shows – an increase in wages due to the project exacerbates the marginal

Project appraisal practitioners need to know whether the cost-of-funds estimate they use reflects the conventional or the modified economic cost of public funds.

⁵ In an optimal tax system, each tax rate will be set so that the marginal excess burden is equal across all taxes. In practice, the marginal excess burden will be tax specific, however.

excess burden and thus increases the cost of public funds. All other things being equal, the direct benefits of a project need to be higher to ensure its economic profitability.

Finally, since the economic cost of funds (whether α^C or α^M) is a cost-scaling factor, it is relevant only for cost-benefit analyses, but not for cost-effectiveness analyses. Clearly, a cost-based ranking of project alternatives, meant to generate the same non-monetized benefits, does not change if all costs are scaled by the same factor.

4. Estimates of the economic cost of public funds

The previous sections suggest that the economic cost of public funds is “a potentially confusing concept” (Jones 2005, p.156). Along the same lines, Håkonsen (1998, p.229) emphasizes “The literature on the marginal cost of public funds (MCF) and the excess burden is presently a very rich one. A problem with this literature is that several different measures are interpreted as MCF.” Indeed, a number of authors have tried to reconcile different estimates of the cost of public funds (Fullerton 1991; Mayshar 1990, 1991; Snow and Warren 1996; Håkonsen 1998; and Jones 2005). Against this background, the purpose of this section is threefold: First, to present Jones’ (2005) review of differences between ‘conventional’ and ‘modified’ estimates; second, to explain why estimates of the conventional cost of public funds are bound to differ across countries; and third, to report on recent estimates of the conventional cost of public funds for pre-enlargement EU countries.

As the economic cost of public funds depends on country-specific circumstances, such as the tax regime, it is bound to vary across countries...

The review of Jones (2005) for wage taxes is reproduced in Table 1, showing that estimates range considerably, from 1 (Fullerton) to 1.57 (Stuart). That said, estimates for the United States suggest no striking difference between conventional and modified estimates. In any event, differences across countries might not be surprising for two reasons. Tax regimes and labour-market conditions vary across countries. As will be explained below, both features affect the distortionary impact of taxation. And then, the spending effect, which affects the modified cost of funds, depends, too, on labour-market conditions – more specifically the labour-supply response to public spending. As this response is probably country specific, estimates of the modified cost of funds are likely to differ from country to country. More fundamentally, commenting on the estimates of the modified cost of funds, Jones notes that “it is difficult to know the importance of the spending effect in each of them” (Jones 2005, p.170) – a lack of knowledge that seriously impairs the value of such estimates for the appraisal of specific public investment projects.

Turning to reasons why the cost of public funds is likely to differ across countries, differences in tax and welfare regimes are bound to be decisive, notably differences in average tax rates, marginal tax rates, progressivity of the tax system, and unemployment benefit schemes.

Differences in tax regimes combine with differences in the wage elasticity of labour supply. The excess burden of taxation and, by extension, the economic cost of public funds, is the higher the more the supply of labour reacts to a change in after-tax wages – a fact illustrated and discussed in Box 3. All other things being equal, countries with an elastic labour supply will have higher economic cost of public funds than countries with an inelastic supply. In fact, if the supply of labour is completely inelastic, an increase in the wage tax does not change labour supply and, thus, output. In this case, the conventional excess burden is zero ($\beta^C = 0$) and the conventional economic cost of public funds is one ($\alpha^C = 1$). It follows that the modified excess burden is negative ($\beta^M < 0$) and the modified economic cost of public funds is smaller than one ($\alpha^M < 1$) if the spending effect of the underlying government expenditure is positive, that is, boosts the supply of labour regardless of the after-tax wage.

Table 1. Estimates of the economic cost of public funds for wage taxes

	Country	Study	Estimate
Conventional α^c			
	United States	Fullerton (1991)	1 – 1.25
		Browning (1976,1987)	1.32 – 1.47
	Canada	Campbell (1975)	1.25
		Dahlby (1994)	1.38
	New Zealand	Diewert and Lawrence (1996)	1.18
	Australia	Campbell and Bond (1997)	1.19 – 1.24
		Findlay and Jones (1982)	1.275 – 1.55
Modified α^m			
	United States	Ballard and Fullerton (1992)	1.047 – 1.315
		Ballard <i>et al.</i> (1985)	1.16 – 1.31
		Stuart (1984)	1.07 – 1.57

Source: Jones (2005)

There is another reason why estimates of the economic cost of public funds vary – a reason more fundamental and unrelated to differences between countries. Two types of labour-supply curves have been used to measure and estimate the excess burden. One is the so-called uncompensated, or ordinary, supply curve. It shows the actual response of households to a wage change. The other is the so-called compensated supply curve. It represents a hypothetical response, capturing only the fact that lower wages make work less attractive but ignoring that they reduce income and, thus, increase the necessity to work. Box 3 sets out in more detail the difference between both concepts and why they affect empirical estimates of the economic cost of public funds. Suffice it to emphasize here that compensated labour-supply curves are more elastic than uncompensated ones and that cost-of-funds estimates based on the former are higher than those based on the latter.⁶

... but differences in cost-of-funds estimates also reflect differences in definition and measurement.

