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LEADING ARTICLE

Discounting the Recommendations of the Second Panel on Cost-Effectiveness in Health and Medicine

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Abstract Twenty years ago, the "Panel on Cost-effectiveness in Health and Medicine" published a landmark text setting out appropriate methods for conducting cost-effectiveness analyses of health technologies. In the two decades since, the methods used for economic evaluations have advanced substantially. Recently, a "second panel" (hereafter "the panel") was convened to update the text and its recommendations were published in November 2016. The purpose of this paper is to critique the panel's updated guidance regarding the discounting of costs and health effects. The advances in discounting methodology since the first panel include greater theoretical clarity regarding the specification of discount rates, how these rates vary with the analytical perspective chosen, and whether the healthcare budget is constrained. More specifically, there has been an important resolution of the debate regarding the conditions under which differential discounting of costs and health effects is appropriate. We show that the panel's recommendations are inconsistent with this recent literature. Importantly, the panel's departures from previously published findings do not arise from an alternative interpretation of theory; rather, we demonstrate that this is due to fundamental errors in methodology and logic. The panel also failed to conduct a formal review of relevant empirical evidence. We provide a number of suggestions for how the panel's recommendations could be improved in future.

Key points

The discounting recommendations of the Second Panel on Cost-effectiveness in Health and Medicine are inconsistent with theoretical and empirical evidence.

The panel's work includes fundamental errors in methodology and logic.

Under a healthcare sector perspective, the recommended discount rate of 3% per annum is too high, resulting in systematic bias against health technologies with upfront costs and long term health effects.

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1 Introduction

Twenty years ago, the "Panel on Cost-effectiveness in Health and Medicine" published a landmark text setting out appropriate methods for conducting cost-effectiveness analyses (CEAs) of health technologies [1]. In the two

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decades since, the methods used for economic evaluations have advanced substantially. Recently, a “second panel” was convened to update the text and its recommendations were published in November 2016 [2].

An overarching recommendation by the second panel (hereafter “the panel”) is that CEAs should be undertaken from two distinct perspectives: “societal” and “healthcare sector”. The panel notes in its revised discounting guidance that it considers the societal perspective as analogous to a “welfarist” perspective, in which a decision maker seeks to maximise “utility” and the healthcare system has no fixed budget. The panel regards the healthcare sector perspective as analogous to an “extra-welfarist” perspective, in which a decision maker seeks to maximize the present value of population health, subject to a fixed healthcare budget.

The last two decades have seen major advances in the theoretical understanding of how discount rates should be determined under each of these perspectives. In a series of papers published between 2005 and 2012, researchers in the United Kingdom and the Netherlands provided detailed critiques of the arguments for and against “differential discounting” of incremental costs and health effects within CEAs, and in the process produced robust theoretical frameworks for identifying the appropriate discount rates under each perspective [3–7].

In this paper we present a detailed critique of the panel’s presentation of the theory for discounting under both the welfarist (societal) and extra-welfarist (healthcare sector) perspectives. Although the panel’s discounting chapter is appropriately structured around consideration of these two perspectives, their key recommendation of a common discount rate of 3% per annum for incremental costs and health effects does not appear to be supported by theoretical and empirical evidence, regardless of the perspective adopted. We describe several fundamental methodological errors in the panel’s derivation of appropriate discount rates, and we argue that the panel makes insufficient use of relevant empirical evidence to support their recommendations. We also provide some recommendations for addressing the issues identified in the panel’s discounting guidance. By engaging critically with the detailed content of the updated guidance, we seek to support the panel’s objective of improving the quality of CEAs conducted internationally.

2 Discounting from a ‘Welfarist’ (‘Societal’) Perspective

We first consider the panel’s recommendations when a societal perspective is adopted. In this case, the panel considers a welfarist perspective, in which utility is assumed to be the maximand and there is no fixed healthcare system budget. This section of their work is particularly problematic, since it contains numerous apparent errors in methodology, specification, description and logic. As a result, our critique is substantial and we will present it in four sections: first we summarize the methodology adopted by the panel, then we critique it, then we propose a modified approach, and finally we compare the panel’s findings to those of our modified approach and recent theoretical work.

