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Themed Section

Social Decision-Making Analysis: A General Approach to Inform Decisions on Resources in the Public Sector

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ABSTRACT

Objectives: Public expenditure aims to achieve social objectives by improving a range of socially valuable attributes of benefit (arguments in a social welfare function). Public expenditure is typically allocated to public sector budgets, where budget holders are tasked with meeting a subset of social objectives.

Methods: Decision makers require an evidence-based assessment of whether a proposed investment is likely to be worthwhile given existing levels of public expenditure. However, others also require some assessment of whether the overall level and allocation of public expenditure are appropriate. This article proposes a more general theoretical framework for economic evaluation that addresses both these questions.

Results: Using a stylized example of the economic evaluation of a new intervention in a simplified UK context, we show that this more general framework can support decisions beyond the approval or rejection of single projects. It shows that broader considerations about the level and allocation of public expenditure are possible and necessary when evaluating specific investments, which requires evidence of the range of benefits offered by marginal changes in different types of public expenditure and normative choices of how the attributes of benefit gained and forgone are valued.

Conclusions: The proposed framework shows how to assess the value of a proposed investment and whether and how the overall level of public expenditure and its allocation across public sector budgets might be changed. It highlights that cost-benefit analysis and cost-effectiveness analysis can be viewed as special cases of this framework, identifying the weakness with each.

Keywords: attribute of benefit, economic evaluation, marginal value of public funds, opportunity cost, social welfare.

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Introduction

Across Organisation for Economic Co-operation and Development countries, public expenditure accounts for a substantial proportion of the whole economy: on average approximately 41% of gross domestic product in 2019.[1] These public funds are intended to achieve a wide range of socially valuable objectives (henceforth social objectives) by improving a range of socially valuable attributes of benefit (henceforth attributes). Public expenditure tends to be allocated to public sector budgets, where decision makers, who are accountable for them, are given goals framed around a subset of social objectives. In this context, decision makers require an evidence-based assessment of whether a proposed investment is likely to be worthwhile given existing levels of public expenditure. However, some assessment of whether the overall level and allocation of public expenditure are appropriate is also required. Addressing both these questions requires an understanding of the range of benefits currently offered by marginal changes in different types of public expenditure and how the attributes gained and forgone might be valued.

Estimates of the marginal productivity of public expenditure indicate what socially valuable attributes are likely to be gained or forgone due to a marginal increase or reduction in different categories of public expenditure. These same estimates also reflect the opportunity costs, in terms of the range of attributes forgone, associated with investments that impose additional net costs on different types of public expenditure. Therefore, estimates of the marginal productivity of public expenditure are necessary to address whether or not a particular investment is worthwhile given public sector budgets and whether the current level of public expenditure and its allocation across budgets are appropriate.

For different reasons, the most commonly used methods of economic evaluation such as cost-effectiveness analysis (CEA) and cost-benefit analysis (CBA) are unable to address either of these questions adequately. In general, CBA does consider a broad range of attributes and also specifies a particular way to value them. However, it generally does not address the same range of opportunity costs associated with the existing level and allocation of public expenditure. As a consequence, it cannot identify whether

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particular investments are worthwhile, given current public expenditure, nor can it indicate how public expenditure ought to change. CEA has generally focused on single attribute and costs that fall on a particular budget. Although CEA does attempt to account for a narrow range of opportunity costs, it fails to account for the breadth of attributes that may be gained or forgone and, unlike CBA, it does not attempt to value them. Therefore, CEA is not able to address either of these questions adequately. Even the more recent extensions of CEA that attempt to account for the reality of a range of social objectives[2,3] and multiple constrained public sector budgets fail to fully account for the implications of the private consumption value of attributes and do not address the broader questions of the appropriate level and allocation of public expenditure.[4,5]

Building on Walker, Griffin, Asaria, Tsuchiya, and Sculpher,[5] this study fills this gap by providing a more general theoretical framework for economic evaluation to integrate both the opportunity costs of existing public expenditure and the social value of attributes. In doing so, it places methods of economic evaluation in health and social care within the broader fields of public finance and welfare economics and shows how broader questions of the level and allocation of public expenditure can be informed. We demonstrate that the 2 common approaches to evaluation (CBA and CEA) can be seen as special cases of this more general approach, which we term "social decision-making analysis" (SDMA).

Section (2) develops a more general framework and compares it with CBA and CEA (2.1). Section 3 uses a stylized numerical example to illustrate how this framework overcomes the weaknesses of CEA and CBA and demonstrates that a more complete evaluation of a proposed investment can also be used to examine whether the level and allocation of public expenditure are appropriate. Section 4 discusses and concludes.