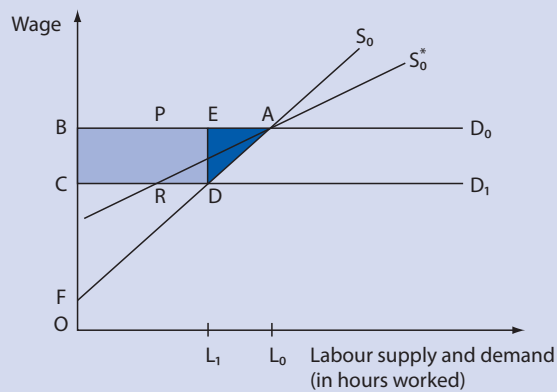
Knowing the essence of uncompensated labour-supply responses and elasticities, we are well prepared to review a study by Kleven and Kreiner (2006) that estimates the conventional cost of public funds for EU-15 countries. A salient feature of this study – setting it apart from most others – is that it explicitly distinguishes between two components of the aggregate labour-supply response. One reflects how employed people adjust the hours they work to a wage change; this is the intensive labour-supply response and the parameter measuring it is the uncompensated intensive supply elasticity. The other component reflects the entry and exit of people into the labour market due to a wage change; this is the extensive labour-supply response and the parameter measuring it is the participation elasticity or extensive supply elasticity.

⁶ Obviously, this statement applies to a wage tax. For a consumption tax, for instance, one needs to distinguish between compensated and uncompensated demand curves. The excess burden associated with the former is higher than that associated with the latter.

Box 3. Wage elasticity of labour supply and estimates of the economic cost of public funds

To examine the link between the elasticity of labour supply and the economic cost of public funds recall from Figure B1 and Box 1 that the conventional cost of public funds has been defined as the decline in the private surplus relative to the additional tax revenue. Both the decline in the private surplus ($CDEB + DAE$) and the additional tax revenue ($CDEB$) would be smaller for a flatter – that is, more wage-elastic – labour-supply curve. This is clear from Figure B3, which replicates Figure B1, but includes for comparison a more elastic labour-supply curve S_0^* . For this curve, the decline in the private surplus is $CRPB + RAP$ and additional tax revenues amount to $CRPB$ (implying an excess burden equal to RAP). The ratio between the two and, thus, the cost of public funds is the larger the greater the labour-supply elasticity is.

Figure B3. Excess burden, cost of funds, and elasticity of labour supply – conventional approach



Note: S_0^* can be understood to present a more elastic ordinary labour-supply curve than S_0 . Alternatively, it might be understood to be the compensated labour-supply curve associated with the uncompensated (that is, ordinary) labour-supply curve S_0 .

Instead of interpreting S_0 and S_0^* as two different labour-supply curves, one can, alternatively, interpret them as two curves highlighting different aspects of households' response to a change in wages. This takes us to an important subtlety we have ignored so far.

The link between wages and labour supply comprises two effects. For one thing, higher wages make leisure less attractive relative to work, enticing households to work more and reduce leisure. This so-called substitution effect implies a positive link between the wage rate and labour supply – consistent with upward-sloping labour-supply curve as shown in the diagram above. For another, higher wages boost households' income, thereby making leisure more affordable and, thus, increasing households' demand for leisure and reducing their supply of labour. This so-called income effect implies a negative link between the wage rate and labour supply, suggesting a downward-sloping labour-supply curve – in contrast to what is shown in the diagram above.

Cognizant of the substitution effect and the income effect of a wage change, there are two ways to picture households' response to a wage change. One rests only on the substitution effect triggered by a wage change, thereby considering only that lower wages render work less attractive relative to leisure. The income effect of lower wages – implying that lower wages reduce the affordability of leisure – is assumed to be compensated. Suppose S_0^* in Figure B3 shows this hypothetical 'compensated' labour-supply response.

The other way to look at things is to picture a curve that reflects actual labour supply, accounting for both the substitution effect and the income effect of a wage change. For a fall (increase) in wages, the substitution effect entices households to reduce (increase) their supply of labour whereas the income effect makes them supply more (less). As the substitution effect and the income effect work in opposite directions, this type of labour-supply curve must be steeper (that is, picture a smaller cut in labour supply for a given wage cut) than the one capturing only the substitution effect. Suppose S_0 in Figure B3 is this labour-supply curve. As the income effect is not compensated, it is called the 'uncompensated', or ordinary, labour-supply curve and the underlying wage elasticity of supply is labelled 'uncompensated', or ordinary, supply elasticity. An upward-sloping uncompensated supply curve like S_0 assumes that the substitution effect is larger than the income effect. This is not necessarily so. In fact, the uncompensated supply curve might combine an upward-sloping segment for relatively low wages (the substitution effect dominates the income effect) and a downward-sloping, or backward-bending segment for high wages (the income effect dominates the substitution effect).

