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ARTICLE

Citizen Preferences and BCA: A Model of Willingness-to-Pay behind a Veil of Ignorance

Morgan Beeson, Susan Chilton, Hugh Metcalf and Jytte Seested Nielsen

Newcastle University Business School, Newcastle upon Tyne, United Kingdom
Corresponding author: Morgan Beeson; Email: morgan.beeson@newcastle.ac.uk

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Abstract

Public sector allocative decisions should reflect, as far as possible, the preferences of those affected by the decisions. Conventional benefit–cost analysis (BCA) will simply aggregate individuals' private willingness-to-pay (WTP) over all affected individuals to estimate the total benefits of a policy that delivers a public good. Given the nature of a public good, it is not unreasonable to consider that an individual may have altruistic preferences over the consumption of the public good by others. In this paper, we set out the theoretical underpinnings for a new citizen-based WTP, informed by political philosophy. Our model extends the standard social utility model (Bergstrom, 2006) of WTP for a public good when individuals are altruists by incorporating a Veil of Ignorance (VoI; Harsanyi, 1955). Our findings show that our WTP (Citizen) correctly includes altruistic as well as distributional preferences of individuals in society into WTP for use in a BCA. When WTP (Citizen) are aggregated for use in a BCA, equal weight is given to each individual's preference and the BCA will correctly identify potentially Pareto-improving projects in a consistent manner.

1. Introduction

A conventional benefit–cost analysis (BCA) will simply aggregate individuals' private willingness-to-pay (WTP) over all affected individuals to estimate the total benefits of a policy that delivers a public good. Here, the individual is effectively a consumer and WTP is assumed to reflect the private benefits to that individual from the public good. For the purposes of this paper, we denote this as WTP (Private).

Given the nature of a public good, it is not unreasonable to consider the alternative that an individual may have some preferences over the consumption of a public good by others. Indeed, allowing concern for others to enter directly into WTP values has been considered in the theoretical literature (Bergstrom, 1982; Jones-Lee, 1991; McConnell, 1997; Johansson & Kriström, 2021 among others; and Robinson & Hammitt, 2011 for an overview). It has caused some debate as to whether the Kaldor-Hicks hypothetical compensation test (Kaldor,

1939; Hicks, 1940) correctly identifies potential Pareto improvements when such concerns are included in WTP (Milgrom, 1993; Flores, 2002; Bergstrom, 2006).

Bergstrom (2006) provides us with the standard model of WTP for a public good when individuals are pure altruists. In this model, individuals are still treated as consumers, but they derive utility from others' utility including their consumption of the public good. We denote this as WTP (Social). Unfortunately, WTP (Social) has been shown susceptible to the problem of overestimation of the value of the public good if the cost of provision to other individuals in society is ignored. This is better known as the "naïve benefit cost analyst" problem (Bergstrom, 2006).

In this paper, we set out the theoretical underpinnings for a new citizen-based WTP, which we denote as WTP (Citizen). Its key feature is the integration of a Veil of Ignorance (VoI) (Harsanyi, 1955) into the standard social utility model (Bergstrom, 2006). Under our citizen approach, an individual is placed behind a VoI. The VoI creates uncertainty regarding the individual's position within society, generating impartiality, and leaving individuals to value the good based on the distribution of benefits and cost-sharing rules alone. Our approach is influenced by moral philosophy but remains grounded in welfare economics (see Sugden, 1981 pg. 52–57 for a discussion of this branch of welfare economics and Orr, 2007 for a discussion of WTP behind a VoI).

For each individual, we model three WTPs. WTP (Private) is based on their private utility function and includes only self-interest. WTP (Social) is based on their social utility function and includes altruism. Finally, we derive our WTP (Citizen) which is based on the expected social utility of the individual who is uncertain of their position in society. As these WTPs will differ, we consider the consequences when each WTP is used as a monetary value for the benefits of a project in a BCA. To do so, we set up the Benefit Condition to determine which, if any, of WTP (Private), WTP (Social), and WTP (Citizen) when used in a BCA will consistently and correctly identify potential Pareto improvements based on the Kaldor hypothetical compensation test. If this condition is met, WTP is a measure of the individual benefit from the public good which accurately reflects the individual's altruistic and distributional preferences. We show that our WTP (Citizen) meets our Benefit Condition while WTP (Social) and WTP (Private) do not. This leads us to conclude that for a BCA when individuals have altruistic and distributional preferences, WTP (Citizen) is the best of the three measures considered.