A More General Framework

The process of social choice in many contexts can be viewed as a devolved hierarchy where a socially legitimate higher authority or principal (eg, government operating through some social democratic process) is responsible for improving all attributes and is accountable for the scale of public expenditure and how it is allocated to different budgets. This authority devolves responsibility to agents (decision makers) to improve a subset of specific attributes ($a_1,\ldots,a_N$) and who are made accountable for the public resources allocated to their budgets ($c_1,\ldots,c_M$). In this way, the higher authority is able to monitor the performance of each agent in improving specific and observable attributes with the resources made available to them.

These common arrangements pose a number of questions: how much public resource should be raised; how should it be allocated between the different budgets; which budgets should fund particular investments; to what extent will devolved decisions based on the narrower interests of particular decision makers fail to improve social value; and what additional responsibilities would be required to ensure they do?

To address these more general questions one first needs to specify how the higher authority would view the value of a proposed investment. An assessment of the social value of all the direct and indirect effects of the project on all attributes, net of the social value of opportunity costs falling on a range of attributes (due to direct and indirect cost falling on different budgets) is required. For simplicity, we assume that individuals are equally weighted, although distributional considerations could be incorporated. A project would be regarded as good value if the net social benefit (NSB), aggregated across all individuals, is greater than 0. The NSB of the project can be formalized as follows:

$$NSB = v_{a_1}\left[\Delta a_1 - \frac{\Delta c_1}{k_{c_1}^{a_1}} - \ldots - \frac{\Delta c_M}{k_{c_M}^{a_1}}\right] + \ldots + v_{a_N}\left[\Delta a_N - \frac{\Delta c_1}{k_{c_1}^{a_N}} - \ldots - \frac{\Delta c_M}{k_{c_M}^{a_N}}\right] \quad (1)$$

In (11), $v_{a_1},\ldots, v_{a_N}$ capture the social value (or private consumption value) of each attribute, which requires normative judgments (for simplicity of exposition we assume attributes to be separable). The terms $\Delta a_1,\ldots,\Delta a_N$ and $\Delta c_1,\ldots,\Delta c_M$ are functions of *all* possible *direct* and *indirect* effects of the new project on the attributes and available expenditure within budgets, respectively, and are generally informed by an economic evaluation of the proposed investment. Direct and indirect effects can occur for any individuals including direct recipients and others (eg, informal carers).

Equation (11) includes the opportunity costs falling on each attribute (eg, a_1) due to costs falling on *all* budgets, $\Delta c_1/k_{c_1}^{a_1},\ldots,\Delta c_M/k_{c_M}^{a_1}$. These opportunity costs are determined by the direct or indirect impacts of the new project on available expenditure within each budget ($\Delta c_1,\ldots,\Delta c_M$) and the shadow prices of each budget, $1/k_{c_1}^{a_1},\ldots,1/k_{c_M}^{a_N}$. Shadow prices are generally informed by empirical studies investigating the causal relationship between marginal changes in expenditure and the effects on a particular attribute. For example, $1/k_{c_1}^{a_1}$ is the shadow price of c_1 in terms of a_1 and reflects the amount of a_1 generated, on average, by changes in available expenditure within c_1. Therefore, $k_{c_1}^{a_1}$ measures the amount of resource from c_1 that is needed to generate, on average, 1 unit of a_1, so it reflects the marginal productivity of c_1 in producing a_1.[6,7]

We can reformulate (11) as follows:

$$NSB = v_{a_1}\Delta a_1 + \ldots + v_{a_N}\Delta a_N - \underbrace{\left(\frac{v_{a_1}}{k_{c_1}^{a_1}} + \ldots + \frac{v_{a_N}}{k_{c_1}^{a_N}}\right)}_{MVPF_{c_1}}\Delta c_1 - \ldots - \underbrace{\left(\frac{v_{a_1}}{k_{c_M}^{a_1}} + \ldots + \frac{v_{a_N}}{k_{c_M}^{a_N}}\right)}_{MVPF_{c_M}}\Delta c_M, \quad (2)$$

where $v_{a_1}/k_{c_1}^{a_1},\ldots, v_{a_N}/k_{c_M}^{a_N}$ reflect the social value of improving particular attributes through marginal changes in expenditure within each budget. For example, $v_{a_1}/k_{c_1}^{a_1}$ reflects the social value of improving a_1 through marginal changes in public expenditure devoted to c_1. Observing $v_{a_1}/k_{c_1}^{a_1} < 1$ would suggest that an additional £1 made available to c_1 would offer benefits to a_1, but the social value of these benefits would be less than the social value of transferring that same £1 to private consumption. However, public expenditure on c_1 may have positive direct and indirect benefits on a range of other attributes. Therefore, a more complete picture of the overall social value of marginal changes in particular categories of public expenditure is the sum of the social value of the marginal benefits across all attributes to the marginal cost of producing them (eg, $v_{a_1}/k_{c_1}^{a_1} + \ldots + v_{a_N}/k_{c_1}^{a_N}$).