Each type of labour-supply curve has been used to estimate the economic cost of public funds. For the compensated, relatively elastic supply curve, estimates should be based on the decline in surplus of $CRPB + RAP$ and the hypothetical increase in tax revenue of $CRPB$, thereby resulting in (conventional) marginal cost of public funds of $1 + RAP/CRPB$. For the uncompensated, relatively inelastic supply curve, estimates should be based on the decline in surplus of $CDEB + DAE$ and an actual increase in tax revenue of $CDEB$, thereby resulting in (conventional) marginal cost of public funds of $1 + DAE/CDEB$, which is larger than the estimate based on the compensated supply curve. That said, Jones (2005) suggests that some researchers have combined estimates of the 'compensated' decline in the private surplus based on S_0^* with estimates of the actual changes in tax revenue based on S_0 – and *vice versa*.

As in Boxes 1 and 2, Figure B3 shows the case of introducing a wage tax, although in interpreting the diagram, we had an increase in the tax rate on wages in mind. Drawing a diagram for an increase in the tax rate is straightforward and only slightly more complex.

Using elasticity estimates from the empirical literature and country-specific information on income, marginal and average tax rates, and effective tax rates on participating in the labour-market, Kleven and Kreiner simulate the economic cost of funds under alternative elasticity assumptions; they do this for both a proportional change in the marginal tax rate of all income groups (distinguishing ten groups) and a change in the marginal tax rate of one income group at a time. Table 2 contains a subset of their simulations of a proportional tax change.

Table 2. Estimates of the economic cost of public funds for wage taxes for EU-15 countries under different labour-supply elasticity assumptions

Country	S1	S2	S3	S1*	S3*
Austria	1.00	0.90	1.18	1.25	1.56
Belgium	1.00	0.83	1.32	1.41	2.14
Denmark	1.00	0.85	1.29	1.48	2.22
Finland	1.00	0.86	1.31	1.46	2.23
France	1.00	0.88	1.21	1.32	1.72
Germany	1.00	0.90	1.23	1.38	1.85
Greece	1.00	0.92	1.11	1.12	1.26
Ireland	1.00	0.89	1.16	1.21	1.45
Italy	1.00	0.89	1.19	1.22	1.52
Luxembourg	1.00	0.89	1.14	1.14	1.32
Netherlands	1.00	0.90	1.18	1.24	1.52
Portugal	1.00	0.88	1.15	1.15	1.36
Spain	1.00	0.94	1.07	1.10	1.19
Sweden	1.00	0.86	1.28	1.43	2.08
United Kingdom	1.00	0.93	1.10	1.13	1.26

Source: Kleven and Kreiner (2006)

Notes: Figures shown are estimates of the conventional marginal cost of funds, that is, a^c in the taxonomy of this paper. The first three simulations account only for intensive labour-supply responses: S1 uses an uncompensated supply elasticity of zero; S2 uses an uncompensated aggregate supply elasticity of zero, with positive (negative) elasticities for low-income (high-income) groups; S3 uses an elasticity of 0.1 for all income groups. S1* and S3*, respectively, adds an extensive labour-supply elasticity to S1 and S3. This extensive labour-supply elasticity is assumed to average 0.2 and to fall from 0.4 for the lowest income groups to zero for the highest income groups; in Kleven and Kreiner (2006), S1* and S3* is labelled S5 and S6, respectively.

Recent cost-of-funds estimates account for intensive and extensive labour-supply responses to changing wages.

The first three simulations (S1, S2, S3) account only for intensive labour-supply responses whereas the fourth and the fifth (S1*, S3*) account for intensive as well as extensive labour-supply responses. Simulation S1 sets a benchmark by assuming that the uncompensated intensive labour-supply elasticity is zero, implying a vertical labour-supply curve. In these circumstances, the wedge between gross and net wages does not change households' work-leisure choice, the conventional marginal excess burden is zero, and the conventional marginal cost of public funds is one, that is, the welfare cost of transferring one euro from the private to the public sector is one euro. Note that in this case, the modified cost of public funds would be smaller (larger) than one for projects with positive (negative) spending effects.

Simulation S2 retains an aggregate labour-supply elasticity of zero, but has the elasticity falling from a positive value for low-income groups (0.2 to 0.1) to a negative value for high-income groups (-0.1 to -0.2), implying a backward-bending labour-supply curve (a concept explained in Box 3). Positive elasticities work towards cost of public funds larger than one whereas negative elasticities suggest cost smaller than one. The simulation shows that the latter effect dominates the former for all EU countries, implying that the positive revenue and output effect resulting from the increase in the supply of labour by high-income workers outweighs the negative revenue and output effect resulting from the decline in the supply of labour by low-income workers. The possibility

of a 'negative' excess burden due to a backward-bending labour-supply curve was first noted by Atkinson and Stern (1974).

Simulation S3 rests on an intensive labour-supply elasticity of 0.1 for all income groups. The impact of this ranges from excess cost of 7 euro cents for each euro raised in the case of Spain to 32 cents in the case of Belgium. Broadly speaking, three groups of countries can be distinguished: First, southern European and Anglo-Saxon countries and Luxembourg, with relatively low economic cost of funds (1.07 to 1.16); second, the Nordic countries and Belgium, with much higher cost (1.28 to 1.32); third, all other countries – including the large continental economies Italy, France, and Germany – with economic cost of public funds somewhere in the middle (1.18 to 1.23). Although crude, this classification hints at a positive correlation between the economic cost of public funds and the size of both the welfare system and the government's tax take. Countries with relatively generous low-income support schemes and high marginal tax rates – the Nordic countries, for instance – tend to have relatively high cost of public funds. The opposite seems to hold for countries with limited low-income support schemes, strong pressure to accept low-wage jobs, and low marginal tax rates – as in the Anglo-Saxon countries, for instance.