We relate our WTP (Citizen) to some ethical considerations and demonstrate that our WTP (Citizen) when used in a BCA, achieves the democratic principle of "one person, one vote." This contrasts with the principle of "one pound, one vote" reflected in conventional BCA (see Jones-Lee, 1989 for a discussion). One of the strengths of the WTP (Citizen) is that this change in ethical (democratic) principle is achieved whilst still accounting for differences in people's strength of preferences for one, as opposed to another, use of society's scare resources. We discuss our findings in relation to the principle of consumer sovereignty and how the WTP (Citizen) can incorporate both efficiency and equity considerations into a BCA.

The remainder of the paper is as follows. Section 2 sets up the conceptual framework including our Benefit Condition. WTP (Private), WTP (Social), and WTP (Citizen) are derived and assessed against our Benefit Condition in Sections 3, 4, 5, respectively. Section 6 presents some illustrative BCA simulations. Democratic accountability is discussed in Section 7 and Section 8 presents Discussion and Conclusions.

2. Conceptual framework

Here we set up a model describing a society of altruists who are offered a project that confers benefits to each member of society. The project is to be evaluated using a BCA. We define three different WTPs to be derived in Sections 3, 4, 5: WTP (Private), WTP (Social), and WTP (Citizen). WTP (Private) is based on the individual's private utility function and includes only self-interest. WTP (Social) is based on the individual's social utility function and includes altruism. WTP (Citizen) is also based on the individual's social utility function but in expectation as individuals are placed behind a VoI making them uncertain of their position. As these WTPs will differ, we consider the consequences when each WTP is used as a monetary value for the benefits of a project in a BCA.

2.1. *The society*

Consider a society of N individuals indexed $i = 1, \ldots, N$. The society has N unique positions indexed $p = 1, \ldots, N$. Positions are ranked by income w_p where $w_1 \leq w_2 \leq w_3 \leq \cdots \leq w_N$.[1] Individual i is in Position p. The distinction between individual and position is made to consider the choice behind a VoI which is discussed below.

2.2. *A project*

There is a project available that provides a public good (hereafter, project) which confers non-negative discrete benefits to all individuals in the society. The individual in Position p benefits $x_p \geq 0$.[2] The project has a total cost to society of C. A coercive taxation mechanism funds the project. Each individual pays a share t_p of the cost where $\sum_p^N t_p = 1$ to ensure the full cost is covered. The income left after taxation is $w_p - t_p C$ and is spent on a single private good.

2.3. *Private and social utility functions*

Following Bergstrom (2006), each individual has a private utility function which reflects only their preferences for their own outcomes. In addition, individuals also have preferences over others' outcomes. The individual's full set of preferences is reflected by their social utility function. Assuming the project is provided, the private utility function of Individual i who is in Position p is given by Equation 1.

$$u_p^i = x_p + w_p - t_p C \tag{1}$$

Individual i derives private utility from their own benefit from the project, x_p, and their own consumption of the private good which is their income, w_p, less their contribution to the project, $t_p C$.[3] The social utility function of Individual i is given by Equation 2.

[1] As positions are ranked by income with ties possible, the specification is sufficiently general to cover the potential for a society where everyone has a different income, a society where everyone has the same income, or anything in between.

[2] This assumption allows for the possibility of pure public goods or impure public good with distributional consequences.

[3] Following Bergstrom's (2006) model, we assume a marginal utility of income equal to 1. As a project is a discrete change in public good provision, the loss of generality from this assumption should be limited.

$$U_p^i = x_p + w_p - t_p C + \sum_{q \neq p}^{N} \left[\alpha_q^i x_q + \beta_q^i \left(w_q - t_q C \right) \right] \tag{2}$$

Equation 2 is a generalized form of the social utility function in Bergstrom (2006). The α_q^i and β_q^i terms are weights placed on the individual in Position q's benefit from the project and consumption of the private good, respectively. The summation covers all positions q, except $q = p$ because Individual i is in Position p.