2.1 Methodology Adopted by the Panel

Following Claxton et al., the panel assumes that the health effects and costs associated with funding health technologies in the absence of a budget constraint may be considered in “consumption” terms [6]. In accordance with the Claxton paper, the panel assumes that the “consumption value” of the health effects may be derived by multiplying the number of units of health gained in each time period t, denoted as ΔH_t, by the “consumption value of health” in each time period, denoted as V_t, then aggregating over all time periods. In common with the Claxton paper, the panel uses a two-period model to derive appropriate discount rates.

However, rather than discounting using the “social rate of time preference for consumption”, denoted as r_c in the Claxton paper, the panel chooses to discount using the “pure social rate of time preference for consumption”, which it denotes as ρ_c. The importance of the distinction between these two rates is considered later. After discounting, the consumption value of the health effects in period 2 is given by $(V_2 \cdot \Delta H_2)/(1+\rho_c)$, such that the total *discounted* consumption value of the health effects over both periods is given by:

$$V_1 \cdot \Delta H_1 + \frac{V_2 \cdot \Delta H_2}{1+\rho_c}. \quad (1)$$

Next, the panel considers the costs incurred when a technology is funded. It denotes the total incremental costs in each period as ΔS_t, which comprise both “healthcare costs”, denoted as ΔE_t, and “non-healthcare costs”, denoted as ΔF_t, such that $\Delta S_t = \Delta E_t + \Delta F_t$. Since, under a welfarist perspective, both “healthcare costs” and “non-healthcare costs” are assumed to displace consumption, the distinction between these is not important; however, this distinction becomes relevant when considering an extra-welfarist perspective later.

The panel then introduces a parameter, λ_t, which is defined as “the inverse of the marginal utility of income or consumption”. This is confusing for two reasons: first, λ is conventionally used to denote the “cost-effectiveness threshold”, which is not necessarily determined by the marginal utility of income or consumption; and second, the "marginal utility of income" and the "marginal utility of consumption" are conceptually different, so should not be conflated.

Assuming λ_t represents the inverse of the marginal utility of consumption, the utility gain or loss resulting from a marginal change in consumption may be derived by dividing the change in consumption by λ_t. In the panel's two-period model, the undiscounted utility loss associated with the consumption forgone when total incremental costs of ΔS_t are incurred in each period is $\Delta S_t/\lambda_t$. After discounting using the pure social rate of time preference for consumption, ρ_c, the total *discounted* utility loss associated with the forgone consumption over two periods is given by:

$$\frac{\Delta S_1}{\lambda_1} + \frac{\Delta S_2}{\lambda_2 \cdot (1+\rho_c)}. \quad (2)$$

The panel argues that the decision to adopt the technology should be based upon a consideration of whether the following decision rule holds:

$$V_1 \cdot \Delta H_1 + \frac{V_2 \cdot \Delta H_2}{1+\rho_c} \geq \frac{\Delta S_1}{\lambda_1} + \frac{\Delta S_2}{\lambda_2 \cdot (1+\rho_c)}. \quad (3)$$

Note that the left hand side (LHS) of Eq. 3 is formed from the terms in Eq. 1, while the right hand side (RHS) is formed from the terms in Eq. 2.

The panel then uses Eq. 3 to derive an expression of the "social discount rate". To assist in this, two additional equations are specified:

$$V_2 = V_1 \cdot (1 - g_c) \quad (4)$$

$$\lambda_2 = \lambda_1 \cdot (1 + g_c) \quad (5)$$

where g_c represents "growth in the marginal utility of consumption".

Substituting Eqs. 4 and 5 into Eq. 3 results in the following decision rule:

$$V_1 \cdot \Delta H_1 + \frac{V_1 \cdot (1-g_c) \cdot \Delta H_2}{1+\rho_c} \geq \frac{\Delta S_1}{\lambda_1} + \frac{\Delta S_2}{\lambda_1 \cdot (1+g_c) \cdot (1+\rho_c)} \quad (6)$$

Next, the panel assumes that g_c and ρ_c are "small", such that their product is approximately zero, so Eq. 6 can be approximated by:

$$V_1 \cdot \Delta H_1 + \frac{V_1 \cdot \Delta H_2}{1+\rho_c+g_c} \geq \frac{\Delta S_1}{\lambda_1} + \frac{\Delta S_2}{\lambda_1 \cdot (1+\rho_c+g_c)}. \quad (7)$$

According to the panel, Eq. 7 implies that the "social discount rate", r, is:

$$r = \rho_c + g_c. \quad (8)$$

The panel concludes that "the same discount rate should be used for both costs and the consumption value of health". By contrast, Claxton et al. concluded that a different discount rate should be applied to costs and health effects under this perspective if the consumption value of health, V_t, is changing over time [6]. The panel's conclusions therefore represent a clear and contradictory departure from recent theory in this area, which is particularly notable since the approach adopted by the panel bears many similarities to that adopted by Claxton et al. The panel gives no explanation as to why their findings differ from previous work.