The economic cost of public funds is far from negligible and is positively correlated with the size of the welfare system and the government's tax take.

Simulation S1* uses the same intensive labour-supply elasticity as simulation S1 (that is, zero) but accounts for an extensive labour-supply response (for details see Table 2), thereby isolating the impact of tax-induced market entry and exit decisions on the economic cost of public funds. As a comparison between S1* and S1 shows, the impact of the extensive labour-supply response on the cost of funds is considerable. Take France, for instance, where the extensive labour-supply response would raise the economic cost funds from one euro to EUR 1.32. What is more, the difference between S1* and S1 is larger than the difference between S3 and S1, suggesting that the extensive labour-supply response (indicated by the difference between S1* and S1) has a greater impact on the economic cost of public funds than the intensive response (the difference between S3 and S1).

Finally, simulation S3* combines the extensive labour-supply elasticities of simulation S1* with the intensive labour-supply elasticities of simulation S3. The differences between S3* estimates and S3 estimates confirm the importance of the extensive labour-supply response for the economic cost of public funds. Extensive labour-supply responses seem to be especially important for the cost of funds in the Nordic countries, Belgium, Germany, and France – that is, countries with high effective tax rates on participating in the labour market. That said, S3* estimates substantiate the country ranking and grouping mentioned above.

Running through alternative simulations does not mean they are equally valid. For instance, the purpose of S1 is mainly to set a benchmark. And then, the difference between S1* and S1 is meant to single out the importance of the extensive labour-supply response, that is, wage-driven decisions to enter or exit the labour market. Kleven and Kreiner (2006, p.21) consider S3* a "natural baseline" and in the summary of their findings it takes centre stage.

To wrap up, the economic cost of public funds appears to be far from negligible – though estimates vary considerably. While there are good reasons for estimates to differ across countries, one would expect similar estimates for the same country (and the same tax). This is not the case, however, because different studies define the economic cost of public funds differently, some estimating the conventional cost of funds, others the modified cost of funds. In addition, some studies measure the cost of funds on the basis of compensated labour-supply curves while others measure them on the basis of uncompensated labour-supply curves. Notwithstanding these differences, the empirical evidence suggests that the economic cost of one euro raised with distorting taxes is larger than one euro.

5. The economic cost of public funds, user fees, and the privatization of public goods and services

In developing the cost-benefit rules (5) and (7), it was assumed that project outputs are supplied free of charge. This is a sensible assumption when these rules are used to assess the economics of pure public goods, because trying to sell such goods for a price would result in no or a suboptimal demand for them. That said, goods and services with public-goods characteristics can be and are sold for a price, although probably one not high enough to cover all cost. This is true, too, for goods that markets would undersupply because of scale economies and positive externalities. Many goods and services feature public-goods characteristics, scale economies, and/or positive externalities, notably transport infrastructure, health, and education services. Against this background, it makes sense to ask how user fees change the cost-benefit assessment.

Following Brent (2006), a simple way to introduce user fees F in our presentation is to amend Equation (5) as follows:⁷

$$(8) \quad B - F = \alpha^c (C - R - F)$$

The rationale for this extension is straightforward. On the left-hand side of (8), user fees are subtracted to show the benefit of a project to users after they have paid for it. On the right-hand side of (8), user fees enter with a negative sign in the term in brackets because they reduce the project's net financing needs and, thus, the amount of public funds to which the excess burden of taxation applies. It is convenient to express user fees F as a ratio of direct project cost C . Introducing the symbol λ for this cost-recovery ratio and rearranging (8) leads to

$$(9) \quad B = \alpha^c \left[C \left(1 - \lambda \frac{\alpha^c - 1}{\alpha^c} \right) - R \right] \quad \text{with} \quad 0 \leq \lambda = \frac{F}{C} \leq 1.$$

While charging for the use of public services helps contain the excess burden of taxation ...

Because of user fees and, thus, less need for distortionary taxation, the right-hand side of (9) is smaller than the right-hand side of (5). To illustrate, assume that without user fees, α^c , C , and R combine so that direct project benefits (B) must exceed direct costs (C) by, say, 20 percent; with user fees, this hurdle falls below 20 percent. A corollary is that projects not passing the cost-benefit test without user fees might become economically viable with them.

Obviously, without user fees ($\lambda = 0$), Equation (9) simplifies to (5). For the other extreme – that is, full cost recovery ($\lambda = 1$) – Equation (9) becomes $B = C - \alpha^c R$. Thus, with full cost recovery, there is no need to tax and no excess burden. What is more, for projects with positive indirect spending effects ($R > 0$), implying that distortionary tax rates can be cut, projects might be welfare enhancing even if their direct benefits (B) are smaller than their direct costs (C). And then, (9) shows that user fees would not matter for the cost-benefit comparison if the economic cost of raising one euro was one euro ($\alpha^c = 1$).