Therefore, the information required to evaluate a particular proposed investment also provides an estimate of the marginal value of public funds (MVPFs) for changes in each category of public expenditure.[8,9] The MVPF of a particular budget captures the extent to which transferring resources from private consumption to public expenditure is likely to improve social value overall through its effect on all attributes. For example, if $MVPF_{c1} > 1$, then an additional £1 available in c_1 will generate a change in all relevant attributes with a social value that is greater than the social value of the same £1 devoted to private consumption. This suggests that an increase in public expenditure, funded through private consumption, would improve social value. However, the extent to which public expenditure might be increased will depend on how quickly the returns to public

expenditure diminish (eg, how quickly $k_{c_1}^{a_1}$ rises with increased expenditure on c_1) and the costs associated with raising public expenditure through socially acceptable means of taxation or public sector borrowing.[10-12]

Estimates of MVPF can also inform allocation decisions between public sectors. For example, estimates of the MVPF for c_1 and c_2 would suggest that reallocating funding from c_1 to c_2 is likely to generate greater social value as long as $MVPF_{c1} > MVPF_{c2}$. Equation (22) indicates that estimates of MVPF are necessary when considering the social value of a particular project. For example, a project that imposes costs on a budget with a high MVPF will be less valuable than the same project funded from a budget with a lower MVPF. In this sense estimates of the MVPF for different types of public expenditure indicate not only the social value of marginal increases in public expenditure but also the social value of the opportunity costs when costs fall on particular public sector budgets.

A Comparison With Common Economic Evaluation Methods

Equation (22) allows us to highlight the differences between the proposed social decision-making approach and common economic evaluation methods such as CBA and CEA. CBA would evaluate whether a new project is good value for money by computing the individual NSB as follows:

$$NSB = v_{a_1}\Delta a_1 + \ldots + v_{a_N}\Delta a_N - \Delta c_1 - \ldots - \Delta c_M, \tag{3}$$

where $v_{a_1},\ldots, v_{a_N}$ are assumed to be the individual willingness to pay for each attribute. In addition to this normative assumption, a comparison between (22) and (33) suggests that CBA would be equivalent to SDMA if:

$$\underbrace{\frac{v_{a_1}}{k_{c_1}^{a_1}} + \ldots + \frac{v_{a_N}}{k_{c_1}^{a_N}}}_{MVPF_{c_1}} = \ldots = \underbrace{\frac{v_{a_1}}{k_{c_M}^{a_1}} + \ldots + \frac{v_{a_N}}{k_{c_M}^{a_N}}}_{MVPF_{c_M}} = 1 \tag{4}$$

This identifies the key implicit assumption in CBA: that the MVPF of all categories of public expenditure are necessarily equal to 1; that is, when the effect on all attributes $(a_1,\ldots,a_N)$ is accounted for, an additional £1 available to any public budget (eg, c_1) will be worth the same as £1 spent on private consumption or on any other public sector budget. This assumption implies that the level and allocation of public expenditure are already set optimally with respect to the welfare function implied by the social value of attributes and that there are no welfare costs or other constraints on raising public finance.

In contrast, the individual net benefit (NB) in CEA can be written as follows:

$$NB = \Delta a_1 - \frac{1}{k_{c_1}^{a_1}}\Delta c_1 \tag{5}$$

A comparison between (22) and (55) reveals the unsurprising narrow scope of CEA, which only focuses on the effects on a_1 and the a_1-opportunity costs due to costs falling on c_1. The only circumstances in which (2) and (5) would lead to same decision would be if the project only offered benefits of a_l with no direct or indirect costs on other public sector budgets or private consumption and the opportunity costs associated with the direct and indirect costs of the project did not fall on any other attribute. Only in these very narrow circumstances would it not be necessary to value the attributes and provide an estimate of the MVPF. In all other circumstances, a valuation of the attributes affected (applied to both benefits and opportunity costs) combined with estimates of the marginal productivity of public expenditure in producing these attributes would be required. Once available, both the net social value of the project and the MVPF would be available to inform whether the project was worthwhile and whether the level and allocation of public expenditure were appropriate.