2.2 Critique of the Panel's Methodology

There are a number of methodological and logical errors in the steps taken by the panel to derive the "social discount rate". Taken together, these errors account for the apparent differences between the panel's conclusions regarding the social discount rate and those of recent theoretical work.

First, the decision rule specified in Eq. 3 conflates considerations of "consumption" and "utility". The LHS of Eq. 3 denotes the total discounted *consumption* value of the health effects of adopting a technology, while the RHS denotes the discounted *utility loss* associated with the consumption forgone due to the incremental costs of the technology. Confusingly, the panel refers to the expression on the LHS of Eq. 3 as the "present value of the utilities gained" (Table 10.2 in the panel's report), even though there is no consideration of "utility" within these terms. To compound this confusion, the panel refers to the expression on the RHS of Eq. 3 as the "present consumption value forgone", when in fact these terms denote the present value of the *utility loss* associated with the consumption forgone, rather than the present value of the consumption forgone per se.

Because of this conflation of consumption and utility, using Eq. 3 would not necessarily result in decisions that are utility maximizing. It follows that Eq. 3 is an inappropriate decision rule, given the context of a utility-maximizing decision maker operating under a welfarist perspective.

A possible cause of this conflation within Eq. 3 is that the panel's report includes two conflicting definitions of the "consumption value of health". In an earlier chapter, titled "Theoretical Foundations of Cost-Effectiveness Analysis in Health and Medicine", the panel briefly considers the issue of "changes over time in the consumption value of health, that is, how changes in health (QALYs) translate into changes in utility". In this chapter, the panel defines the consumption value of health as "the amount of consumption that is equivalent to one unit of health in any given period". Both definitions cannot be correct—either the "consumption value of health" translates health into *consumption* terms (as defined in the discounting chapter), or it translates health into *utility* terms (as defined in the 'theoretical foundations' chapter). The definition given in the discounting chapter is not only more intuitive—a "*consumption* value of health" would be expected to translate health into consumption terms, not utility terms—but is also consistent with the definition adopted by Claxton et al. [6], who defined the consumption value of health, V_t, as "the amount of consumption in period t regarded as equivalent to 1 unit of health in period t". It is this definition which we will adopt for the remainder of this critique. However, the panel appears to have erroneously adopted the definition given in the earlier chapter in a footnote accompanying the discounting chapter and in the specification of Eq. 3.

The remaining equations specified by the panel are also problematic. Equation 4 implies that change in the consumption value of health from period 1 to period 2 is determined by the rate of growth in the marginal utility of consumption. Yet there is no logical reason why this must be the case, nor is one clearly presented by the panel. Societal preferences might change over time in such a way that health is valued relatively more in consumption terms, even if overall consumption—and the marginal utility associated with additional consumption—does not change. In common with Eq. 3, Eq. 4 conflates considerations of "consumption" and "utility", since V_t denotes the *consumption* value of health in each period, while g_c represents growth in the marginal *utility* of consumption. Growth in the consumption value of health, and growth in the marginal *utility* associated with consumption, are different concepts that should not be conflated.

Equation 5 is logically flawed. The panel states that λ_t represents "the inverse of the marginal utility of income or consumption", while g_c denotes "growth in the marginal utility of consumption". Logically, if the marginal utility of consumption is increasing, then the *inverse* of the marginal utility of consumption must be falling. It follows that if $g_c > 0$ then $\lambda_2 < \lambda_1$, while if $g_c < 0$ then $\lambda_2 > \lambda_1$. Yet Eq. 5 implies the opposite.

Because of these problems with Eqs. 4 and 5, Eq. 6 is not an appropriate respecification of Eq. 3, which itself is not necessarily a utility-maximizing decision rule.

After approximating Eq. 6 with Eq. 7, the panel determines that the "social discount rate" is given by $r = \rho_c + g_c$. Based on this finding, the panel concludes that "the same discount rate should be used for both costs and the consumption value of health".