Arguably, for the goods considered here, full cost recovery ($\lambda = 1$) is not a true option. In fact, economic reasoning militates against it. Take health and education services, for example, which generate benefits to society that exceed private benefits. For simplicity, assume that the marginal costs of supplying these services are constant, thus making them equal to average production costs. The optimal supply and consumption of such services is attained when their social marginal benefits equal their marginal costs, both being larger than private marginal benefits. To make users demand

⁷ The arguments that follow could also be developed on the basis of Equation (7).

the socially optimal quantity, one cannot charge them more than what they are willing to pay, that is, the private marginal benefit. But this implies less than full cost recovery and a need for covering the gap between cost and user fees through taxation. To conclude, full cost recovery, while avoiding the excess burden of taxation, would result in too low a supply and consumption of health and education services.

Another example is a service characterized by economies of scale, a case in point being the service that roads, bridges, tunnels and other transport infrastructure offer. A salient feature of such services is that their average costs exceed their marginal costs. To encourage an optimal use of the infrastructure, user fees should be equal to marginal costs. Again, this would imply less than full cost recovery and a need for taxation. An alternative is to set user fees so that they cover average cost. While this would avoid the excess burden of taxation, it would result in a suboptimal use of the infrastructure.

All this suggests a trade-off between welfare changes caused by distortionary taxation and welfare changes caused by not optimally pricing public goods and services. On the one hand, the more complete the cost recovery is, the more the consumption of public goods and services is pushed below its optimum. On the other hand, the closer user fees are to the level ensuring an optimal use of public goods and services, the greater is the need for raising funds *via* taxation and, thus, the bigger the excess burden. HM Treasury (2000) highlights this trade-off in the context of pricing the dissemination of government information resources. Engel *et al.* (2008) show how this trade-off ought to enter welfare-maximizing contracts governing public-private partnerships.

... it might lead to a sub-optimally low demand for public services.

A qualification is due. As Brent (2006) points out, the link between user fees and the economic cost of public funds described above assumes that the government is the sole supplier of the goods and services under consideration. The link becomes more complex when the private sector supplies them too and when both the government and the private sector consume them. For instance, one could think of public and private roads used by public and private cars; public and private hospitals treating publicly and privately insured patients; public and private schools educating pupils paying school fees with government vouchers and pupils paying out of their parents' pockets; and so on.

In these circumstances, four relationships need to be considered. (i) The government produces for its own consumption; in this case, there is no link between user fees and the economic cost of public funds; this is because whatever user fee the government charges as a provider of services, it needs to pay as a user; hence, this relationship is irrelevant for the excess burden of taxation. (ii) This is true too when the private sector produces for its own consumption. (iii) The government produces for private consumption, which is the case captured by the equations above. (iv) The government consumes and pays for privately produced goods and services; as the government needs to raise taxes to finance its consumption, this relationship introduces an excess burden of taxation not mentioned so far.

Besides making the link between user fees and excess burden more complex, these relationships are important when the government considers ceding its own production, be that through straight privatization or public-private partnerships. Brent (2006) and Engel *et al.* (2008) discuss in greater detail how this affects the decision whether or not and how to privatize. Suffice it to note the key factors at play in Brent's analysis. Relationships (i) and (iii) – that is, those with government supply – disappear. As a result, the excess burden coming with relationship (iii) disappears, too. At the same time, government consumption initially captured by relationship (i) now falls under relationship (iv), increasing the excess burden associated with that relationship. Whether privatization is worthwhile depends on how efficient private sector production is compared to public sector production, the

level of government user fees prior to privatization, and the economic cost of public funds. Brent applies this framework to the privatization of psychiatric hospital services in the United States. Privatization can be either to for-profit private hospitals or to non-profit private hospitals. With economic cost of public funds based on Browning (1976, 1987) – see Table 1 above – Brent finds privatization to for-profit hospitals worthwhile but privatization to non-profit hospitals welfare reducing.

The link between user fees and the economic cost of public funds sheds a fresh perspective on privatization and public-private partnerships.

To summarize, with user fees appropriate for the type of goods and services examined here, economic cost of public funds larger than one remain relevant for cost-benefit analyses. User fees help contain the excess burden of taxation, thereby alleviating one type of economic inefficiency. Yet, to the extent that they prevent demand from reaching its socially optimal level, they give rise to another type of inefficiency. There is thus a trade-off to consider. What is more, the link between user fees and the economic cost of public funds sheds a fresh perspective on privatization and public-private partnerships – a perspective the literature is just beginning to explore.

6. The economic cost of public funds, discounting, and debt finance

So far, the analysis was cast in an atemporal, or one-period, framework. Clearly, in reality, project costs and benefits spread over many periods. This makes it necessary to compare costs and benefits occurring at different points in time – a task achieved by properly discounting future costs and benefits. But what is, then, the link between the economic cost of public funds and the discount rate to be used in cost-benefit analyses – that is, the social discount rate? Moreover, in an intertemporal, or multi-period, framework, the government might issue debt rather than raise taxes to finance public projects. How does debt finance change the perspective on the economic cost of public funds?

The essence of both questions can be addressed in a two-period framework. Moreover, assuming that all direct project costs C arise in the first period (the present) while direct benefits B and indirect benefits R arise in the second period (the future) simplifies the analysis without fundamentally affecting its results.