An Application of SDMA

We now illustrate the application of SDMA to the economic evaluation of a new intervention in a simplified UK context using a stylized numerical example. The new intervention may affect health as measured by health quality-adjusted life-years (H-QALY, a_1) and H-QALY-opportunity costs ($\Delta c_1 / k_{c_1}^{a_1}$).[13] The intervention may also have an impact on the (publicly funded) Adult Social Care (ASC) sector. ASC aims to improve, maintain, or minimize reductions in wellbeing as measured by the social care quality-adjusted life-years (SC-QALYs, a_2) and SC-QALY-opportunity costs ($\Delta c_2 / k_{c_2}^{a_2}$) of service users and carers.[14] Finally, the new intervention may affect the private sector via its effects on H- and SC-QALY. Assuming that all goods and services produced in the private sector are consumed, improving paid production (a_3) is the key goal of this sector. Sectors, budgets, and attributes in this simplified context are presented in Table 1. A graphical and intuitive illustration of the causal links that underpin this stylized example formalized in equation (6) is presented in Figure 1.

The application of SDMA allows a higher authority responsible for all attributes and accountable for all budgets to assess the value of the new intervention as follows:

[Societal perspective]

$$NSB^{Societal} = v_{a_1}\Delta a_1 + v_{a_2}\Delta a_2 + v_{a_3}\Delta a_3 + \underbrace{-\left(\frac{v_{a_1}}{k_{c_1}^{a_1}} + \frac{v_{a_2}}{k_{c_1}^{a_2}} + \frac{v_{a_3}}{k_{c_1}^{a_3}}\right)}_{MVPF_{c_1}}\Delta c_1 \underbrace{-\left(\frac{v_{a_1}}{k_{c_2}^{a_1}} + \frac{v_{a_2}}{k_{c_2}^{a_2}} + \frac{v_{a_3}}{k_{c_2}^{a_3}}\right)}_{MVPF_{c_2}}\Delta c_2, \tag{6}$$

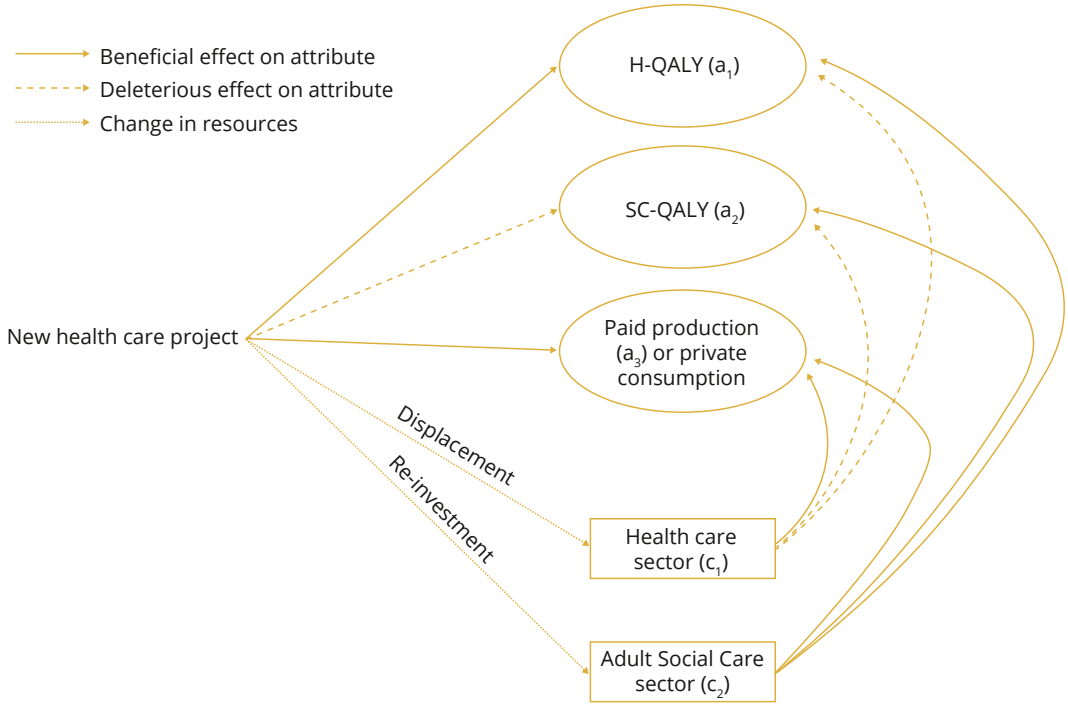
where Δa_1, Δa_2, and Δa_3 capture all (direct and indirect) effects of the new intervention on H-QALY, SC-QALY, and paid production and Δc_1 and Δc_2 capture all effects on healthcare (HC) and ASC

Table 1. Sectors, budgets, and attributes in the assumed society.