This raises several additional methodological concerns. If decisions are made by comparing the discounted incremental cost-effectiveness ratio (ICER) to a cost-effectiveness threshold, then every term within the optimal net benefit decision rule must also be included within the ICER decision rule for the two decision rules to remain consistent. This can be achieved by incorporating terms within the discount rate(s) applied to incremental costs and/or health effects, or within the cost-effectiveness threshold itself.

In the Claxton paper, the appropriate discount rates were derived by specifying the optimal net benefit decision rule, then rearranging this to resemble an ICER decision rule, which in turn revealed the optimal discount rates to apply to incremental costs and health effects when decisions are made by comparing the ICER to a single cost-effectiveness threshold [6].

The panel did not take the step of rearranging the net benefit decision rule into an ICER decision rule. Instead, they appear to have determined the "social discount rate" by comparing the denominators of the period 2 terms on the LHS and RHS of the net benefit decision rule in Eq. 7; since each contains the expression $1 + \rho_c + g_c$, they concluded that the social discount rate is $r = \rho_c + g_c$. However, this overlooks other important terms within Eq. 7: each of the denominators on the RHS includes λ_1, while each of the numerators on the LHS includes V_1. Since these terms are included in the panel's specification of the optimal net benefit decision rule, logically they must also be included in the ICER decision rule. It is not clear how the panel intends to do this. If a discount rate of $r = \rho_c + g_c$ is applied to incremental costs and health effects, then the only remaining means for incorporating λ_1 and V_1 into the ICER decision rule is through the cost-effectiveness threshold, yet no guidance is provided on how to do this.

These fundamental errors in the panel's methodology, combined with its rejection of the current state of knowledge on the "logical consistency" arguments relating to differential discounting, call into question the validity of the panel's recommendations on appropriate discounting under a societal perspective.

2.3 A Modified Approach

Modifying the panel's methods to address the problems noted above leads to conclusions that are identical to those of Claxton et al. [6]. A modified approach is reported in Appendix 1.

Under this modified approach, the discount rate for incremental costs is approximated by the pure social rate of time preference for consumption (ρ_c) *minus* growth in the marginal utility of consumption (g_c). Incremental health effects should be discounted at a rate approximately equal to the discount rate applied to incremental costs *minus* growth in the consumption value of health (g_v). Under the conventional assumption that g_v is positive, this implies that a lower discount rate should be applied to health effects than costs; however, if g_v is negative then a higher discount rate should be applied to health effects.

2.4 Comparisons with Recent Theoretical Work

It is informative to compare the "social discount rate" (r) specified by the panel to the discount rates derived under the modified approach in Appendix 1 and also the discount rates reported by Claxton et al. [6].

As noted in Eq. 8, the panel concluded that the "social discount rate" is given by:

$$r = \rho_c + g_c.$$

In contrast to the optimal discount rate for costs derived under the modified approach in Appendix 1 (Eq. 20), which includes a negative sign on the g_c term, the "social discount rate" derived by the panel includes a positive sign on the g_c term. The g_c term accounts for changes in the marginal utility of consumption over time—conventionally it is assumed that rising incomes result in increased consumption and a diminished marginal utility of consumption, such that $g_c < 0$. However, the positive sign on the g_c term in the panel's "social discount rate" is counterintuitive. It means that a negative value of g_c results in a lower discount rate. Yet a negative value of g_c implies that future consumption has lower marginal utility than present consumption, which ought to result in a *higher* discount rate. Put another way, the panel's preferred "social discount rate" discounts future consumption more heavily if it is associated with higher marginal utility, and less heavily if it is associated with lower marginal utility. This is illogical. The greater the marginal utility associated with future consumption, the lower the discount rate a utility-maximizing decision maker would apply to future consumption.

When the panel compares their "social discount rate" to the Ramsey equation, they regard their g_c term as analogous to Ramsey's $\theta \cdot g$ term, where θ is determined by the elasticity of the marginal utility of consumption and g represents the consumption growth rate. However, the purpose of the $\theta \cdot g$ term in the Ramsey equation is to place greater weight on future consumption (through a lower discount rate) if it is associated with greater marginal utility than present consumption, and less weight on future consumption (through a higher discount rate) if it is associated with diminished marginal utility compared to present consumption. The panel's g_c term has the opposite effect.