We use this functional form as it is sufficiently broad to encompass the cases often discussed in the literature on altruism in WTP including: self-interest ($\alpha_q^i = \beta_q^i = 0$), pure altruism ($\alpha_q^i = \beta_q^i > 0$) (Jones-Lee, 1991; 1992)[4], paternalistic altruism ($\alpha_q^i \neq \beta_q^i$) (Jones-Lee, 1991; Jones-Lee, 1992), and distributional preferences such as Engelmann and Strobel (2007)'s quasi-maximin model of which the efficiency motive ($\forall q, \alpha_q^i = \alpha^i, \beta_q^i = \beta^i$) and maximin motive ($\alpha_1^i > 0$ and or $\beta_1^i > 0; \forall q > 1, \alpha_q^i = \beta_q^i = 0$) are the two extreme cases.

2.4. Veil of ignorance

In front of a VoI, individuals are certain of their own position ($i = p$) and all other individuals' positions. Behind a VoI, individuals are uncertain of their own and other's positions. In accordance with Harsanyi's (1955) equi-probability model, individuals know that the probability of being in each position is $1/N$. Both Harsanyi (1955) and Rawls (1972) consider a VoI as discerning an individual's impersonal ethical preferences through the introspection of one's own set of possible personal preferences across positions in society, see Orr (2007) for a discussion.

Individuals are expected utility maximizers. Behind a VoI, an individual must consider themselves in each position. Their expected social utility function is given in Equation 3 as the sum of their social utilities (Equation 2) across each of the N positions divided by N.

$$EU^i = \frac{1}{N} \sum_{p=1}^{N} U_p^i = \frac{1}{N} \sum_{p=1}^{N} \left[x_p + w_p - t_p C + \sum_{q \neq p}^{N} \left[\alpha_q^i x_q + \beta_q^i \left(w_q - t_q C \right) \right] \right] \tag{3}$$

Which can be rearranged to give Equation 4.

$$EU^i = \frac{1}{N} \sum_{p=1}^{N} \left[\left(1 + (N-1)\alpha_p^i \right) x_p + \left(1 + (N-1)\beta_p^i \right) \left(w_p - t_p C \right) \right] \tag{4}$$

2.5. BCA using three different WTPs

The project is evaluated using BCA. In accordance with Hicks's (1942) definition of compensating variation (CV), an individual's WTP is the adjustment in income required for utility with the project to return exactly to the level of utility without the project. Unweighted WTP, aggregated across the population, is used as the measure of benefits in the BCA. The BCA recommends the project if aggregate WTP exceeds the total cost of the project.

[4] Also called benevolence (Bergstrom, 1982; 2006) and non-paternalistic altruism (Flores, 2002) in the literature.

We propose three different WTPs that can be derived for each individual:

- $WTP^i(Private)$ is the individual's CV based on their private utility function (Equation 1),
- $WTP^i(Social)$ is the individual's CV based on their social utility function (Equation 2), and
- $WTP^i(Citizen)$ is the individual's CV based on their social utility function in expectation (Equation 4) as the individual is placed behind a VoI.

WTP (Private) is the individual's private value of the project. WTP (Social), unlike WTP (Private), also reflects the individual's altruistic and distributional preferences. WTP (Citizen) reflects the same preferences as WTP (Social), but individuals are placed behind a VoI.

The three WTPs, which are derived in Sections 3, 4, 5, will give different monetary values for the benefits of a project. When used in a BCA, these WTPs may lead to different recommendations. *A priori*, we cannot say which WTP, when used in a BCA, will correctly identify projects that are potentially Pareto improving based on individuals' social utility functions in a consistent manner. To explore this, we consider the Kaldor hypothetical compensation test.