Sector of the society	Public budget	Key attribute pursued
Healthcare	c_1	a_1 (H-QALY)
Adult Social Care	c_2	a_2 (SC-QALY)
Private sector	-	a_3 (paid production)

H-QALY indicates health quality-adjusted life-year; SC-QALY, social care quality-adjusted life-year.

Figure 1. Illustration of Eq. (6) in the stylized example on SDMA. This figure illustrates the multiple effects on attributes and impacts on budgets of the new intervention as discussed in the stylized example in section 3. The new intervention has a beneficial effect on H-QALY and paid production but a deleterious effect on SC-QALY. Because it is funded through the HC budget, it causes a displacement of resources in the HC sector that, in turn, generates H-QALY and paid production losses (opportunity costs). In contrast, the new intervention produces some savings in the ASC sector that, when reinvested, generate a gain (negative opportunity costs) in all attributes. By taking account of all these effects and their social value, SDMA can yield an assessment about whether the new intervention provides good value for money.



ASC indicates Adult Social Care; HC, healthcare; H-QALY, health quality-adjusted life-year; SC-QALY, social care quality-adjusted life-year; SDMA, social decision-making analysis.

$$NSB^{Societal} = 70,000 \times 1.000 - 500,000 \times 0.030 + 1 \times 23,000 + -\underbrace{\left(\frac{70,000}{15,000} + \frac{500,000}{450,000} + \frac{1}{1.330}\right)}_{=6.5297} \times 16,000 + \underbrace{\left(\frac{70,000}{40,000} + \frac{500,000}{100,000} + \frac{1}{53.547}\right)}_{=6.7687} \times 4,000 = 600. \quad (7)$$

costs. The marginal productivity of HC and ASC expenditure in producing each of these 3 attributes is captured by the ks, and the social value of attributes is reflected in the versus estimates of all effects of the intervention on attributes and budgets are informed by economic evaluation. Although information on the social value of attributes (vs) requires normative judgments, estimates of marginal productivity (ks) are purely positive questions that are generally provided by empirical studies investigating the causal relationship between expenditure in one sector and the outcome of interest.

We use illustrative estimates of marginal productivity that reflect empirical evidence (where available) in this stylized numerical example (see section A1 of the Appendix in Supplemental Materials found at https://doi.org/10.1016/j.jval.2024.01.015). The example in which the HC sector bears the total cost of the new intervention (£16 000) is presented in Table 2. For each patient, the new intervention generates, on average, a gain of 1 H-QALY (row 1 of HC perspective) but increases HC costs by £16 000 (row 2) producing H- and SC-QALY-opportunity costs of 1.066667 and 0.035556, respectively (row 5 of HC and ASC perspective). However, the new intervention reduces, on average, SC-QALY by 0.03 (row 1 of ASC perspective) and decreases ASC costs by £4000 (row 2) generating additional 0.04 SC-QALY for each ASC client (row 6). In turn, the reduction in costs falling on ASC generates additional 0.1 H-QALY (row 6 of HC perspective). Moreover, the H-QALY gains (net of the SC-QALY loss) of the intervention means that patients are overall more productive and produce on average an additional £23 000 (row 1 of private sector perspective). However, the additional costs falling on HC imply a paid production-opportunity cost of £12 030 (row 5) and the lower costs for ASC mean an additional paid production of £75 (row 6).

Whether the new intervention is good value for money for society as a whole depends on the social value of each attribute (vs) and the MVPF of each budget. For example, assuming (for illustrative purposes) that a H-QALY is worth £70 000 of private consumption[15] and a SC-QALY £500 000 (row 8 of HC and ASC perspective). The new intervention would provide good value for money offering a $NSB^{Societal}$, in equation (66), of £600 (row 10):

Table 2. The effects of a new intervention with 2 public sectors and a private sector.