By contrast, Claxton et al. assumed that future consumption and the consumption value of future health effects could be discounted at the "social rate of time preference for consumption" (r_c) [6]. Conceptually, r_c is identical to the exposition of the social discount rate given by Ramsey, and includes three components: 'pure' time preference, catastrophic risk, and the $\theta \cdot g$ term described above [8]. The distinction between 'pure' time preference and catastrophic risk is important: whilst some authors have argued that 'pure' time preference for societal decisions ought to be zero, societal catastrophic risk is always small but positive.

The panel does not specify whether their definition of ρ_c incorporates catastrophic risk. Their definition of ρ_c as "the pure social rate of time preference (describing impatience) for consumption" appears to exclude catastrophic risk. However, since the panel considers its "social discount rate" as being equivalent to the discount rate implied by the Ramsey rule, this implies that catastrophic risk is indeed included within ρ_c. It follows that the social rate of time preference for consumption (r_c) can be expressed as:

$$r_c = \rho_c - g_c. \quad (9)$$

The optimal discount rates derived under the modified approach in Appendix 1 (Eqs. 20 and 21) can therefore be respecified as:

$$d_c = r_c \quad (10)$$

$$d_h \approx r_c - g_v. \quad (11)$$

These findings are identical to those from Claxton et al. under a welfarist perspective with no fixed healthcare budget [6]. Under this perspective, differential discounting of incremental costs and health effects is required if, and only if, the consumption value of health is changing over time. The panel's conflicting finding—that common discounting is necessary under a welfarist perspective—can be attributed to the numerous apparent errors in methodology noted above.

2.5 Panel's Recommendations from a 'Welfarist' ('Societal') Perspective

Where a societal perspective is adopted, the panel relies upon flawed logic from its consideration of the welfarist perspective to argue for a common discount rate for costs and health effects. However, the panel abandons the "social discount rate" it derived earlier and instead uses a specification of the Ramsey equation to calculate an empirical estimate of the discount rate. The panel draws upon a variety of primarily US-based sources of data, without any clear justification for the specific sources used, to conclude that "a typical estimate of a social discount rate is… about 3.0–3.5%".

3 Discounting from an 'Extra-Welfarist' ('Healthcare Sector') Perspective

We now consider the panel's recommendations on discounting from a healthcare sector perspective. In this case, the panel adopts an extra-welfarist perspective where the objective of the decision maker is to maximize the present value of health. Since the health system budget is assumed to be fixed, incremental costs fall upon the budget and displace health outcomes.

3.1 Methodology Adopted by the Panel

Following Claxton et al., the panel specifies a parameter, k_t, which represents "the health forgone due to marginal dollars spent on healthcare" in each period t [6]. Health is assumed to be discounted at the "social rate of time preference for health"—while Claxton denoted this as r_h, the panel denotes this as ρ_H.

The panel's methodology in this sub-section follows that used by Claxton et al. [6]. However, there is some imprecise use of language: the objective is described as "to maximize health", rather than to maximize the *present value* of health, while the social rate of time preference for health is described as the "social time preference for health". Furthermore, the panel presents a net benefit equation without defining all terms within it or the assumptions required to specify it. The sub-section ends after specifying this equation, with no further explanation provided.

Using the same methodology as Claxton et al., we show how to derive appropriate discount rates from the panel's net benefit equation (Appendix 2) [6]. In accordance with the findings of the Claxton paper, the discount rate for incremental costs is approximated by the social rate of time preference for health (ρ_H) plus the growth rate of k_t, while incremental health effects should be discounted at the social rate of time preference for health (ρ_H). It follows that differential discounting is appropriate if, and only if, k_t is changing over time. That is, if the magnitude of the health forgone when marginal costs are imposed on the health system budget differs between time periods.

3.2 Panel's Recommendations from an 'Extra-Welfarist' ('Healthcare Sector') Perspective

Where a healthcare sector perspective is adopted, the panel uses specifications of discount rates that are appropriate under an extra-welfarist perspective when subject to a fixed budget constraint. Although no discount rates were reported in the panel's sub-section on extra-welfarism, the panel provides a specification of discount rates in Table 10.4. In accordance with the findings of Claxton et al., the appropriate discount rate for health is specified as ρ_H (denoted as r_h in the Claxton paper), while the discount rate for costs is approximately $\rho_H + g_k$ [6].