To start with the link between the economic cost of public funds and the social discount rate, we need to amend cost-benefit rule (5) so that it reflects the intertemporal nature of the problem:⁸

$$(10) \quad \frac{B_1}{1+d} = \alpha^c C_0 - \frac{\alpha^c R_1}{1+d}$$

In (10), d is the social discount rate, B_1 captures future direct benefits, C_0 stands for present direct costs, and $R_1 > 0$ reflects future indirect benefits. Like the discount rate, the economic cost of public funds α^c is assumed to be time-invariant. Moreover, α^c in (10) is of the same size as α^c in (5). The rationale for this is explained in Box 4. The cost-benefit rule (10) expresses the standard requirement that discounted benefits of the marginal project must equal discounted costs.

⁸ Alternatively, the analysis could be based on an intertemporal version of Equation (7).

Box 4. Atemporal and intertemporal economic cost of public funds

The purpose of this Box is to explain the conditions that make α^c in the atemporal world – Equation (5) – of the same size as α^c in the intertemporal world – Equation (10).

As Liu (2003) shows, in an intertemporal model, α^c is the net present value of welfare changes due to distortionary taxation (that is, the numerator in Equation (B3)) divided by the net present value of revenue changes resulting from an increase in tax rates (that is, the denominator in Equation (B3)). Hence, the intertemporal α^c might differ from the atemporal sibling for two reasons.

First, the welfare and revenue changes following the first-period changes in the intertemporal model might differ from the one-period changes in the atemporal model. Second, differences might result from discounting welfare changes (the numerator in the definition of the economic cost of funds) and revenue changes (the denominator in the definition of the economic cost of funds) at a different discount rate.

Indeed, Liu (2003) makes a case for discounting welfare changes at the after-tax (net) interest rate while discounting revenue changes at the before-tax (gross) interest rate. This makes the intertemporal α^c larger than it would be otherwise. Using the definition of α^c in Liu (2003), the intertemporal α^c is the same as the atemporal one if (i) welfare and revenue changes are constant over time – both measured relative to the situation before increasing the tax rate – and (ii) welfare changes and revenue changes are discounted at the same rate. Both assumptions are made here.

The main message transpiring from (10) is that the economic cost of public funds and the social discount rate are two different concepts, both equally important for the appraisal of public projects. This might seem surprising, and possibly confusing, given that the social discount rate is often understood to represent the cost of funds committed to a project. To clarify things, it is useful to go back to first principles and recall what the social discount rate is and how it could be measured.

As (10) illustrates and as stated at the outset, the sole purpose of the social discount rate – more precisely of the social discount factor $1/(1 + d)$ – is to make future costs and benefits comparable to present ones. Discounting is thus nothing more than a weighing exercise. Determining the weights is tricky, however.

To see why, it is useful to return to the benchmark of a perfectly competitive economy. As discussed in Sub-section 2.1, in such an economy, equality of three rates characterize an efficient intertemporal allocation of resources: The marginal rate at which households are willing to substitute present income for future income (MRS) is equal to the rate at which firms can transform income not used today into future income (MRT), and both are equal to $1/(1 + m)$, m being the market rate of interest. The marginal rate of substitution MRS can be expressed as $1/(1 + i)$, i being the time preference rate of an individual representative household; for now, let us assume that this rate reflects society's time preference, too. The marginal rate of transformation MRT can be expressed as $1/(1 + r)$, r being the marginal productivity of capital, that is, of resources not consumed today but invested with a

The economic cost of public funds and the social discount rate are two different concepts, both important for the appraisal of public projects.

view to increasing future consumption possibilities; thus, r captures the opportunity cost of present consumption, a rate that we assume to reflect society's opportunity cost, too. In sum, in this perfect world, $i = r = m$, that is, the social rate of time preference is equal to the social opportunity cost of capital and both are identical to the market interest rate. In these circumstances, choosing the discount rate d is easy. One simply selects the (observable) market interest rate, knowing that it measures social time preference and opportunity cost.

The choice of the social discount rate is complex and controversial.

Departures from this ideal benchmark make the choice of the social discount rate complex and controversial. In particular, capital market imperfections and distortionary taxes undo the equality between i , r , and m . A tax on interest income, for instance, drives a wedge between the social opportunity cost of capital (r) and the social rate of time preference (i). More precisely, a tax on interest income turns i into an after-tax return to households that is lower than the before-tax marginal productivity of capital r . Should one use i or r as the discount rate – or a combination of the two? If funds for a project had been consumed in the absence of it, there is an argument for using i . In contrast, if the project crowds out investment, it is tempting to make a case for choosing r – that is, the social opportunity cost of capital – as the discount rate. And then, there appears to be some logic to using a weighted average of i and r as the discount rate if the funds committed to the project replace consumption and investment.