Row	HC perspective			Adult Social Care perspective			Private sector perspective		
1	Δa_1	1.000	H-QALY	Δa_2	−0.030	SC-QALY	Δa_3	23 000	Production £
2	Δc_1	16 000	HC £	Δc_2	−4000	ASC £			
3	$k_{c_1}^{a_1}$	15 000	HC £ per H-QALY	$k_{c_1}^{a_2}$	450 000	HC £ per SC-QALY	$k_{c_1}^{a_3}$	1.330	HC £ per production £
4	$k_{c_2}^{a_1}$	40 000	ASC £ per H-QALY	$k_{c_2}^{a_2}$	100 000	ASC £ per SC-QALY	$k_{c_2}^{a_3}$	53.547	ASC £ per production £
5	$\Delta c_1 / k_{c_1}^{a_1}$	1.066667	H-QALY	$\Delta c_1 / k_{c_1}^{a_2}$	0.035556	SC-QALY	$\Delta c_1 / k_{c_1}^{a_3}$	12 030	Production £
6	$\Delta c_2 / k_{c_2}^{a_1}$	−0.100000	H-QALY	$\Delta c_2 / k_{c_2}^{a_2}$	−0.040000	SC-QALY	$\Delta c_2 / k_{c_2}^{a_3}$	−75	Production £
7	NB^{HC}	0.033333	H-QALY	NB^{ASC}	−0.025556	SC-QALY	$NB^{Private}$	11 045	Production £
8	v_{a_1}	70 000	PC £ per H-QALY	v_{a_2}	500 000	PC £ per SC-QALY	v_{a_3}	1	PC £ per production £
9	NSB^{HC}	2333	PC £	NSB^{ASC}	−12 778	PC £	$NSB^{Private}$	11 045	PC £
10	$NSB^{Societal}$ = £600								

Note. A negative opportunity cost (eg, $\Delta c_2 / k_{c_2}^{a_1} = -0.100$ H-QALY) implies a gain in the relevant attribute (eg, H-QALY gain).
ASC indicates Adult Social Care; HC, healthcare; H-QALY, health quality-adjusted life-year; SC-QALY, social care quality-adjusted life-year; SDMA, social decision-making analysis.

In our stylized example, the MVPF of HC expenditure is approximately equal to 6.5, whereas that of ASC expenditure is approximately 6.8. Given that these values are substantially greater than 1 (and any reasonable estimate of the marginal cost of raising public funds),[8,9] both sectors could be regarded as "underfunded" because additional social value can be generated by increasing public expenditure in both sectors by transferring resources from private consumption. Moreover, as long as the MVPF of ASC expenditure is greater than that of HC expenditure, additional social value can be generated by reallocating resources from the HC to the ASC budget. Interestingly, funding a new intervention by displacing resources within the ASC budget having a higher MVPF or private consumption means, respectively, reducing or increasing the social value of that intervention. A detailed discussion about these 2 additional scenarios is presented in section A2 of the Appendix in Supplemental Materials found at https://doi.org/10.1016/j.jval.2024.01.015.

The value of the intervention can also be considered from the narrower perspective of each decision maker responsible for only one of the 3 attributes. The NB of the new intervention is the difference between all effects of the intervention on the attribute of interest to the decision maker, net of all the opportunity costs falling on that attribute due to costs imposed on any budget:

$$[\text{HC perspective}] \qquad NB^{HC} = \Delta a_1 - \frac{\Delta c_1}{k_{c_1}^{a_1}} - \frac{\Delta c_2}{k_{c_2}^{a_1}} > 0, \tag{8}$$

$$[\text{ASC perspective}] \qquad NB^{ASC} = \Delta a_2 \frac{\Delta c_1}{k_{c_1}^{a_2}} - \frac{\Delta c_2}{k_{c_2}^{a_2}} > 0, \tag{9}$$

$$[\text{Private sector perspective}] NB^{Private} = \Delta a_3 - \frac{\Delta c_1}{k_{c_1}^{a_3}} - \frac{\Delta c_2}{k_{c_2}^{a_3}} > 0, \tag{10}$$

The new intervention would still be regarded as worthwhile from the perspective of the HC and private sector; however, it would not be from the perspective of the ASC sector (NB^{HC}=0.033333 H-QALY; NB^{ASC}=−0.025556 SC-QALY; $NB^{Private}$=£11 045, row 7 of all perspectives in Table 2). Although the intervention would still be approved from the perspective of the HC and private sector, both would overestimate the social value of the new intervention because both ignore the NSB in the other sectors and, in this case, especially the net loss in the ASC sector ($NSB^{Societal}$=£600, row 10; $NSB^{HC}=NB^{HC}\times v_{a_1}$ =£2333; $NSB^{Private}= NB^{Private}\times v_{a_3}$ =£11 045; $NSB^{ASC}=NB^{ASC}\times v_{a_2}$ =−£12 778, row 9 of all perspectives). In doing so they do not account for the fact that the MVPF for the ASC sector is greater than 1 and greater than in the HC sector. Overestimating the value of an intervention in this way, by failing to consider the MVPF, may lead to projects being accepted as good value when, from a societal perspective, they are not, but it also runs the risk of over-rewarding those offering the intervention to the HC sector (eg, pharmaceutical manufacturers). For example, from the societal perspective, the maximum Δc_1 that can be paid for this intervention would be approximately £16 092, because at that cost the $NSB^{Societal}$ is zero. However, from the HC and the private sector perspective the maximum would be higher (£16 500 and £30 690, respectively) and, if paid, would result in net loss of social value (−£2665 and −£95 320, respectively).