The panel provides a reasonable justification for assuming that $g_k = 0$, although no specific evidence is provided. Recent theoretical work in this space supports the panel's view that k_t could be increasing or decreasing, and that the present direction of change is ambiguous [9]. Ideally, the uncertainty in k_t and g_k ought to be reflected by considering both as stochastic parameters, rather than assuming that $g_k = 0$ with certainty, but the panel's approach is comparable to that adopted in discounting guidance recently proposed in Japan and Canada [10, 11].

The panel then cites Paulden and Claxton, who argued that the discount rate for incremental costs under an extra-welfarist perspective should be determined by the real rate of interest faced by the government that funds the healthcare system [7]. If $g_k = 0$, it follows that the same discount rate should also be applied to incremental health effects. As the panel notes, this real rate of interest may be approximated by the real rate of return on bonds issued by the government in question.

The panel's recommendation under an extra-welfarist perspective is weakened by its consideration of the empirical evidence. The panel states that "in the United States, the real rate of return for governmental bonds ranges from 2% to 4%". However, recent data from the US federal government, published in the Office of Management and Budget's discounting guidance, reports that real interest rates on treasury notes and bonds vary between 0.3 and 1.5% per annum, depending upon the time to maturity [12]. This is an ideal source of data for informing discount rates for US-based CEAs conducted from a healthcare sector perspective. Notably, the highest real interest rate implied by these official data is lower than even the bottom of the "2% to 4%" range cited by the panel.

4 Discussion

The choice of discount rate is a highly technical and even esoteric aspect of economic evaluation. However, it is also an important consideration, with implications for efficiency and equity in health care resource allocation. An inappropriately high discount rate may result in some good value technologies being denied coverage, whilst low value technologies are funded. A high discount rate systematically biases against technologies with upfront costs and long term health effects (such as vaccinations) in favour of technologies where the costs and health effects have a more similar time profile (such as maintenance therapy for chronic conditions). It follows that there are important equity reasons for ensuring that the discount rate is set appropriately.

The panel advances two arguments for maintaining the same recommendation on discount rates as the original panel. First, the panel refers to the original panel's consideration of the Keeler-Cretin "paradox", Weinstein and Stason's "chain of logic", and Viscusi's "equivalence" argument, and maintains that "each of these arguments points out a real logical inconsistency with differential discounting". In doing so, the panel ignores Nord's detailed demonstration that each of these arguments is logically flawed, and so cannot be used to prove that differential discounting is itself logically inconsistent [13].

Second, the panel argues that maintaining a common 3% per annum discount rate ensures backward comparability with CEAs undertaken according to the first panel's recommendations. While backward comparability with previously published CEAs is an understandable motivation for retaining a previously recommended discount rate, it is doubtful if concerns about comparability should take precedence over respecting the theoretical and empirical evidence. Requiring inter-temporal comparability, regardless of changes in the evidence base, inhibits progress in methods development and results in discount rates that are consistently wrong, regardless of the perspective taken.

A limitation of our critique of the panel's recommendations is that it was not possible to be definitive regarding exactly what errors and misinterpretations have been made by the panel, as their exposition lacks clarity in many places. Accordingly, drafting this critique required assumptions in places where the panel's working was ambiguous. Nevertheless, we remain confident in the key findings of our critique.

Since the panel's recommendation of a 3% per annum discount rate for both costs and health effects is not supported from either a welfarist or extra-welfarist perspective, it is informative to consider what would be a more defensible recommendation. Identifying appropriate discount rates from a welfarist perspective is problematic. Two of the three components of the Ramsey equation—social catastrophic risk and 'pure' time preference—are the subject of substantial uncertainty, and there is an ongoing ethical debate, cited by the authors, as to whether pure time preference should even be a consideration in societal decisions. Even more problematic is the third component: the elasticity of the marginal utility of consumption. To estimate this requires the specification of a social welfare function—such a welfare function would underpin the entire analysis, and would need to be consistent with considerations made in the panel's other chapters, including the chapter on "Ethical and Distributive Considerations". The panel has not provided guidance on how such a welfare function would be specified.