This being said, setting the discount rate on the basis of the opportunity cost of capital is contentious – even if the project examined comes fully at the expense of investment. A neat way to illustrate the point is to consider a cost-effectiveness analysis – an analysis comparing the discounted resource cashflows of project alternatives that have the same non-monetized benefits. In this case, there is no logic to using a discount rate based on forgone benefits, or opportunities, because valuing the benefits of these alternatives is not the purpose of the analysis in the first place. Spackman (2004) presents this argument in greater detail in his survey of time discounting. In line with much of the literature, he concludes that the social discount rate should not be based on social opportunity cost but on the social time preference rate.⁹

Even if one were to disagree with this conclusion, a discount rate based on social opportunity cost would not introduce an additional cost-of-funds element into Equation (10). The economic cost of public funds continues to be captured exclusively by α^c , and a discount rate based on social opportunity cost merely implies that forgone opportunities are used to measure the importance of time. This is true, too, when the interest rate on government debt is used as the social discount rate, an approach favoured by Lind (1990), for instance.

This takes us to how the economic cost of public funds and the cost-benefit rule (10) might change if the government issues debt to finance public projects. To fix ideas, let us posit that Ricardian equivalence (Barro 1974) holds, implying that debt finance has no impact on aggregate demand and savings, interest rates, and capital formation. It also implies that the burden of taxation does not shift from the present to the future as households save (consume) more (less) today in anticipation of higher tax obligations tomorrow. However, as taxes will have to be raised eventually to service the

⁹ Spackman (2004) also recalls that the social time preference rate is typically presumed to be lower than the individual time preference rate – in contrast to the equality assumed above for simplicity. One argument on which this hypothesis rests is that as society has a longer life expectancy than individuals, it ought to be less myopic than individuals. Another argument draws on the 'isolation paradox' (Sen 1967). This argument has it that due to consumption externalities individuals give too much weight to present consumption relative to future consumption. Internalizing these externalities, which would be optimal from society's viewpoint, would result in lower individual time preference rates.

debt, debt finance shifts the excess burden of taxation from the present to the future. But there is more to it – as a period-by-period inspection will show.

In the first period, direct project costs (C_0) are the sole resource costs entering the cost-benefit equation.

In the second period, resource flows include direct and indirect project benefits (B_1 and R_1). In addition, one needs to account for the excess burden of taxation. But how big is it? As the government borrowed an amount equal to C_0 in the first period, it will have a debt service obligation of $C_0(1+g)$ in the second period, g being the interest rate on government debt. Extra tax revenue equal to the debt service obligation will have to be raised, suggesting costs of public funds of $\alpha^c C_0(1+g)$ or, equivalently, $(1+\beta^c) C_0(1+g)$. Only part of this, however, constitutes a resource cost and, hence, only part of it should enter the cost-benefit equation. To identify which part, consider the following breakdown of $(1+\beta^c) C_0(1+g)$:

$$(11) \quad (1+\beta^c) C_0(1+g) = C_0(1+g) + \beta^c C_0(1+g)$$

The first term on the right-hand side of (11) is the tax revenue required to service the debt. This term must not enter the cost-benefit equation because it does not represent a resource cost but transfers between households and the government that offset each other: Funds are taken from households through taxation and returned to them as debt repayment and interest income. By contrast, the second term – the excess burden of taxation – represents a resource cost that cost-benefit analyses must account for.

Government borrowing defers but does not avoid the excess burden of taxation.

Putting the pieces together, for debt-financed public projects, the cost-benefit rule needs to include present costs (C_0), future benefits (B_1, R_1), and future resource costs $\beta^c C_0(1+g)$. Using this in (10) and rearranging terms leads to

$$(12) \quad \frac{B_1}{1+d} = \alpha^c C_0 - \frac{\alpha^c R_1}{1+d} + \beta^c C_0 \frac{g-d}{1+d}.$$

This rule is identical to (10) for $g = d$, that is, there is no difference between taxing now or later. It is important to point out that $g = d$ can be for two distinct reasons. For one thing, the interest rate on government debt (g) might just happen to be equal to the social discount rate (d). For another, the government interest rate might be used as the social discount rate, not only eliminating the last term on the right-hand side of (12) but also substituting g for d in the remaining terms.

Suppose the choice of discount rate is so that $g > d$. In these circumstances, projects should be tax financed since debt finance reduces welfare by an amount equal to the last term on the right-hand side of (12). And *vice versa*: If the choice of discount rate is so that $g < d$, debt finance and, thus, taxing later is better than taxing now. That said, for a given government interest rate, choosing a higher social discount rate reduces the number of beneficial projects; thus, while they ought to be debt financed, there will be fewer of them. Finally, if there were no excess tax burden ($\beta^c = 0$), the choice of discount rate would be immaterial for the decision to tax now or later, but it would continue to affect the number of projects and the level of public expenditure that passes the cost-benefit test.

Given the importance of the term $g - d$ for the decision to tax now or later, it is pertinent to investigate how social discount rates used in practice compare with the government interest rate. Reviewing the

literature, Spackman (2004) finds for developed countries a social time preference rate of around 4 to 5 percent and a real return on long-term government debt of 2 to 3 percent. Adopting the social time preference rate as the social discount rate thus implies $g < d$, suggesting that society should prefer debt finance and taxing later over taxing now. The economic intuition follows from the last term on the right-hand side of (12): g measures the rate at which the deferred excess tax burden grows over time while d measures the rate at which the value of the numeraire used in the cost-benefit analysis falls over time; with the rate of fall exceeding the rate of growth, it makes sense to defer the excess burden regardless of the discount rate. Recall that this applies only to the deferred excess burden of taxation ($\beta^c C_0$) but not to the deferred burden of taxation (C_0) because repaying the debt offsets the latter, which thus does not impose any resource cost on the economy.