Of course, if the responsibility within a public sector, for example the HC sector, is extended to improving all attributes, then the new NSB^{HC} would be equal to $NSB^{Societal}$ (=£600) in (77) because this is also matched by a responsibility to account for the social value of all opportunity costs falling on all attributes, which necessarily requires information on the MVPF for each sector.

The consequences of failing to account for the full range of opportunity costs using the MVPF can be illustrated by considering how CBA would estimate $NSB^{Societal}$ under the implicit assumption that each HC or ASC pound is worth a private consumption pound ($MVPF_{HC}=MVPF_{ASC}=1$):In this case CBA would also recommend the approval of the new intervention. However, the value of this intervention would be markedly overestimated at £66 000 rather than £600. Although CBA does indeed take account of a broad range of attributes and their social value, the failure to take account of empirical evidence that the $MVPF_{HC}>1$ and $MVPF_{ASC}>1$ means that the social value of projects will be overestimated, potentially leading to accepting projects that should be

$$NSB_{CBA} = v_{a_1}\Delta a_1 + v_{a_2}\Delta a_2 + v_{a_3}\Delta a_3 - \Delta c_1 - \Delta c_2 == 70,000 \times 1 + 500,000 \times (-0.026) + 1 \times 23,000 - 16,000 + 4,000 = 66,000. \tag{11}$$

rejected. It will also over-reward those offering new interventions to public sectors. In this case, CBA suggests that the maximum Δc_1 society should pay for this intervention would be £82 000 rather than £16 000, which if paid would reduce social value by −£430 357.

Similarly, using CEA to evaluate the new intervention is one more example of how failing to account for the MVPF can lead to suboptimal decisions. The recommendation based on a CEA from the HC sector perspective would be rejection:

$$NB^{HC}_{CEA} = \Delta a_1 - \frac{1}{k^{a_1}_{c_1}}\Delta c_1 = 1 - 1.067 = -0.067, \quad (12)$$

and the additional social value generated by the new intervention would be missed.

Discussion and Conclusions

This proposed framework for economic evaluation builds on existing work[4,5,16] demonstrating that expanding the attributes considered, for example, by adopting value frameworks or an impact inventory to assess health technologies,[2,3] will only improve social decision making if it is also matched by a similar expansion in the assessment of the marginal productivity of different types of public expenditure in delivering them. Without it there is a risk of over-valuing specific projects and the reward that could be offered to those delivering new interventions and innovations. In particular, we show that understanding the social value of marginal increases in public expenditure requires causal estimates of the effect on a range of attributes that go beyond the stated objectives of particular sectors (eg, that health improvement is the primary objective of public HC expenditure). In doing so, we are not only able to better inform the social value of a particular project, but are also able to inform broader questions about the overall level and allocation of public expenditure—questions which existing methods of evaluation, such as CBA or CEA, are not able to address.

This allows the methods of economic evaluation in health and social care to be placed more securely within the broader fields of public finance and welfare economics. The concept of MVPF draws on a relatively recent public finance literature, where it is most commonly promoted as an alternative to benefit-to-cost ratios, or NSB, to summarize the social value of particular projects.[8,9] However, it can also be used to assess the social value of a general increase in public expenditure, which can be compared with the MVPF for how the additional expenditure will be raised, for example, the marginal cost of public funds if it is raised through common forms of taxation.[8] However, how this should be done has not been fully specified, especially when there are multiple budget holders. Therefore, we also add to this broader literature in a number of ways. We show that the MVPF of increasing a particular category of public expenditure rests on the social value of the causal effects of marginal changes in expenditure across a range of attributes. We also show that in addition to reflecting the social value of increasing public expenditure, this reflects the social value of the opportunity costs, given the current level and allocation of public expenditure, of the direct and indirect cost of a project falling on particular public sector budgets (where this direct and indirect cost is described as the mechanistic costs and fiscal externality in the public finance literature).[9] Finally, rather than regarding public expenditure as a single governmental budget, we account of the reality of multiple budgets that may have different MVPFs.