Identifying discount rates under an extra-welfarist perspective requires knowledge of the real rate of return on bonds and the rate of change in k_t, the health forgone due to marginal dollars spent on healthcare. Given that official estimates of the real rate of return on US government bonds are currently in the range of 0.3–1.5% per annum, and since a pragmatic assumption that k_t is stable appears to be reasonable until more robust data are available, a common discount rate at or below 1.5% per annum for costs and health effects would be theoretically and empirically defensible [9, 12]. Such an approach would also be in accordance with recent discounting guidance in other countries [10, 11].

The panel's discounting recommendations do not adequately reflect important developments in theory and practice over the past two decades. As a result, the panel have missed a substantial opportunity to advance the methods of cost-effectiveness analysis.

Compliance with Ethical Standards

Conflict of interest The authors have no relevant conflicts of interest.

Appendix 1: 'Welfarist' ('Societal') Perspective

We will now propose several modifications that could be made to the panel's methods under a welfarist perspective that would address the problems noted in our critique. Our proposed modifications lead to conclusions that are identical to those of Claxton et al. [6].

To resolve the issue with the decision rule in Eq. 3, the LHS must be expressed entirely in utility terms. The LHS is currently expressed in terms of the *consumption* value of the incremental health effects. Since λ_t represents the inverse of the marginal utility of consumption, it follows that dividing each term on the LHS of Eq. 3 by λ_t would yield the associated *utility* gain. A modified decision rule expressed entirely in terms of utility is:

$$\frac{V_1 \cdot \Delta H_1}{\lambda_1} + \frac{V_2 \cdot \Delta H_2}{\lambda_2 \cdot (1+\rho_c)} \geq \frac{\Delta S_1}{\lambda_1} + \frac{\Delta S_2}{\lambda_2 \cdot (1+\rho_c)}. \qquad (12)$$

Next, we will address the issues with Eqs. 4 and 5. A more appropriate specification of Eq. 4 is:

$$V_2 = V_1 \cdot (1 + g_v) \qquad (13)$$

where g_v denotes growth in the consumption value of health. This is the same specification and notation as that used in the Claxton paper. Note that the negative g_c term from the panel's Eq. 4 has been replaced with a positive g_v term in the modified Eq. 13.

To correct Eq. 5, each of the λ_t terms must be inverted:

$$\frac{1}{\lambda_2} = \frac{1}{\lambda_1} \cdot (1 + g_c)$$

which simplifies to

$$\lambda_2 = \frac{\lambda_1}{1 + g_c}. \qquad (14)$$

Note that λ_1 was multiplied by $1 + g_c$ in the panel's Eq. 5, while λ_1 is divided by $1 + g_c$ in the modified Eq. 14.

Substituting Eqs. 13 and 14 into the modified decision rule in Eq. 12 yields:

$$\frac{V_1 \cdot \Delta H_1}{\lambda_1} + \frac{V_1 \cdot (1+g_c) \cdot (1+g_v) \cdot \Delta H_2}{\lambda_1 \cdot (1+\rho_c)} \geq \frac{\Delta S_1}{\lambda_1} + \frac{(1+g_c) \cdot \Delta S_2}{\lambda_1 \cdot (1+\rho_c)} \quad (15)$$

Since λ_1 appears in the denominator of every term in Eq. 15, it can be cancelled:

$$V_1 \cdot \Delta H_1 + \frac{V_1 \cdot (1+g_c) \cdot (1+g_v) \cdot \Delta H_2}{1+\rho_c} \geq \Delta S_1 + \frac{(1+g_c) \cdot \Delta S_2}{1+\rho_c} \quad (16)$$

Conventionally, decisions are made by comparing the discounted ICER of a technology to a cost-effectiveness threshold, rather than by considering a net benefit decision rule such as that in Eq. 16. To derive the optimal discount rates to apply to future incremental costs (ΔS_2) and incremental health gains (ΔH_2), we must therefore rearrange Eq. 16 so that it resembles an ICER decision rule of the form:

$$\frac{\Delta S_1 + \frac{\Delta S_2}{1+d_c}}{\Delta H_1 + \frac{\Delta H_2}{1+d_h}} \leq \psi \quad (17)$$

where d_c and d_h represent the discount rates applied to incremental costs and incremental health effects, respectively, and ψ denotes the cost-effectiveness threshold. Note that the cost-effectiveness threshold is conventionally represented by λ, but λ has already been defined as the inverse of the marginal utility of consumption so ψ is used instead.

As noted by Claxton et al. [6], a reasonable threshold to use under a welfarist perspective with no budget constraint is the current consumption value of health (V_1). We therefore rearrange Eq. 16 to resemble Eq. 17, where $\psi = V_1$.