Lest this paints too rosy a picture of debt finance, a variety of caveats need to be mentioned. With debt finance preferred to taxation, government indebtedness goes up, government creditworthiness deteriorates, and – as a result – the interest rate on government debt increases. There is thus a tendency for g to rise until it equals d . With such an equilibrating mechanism ($g = d$), the last term in (12) drops out, making taxing later as suitable as taxing now.

More fundamental objections to the apparent advantage of debt finance follow from modifying key assumptions made so far. For a start, Ricardian equivalence might not hold, implying that debt finance reduces aggregate saving and investment, capital accumulation, and economic growth. All other things being equal, this would reduce the tax base, thereby raising the economic cost of public funds. Along similar lines, the tax rate increase needed in the future might apply to interest income, too, not only to labour income as assumed so far. This would lower the net return on savings, reduce savings, and thus shrink the tax base. These are important objections to the findings captured in (12), though they have been introduced here in a rather *ad hoc* fashion. Analyzing them more systematically requires an approach that explicitly models saving, investment, capital accumulation, and economic growth. Dahlby (2006) seems to be a first attempt to this end. Under baseline assumptions, he arrives at estimates of the economic cost of funds from government borrowing of 1.2 for Canada and 1.09 for the United States. An alternative scenario suggests estimates of 1.45 and 1.35.

The economic cost of public funds captures the welfare cost of transferring resources from the private sector to the government at any point in time whereas the social discount rate weighs costs and benefits occurring at different points in time.

All in all, this section makes two points. One is that the economic cost of public funds must not be confused with the social opportunity cost of capital – these are two distinct concepts. The former informs about the welfare cost of transferring resources from the private sector to the government at any point in time. The latter informs about the rate at which society can transfer resources across different points in time. This feature makes the social opportunity cost a candidate for time discounting, that is, for weighing costs and benefits not occurring at the same time. But it has been pointed out, too, that the social time preference rate is a better candidate for the social discount rate in cost-benefit analyses.

The other point is that the economic cost of public funds must not be confused with the cost of government borrowing, that is, the interest rate on government debt. Borrowing enables the government to defer the burden and the excess burden of taxation. When the debt falls due, debt service payments and the tax revenue required to meet them exactly offset each other and thus leave welfare unchanged. However, raising distortionary taxes to collect the revenue required for servicing the debt causes an excess burden. Whether or not society gains from facing this excess burden tomorrow instead of today depends on the interest rate on government debt and the social discount rate. The model sketched in this section suggests that, from society's viewpoint, carrying the excess burden later is as bad as carrying it now.

7. Conclusions

As the main findings have been summarized at the end of each section, four concluding remarks will do.

First, economic reasoning and empirical evidence suggest that the excess burden of taxation – and its implication that the economic cost of one euro of public funds exceeds one euro – is too important to disregard in the appraisal of government expenditure. But it is also true that government spending – on infrastructure investment, in particular – might have effects that counterbalance the excess burden. Thus, it would be wrong to consider the excess burden but to ignore effects possibly offsetting it. That said, estimates of the economic cost of public funds that account for these effects nonetheless suggest that it costs society more than one euro to transfer one euro from the private sector to the government.

The fact that the economic cost of one euro of public funds exceeds one euro is too important to disregard in the appraisal of government expenditure.

Second, for the appraisal of public infrastructure investment the most appropriate approach is to apply an estimate of the ‘conventional’ economic cost of public funds and to assess effects that possibly counterbalance the excess burden on a case-by-case basis. As the economic cost of public funds varies across countries, one size does not fit all and country-specific cost estimates should be used.

Third, policymakers and project appraisal practitioners might wonder whether available estimates of the cost of funds are reliable enough. Moreover, they might feel that assessing effects possibly counterbalancing the excess burden is, too, an exercise surrounded by too many uncertainties – and one taking them beyond the boundaries of project appraisal as commonly done. Clearly, accounting for the excess burden and effects offsetting it is a challenge. But so is the monetary valuation of greenhouse gas emissions, for instance, a challenge practitioners shied away from some 10 to 15 years ago, but which has become an integral part of project appraisal since then. Besides, ignoring the excess burden and effects offsetting it does not mean they have not been valued. On the contrary, it means they have implicitly been assumed to perfectly offset each other, implying a value of one for the ‘modified’ economic cost of public funds.

Lastly, there might be political reasons for neglecting the excess burden of taxation in the appraisal of government investment. After all, the scaling factor expressing the economic cost of public funds “declares so explicitly that taxation imposes a burden beyond the value of the revenue raised” (Spackman 2004, p. 488) and – using Browning’s estimate as an illustration – requires that government investment “must be at least 9-16 percent more productive than private expenditures to produce a net welfare gain” (Browning 1976, p. 283). It does not take an overly wicked mind to suspect that this is a message spendthrift policymakers and political parties prefer to disregard. Economists will continue to argue otherwise.

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