This framework also points to a number of research priorities. We do not specify how decision makers should make normative judgments about the social value of attributes, although they might draw on positive empirical estimates of individual willingness to pay for those attributes through studies of revealed or expressed preference or by parameterizing utility functions.[17-19] Rather, the social value of projects and the MVPF can be conditional on a range of reasonably held but quite naturally disputed normative judgments, which can inform accountable deliberation rather than prescribe social choice. However, it is clear that more empirical work is required to estimate the causal effect of marginal changes in different categories of public expenditure on a wider range of attributes. Once these are available, they can be used to inform the social value of any project once its direct and indirect benefits ($\Delta a_1,\ldots,\Delta a_N$) and costs ($\Delta c_1,\ldots,\Delta c_N$) have been estimated. As this body of empirical evidence evolves, we show how it can be marshaled to reveal a more complete picture of the social value of different categories of public expenditure, contributing to the broader debate about whether public expenditure should be increased and, if so, in which areas.

Author Disclosures

Links to the disclosure forms provided by the authors are available here.

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REFERENCES

1. Government at a glance 2021. Organisation for Economic Co-operation and Development. https://www.oecd-ilibrary.org/docserver/1c258f55-en.pdf?expires=1707459517&id=id&accname=guest&checksum=538CAB80CB682C485D59BC72B8088C74. Accessed February 21, 2024.
2. Lakdawalla DN, Doshi JA, Garrison Jr LP, Phelps CE, Basu A, Danzon PM. Defining elements of value in health care—a health economics approach: an ISPOR Special Task Force report [3]. *Value Health*. 2018;21(2):131–139.
3. Neumann PJ, Sanders GD, Russell LB, Siegel JE, Ganiats TG. *Cost-Effectiveness in Health and Medicine*. Oxford, United Kingdom: Oxford University Press; 2016.
4. Vallejo-Torres L. The broader opportunity costs in the broader cost-effectiveness analysis framework. *Appl Health Econ Health Policy*. 2023;21(3):373–384.
5. Walker S, Griffin S, Asaria M, Tsuchiya A, Sculpher M. Striving for a societal perspective: a framework for economic evaluations when costs and effects fall on multiple sectors and decision makers. *Appl Health Econ Health Policy*. 2019;17(5):577–590.
6. Epstein DM, Chalabi Z, Claxton K, Sculpher M. Efficiency, equity, and budgetary policies: informing decisions using mathematical programming. *Med Decis Making*. 2007;27(2):128–137.
7. Stinnett AA, Paltiel AD. Mathematical programming for the efficient allocation of health care resources. *J Health Econ*. 1996;15(5):641–653.
8. Hendren N, Sprung-Keyser B. The case for using the MVPF in empirical welfare analysis. National Bureau of Economic Research. https://www.nber.org/system/files/working_papers/w30029/w30029.pdf. Accessed February 21, 2024.
9. Finkelstein A, Hendren N. Welfare analysis meets causal inference. *J Econ Perspect*. 2020;34(4):146–167.
10. Claxton K, Asaria M, Chansa C, et al. Accounting for timing when assessing health-related policies. *J Benefit Cost Anal*. 2019;10(suppl 1):73–105.
11. Dahlby B. *The Marginal Cost of Public Funds: Theory and Applications*. Cambridge, United Kingdom: MIT press; 2008.
12. Ruggeri G. The marginal cost of public funds in closed and small open economies. *Fisc Stud*. 1999;20(1):41–60.
13. The social care guidance manual. National Institute for Health Care Excellence. https://www.nice.org.uk/process/pmg10/resources/the-social-care-guidance-manual-pdf-72286648234693. Accessed February 21, 2024.
14. People at the heart of care: adult social care reform white paper. Department of Health & Social Care, UK Government. https://www.gov.uk/government/publications/people-at-the-heart-of-care-adult-social-care-reform-white-paper. Accessed February 21, 2024.
15. *The Green Book*. Central Government Guidance on Apprisal and Evaluation; 2022. https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-government/the-green-book-2020. Accessed February 21, 2024.
16. Claxton K, Sculpher M, Palmer S, Culyer AJ. Causes for concern: is NICE failing to uphold its responsibilities to all NHS patients? *Health Econ*. 2015;24(1):1–7.
17. Lakdawalla DN, Phelps CE. Health technology assessment with diminishing returns to health: the Generalized Risk-Adjusted Cost-Effectiveness (GRACE) approach. *Value Health*. 2021;24(2):244–249.
18. Phelps CE. A new method to determine the optimal willingness to pay in cost-effectiveness analysis. *Value Health*. 2019;22(7):785–791.
19. Ryen L, Svensson M. The willingness to pay for a quality adjusted life year: a review of the empirical literature. *Health Econ*. 2015;24(10):1289–1301.