To do this, we first group the V_1 terms on the LHS of the equation:

$$V_1 \cdot \left[\Delta H_1 + \frac{(1+g_c) \cdot (1+g_v) \cdot \Delta H_2}{1+\rho_c}\right] \geq \Delta S_1 + \frac{(1+g_c) \cdot \Delta S_2}{1+\rho_c}$$

Then we divide by the terms in square brackets and rearrange the equation, so V_1 is alone on the RHS:

$$\frac{\Delta S_1 + \frac{(1+g_c) \cdot \Delta S_2}{1+\rho_c}}{\Delta H_1 + \frac{(1+g_c) \cdot (1+g_v) \cdot \Delta H_2}{1+\rho_c}} \leq V_1 \quad (18)$$

If g_c, ρ_c and g_v are "small", Eq. 18 can be approximated by:

$$\frac{\Delta S_1 + \frac{\Delta S_2}{1+\rho_c - g_c}}{\Delta H_1 + \frac{\Delta H_2}{1+\rho_c - g_c - g_v}} \leq V_1 \quad (19)$$

Comparing Eqs. 17 and 19, it follows that:

$$d_c \approx \rho_c - g_c \quad (20)$$

$$d_h \approx \rho_c - g_c - g_v. \quad (21)$$

That is, the discount rate for incremental costs is approximated by the pure social rate of time preference for consumption (ρ_c) *minus* growth in the marginal utility of consumption (g_c). Incremental health effects should be discounted at a rate approximately equal to the discount rate applied to incremental costs *minus* growth in the consumption value of health (g_v). Under the conventional assumption that g_v is positive, this implies that a lower discount rate should be applied to health effects than costs; however, if g_v is negative then a higher discount rate should be applied to health effects.

Appendix 2: 'Extra-Welfarist' ('Healthcare Sector') Perspective

Under an extra-welfarist perspective, the objective of the decision maker is to maximize the present value of health. Since there is a fixed health system budget, incremental costs fall upon the budget and displace health outcomes.

In a two-period model, the present value of the health gained is given by:

$$\Delta H_1 + \frac{\Delta H_2}{1+\rho_H}. \quad (22)$$

Meanwhile, the present value of the health forgone due to incremental costs falling on the health system budget is given by:

$$\frac{\Delta E_1}{k_1} + \frac{\Delta E_2}{k_2 \cdot (1+\rho_H)}. \quad (23)$$

where the panel uses ΔE_t to denote the costs that fall upon the healthcare sector budget in each period t.

The next stage in the process of deriving discount rates is to express a net benefit decision rule. The simplest net benefit decision rule is to adopt a technology if the present value of the health gained, as expressed in Eq. 22, is greater than or equal to the present value of the health forgone, as expressed in Eq. 23:

$$\Delta H_1 + \frac{\Delta H_2}{1+\rho_H} \geq \frac{\Delta E_1}{k_1} + \frac{\Delta E_2}{k_2 \cdot (1+\rho_H)}. \quad (24)$$

However, the panel does not present the net benefit decision rule specified in Eq. 24. Instead, the following net benefit decision rule is reported:

$$\Delta H_1 + \frac{\Delta H_2}{1+\rho_H} \geq \frac{\Delta E_1}{k_1} + \frac{\Delta E_2}{k_1 \cdot (1+\rho_H+g_k)}. \quad (25)$$

The panel provides no definition of g_k, nor do they explain how Eq. 25 may be used to derive appropriate discount rates. The sub-section ends after specifying this equation, with no further explanation provided.

However, following Claxton et al. [6], Eq. 25 may be rearranged to resemble the ICER decision rule in Eq. 17. If the cost-effectiveness threshold is $\psi = k_1$, then:

$$d_c \approx \rho_H + g_k \quad (26)$$

$$d_h = \rho_H. \quad (27)$$

Under an extra-welfarist perspective, where the health system budget is fixed, it follows that the discount rate for incremental costs is approximated by the social rate of time preference for health (ρ_H) plus the growth rate of k_t, while incremental health effects should be discounted at the social rate of time preference for health (ρ_H). Differential discounting is appropriate if, and only if, k_t is changing over time. That is, if the magnitude of the health forgone when marginal costs are imposed on the health system budget differs between time periods.

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