2.6. The Kaldor hypothetical compensation test

The Kaldor hypothetical compensation test prescribes that "if those who gain by adoption of a project do so to a sufficient degree to be able, if required, to compensate those who lose, then the project should be undertaken" (Jones-Lee, 1989, pg. 32). A project is potentially Pareto improving if the Kaldor compensation test is passed.

To model the Kaldor hypothetical compensation test, we first derive individual net benefits. Equation 5 is the net benefit of Individual i who is in Position p which is found by differencing social utility (Equation 2), which reflects the individual's full set of preferences, with and without the project.

$$\Delta U_p^i = x_p + \sum_{q \neq p}^{N} \alpha_q^i x_q - C\left(t_p + \sum_{q \neq p}^{N} \beta_q^i t_q\right) \tag{5}$$

Those individuals with a positive net benefit are gainers and those with a negative net benefit are losers. Next, the net benefits of all individuals across the group are aggregated. Equation 6 is the net benefit aggregated across individuals and rearranged.[5]

$$\sum_{p}^{N}\left[\Delta U_p\right] = \sum_{p}^{N}\left[\left(1+(N-1)\alpha_p\right)x_p\right] - \sum_{p}^{N}\left[\left(1+(N-1)\beta_p\right)t_p\right]\cdot C \tag{6}$$

In addition to the assumptions set out previously, we assume homogenous preferences over others ($\alpha_p^i = a_p$ and $\beta_p^i = \beta_p\ \forall i$) to allow interpersonal comparisons of utility. Then if the aggregate net benefit (Equation 6) is greater than or equal to 0, the gainers can compensate the losers. This means the Kaldor hypothetical compensation test is passed and a potential Pareto improvement is possible. If aggregate net benefit (Equation 6) is less than 0, the gainers cannot compensate the losers and the Kaldor hypothetical compensation test is failed, and a potential Pareto improvement is not possible.

[5] See Appendix A for details.

2.7. The Benefit Condition

We test if any of WTP (Private), WTP (Social), or WTP (Citizen) when aggregated for use in a BCA can correctly identify potential Pareto-improving projects in accordance with the Kaldor hypothetical compensation test. In other words, whether aggregate WTP is a measure of the project benefits which accurately reflects the altruistic and distributional preferences represented by individuals' social utility functions.

To do so, we consider the case in the model where total cost equals aggregate WTP. At this cost, and conditional on aggregate WTP accurately reflecting the preferences in individuals' social utility functions, the result of the Kaldor hypothetical compensation test will be an aggregate net benefit exactly equal to zero as the gainers can exactly compensate the losers. We term this condition the "Benefit Condition" which is set out formally in Equation 7.

$$\text{"Benefit Condition"}: \sum_{p}^{N}\left[\Delta U_p\right] \equiv 0 \; when \; C = \begin{cases} \sum_{i}^{N} WTP^i(Private) \\ \sum_{i}^{N} WTP^i(Social) \\ \sum_{i}^{N} WTP^i(Citizen) \end{cases} \tag{7}$$

That is aggregate net benefit must equal zero when the total cost of the project equals aggregate WTP.

The next three sections take each of WTP (Private), WTP (Social), and WTP (Citizen) in turn. First, we derive WTP based on Equations 1, 2, and 4 and then test whether WTP meets the Benefit Condition. We do so by entering each WTP under the assumption of homogenous preferences over others into Equations 6 and 7 in place of the total cost, C.

3. WTP (Private)

The individual's WTP (Private) for the project is based on their private utility given in Equation 1. An individual's WTP (Private) is the adjustment in income required for private utility with the project to return exactly to the level of private utility without the project. Equation 8 denotes indifference between having and not having the project based on the private utility of Individual i who is in Position p.

$$x_p + w_p - t_p C = w_p \tag{8}$$

When the equality holds, the $t_p C$ term is the individual's WTP (Private), that is, the CV.[6] Individual i's WTP (Private) is found by rearranging Equation 8 to isolate $t_p C$ as shown in Equation 9.

$$WTP^i(Private) = t_p C = x_p \tag{9}$$

[6] The model is set up based on CV to measure WTP. Alternatively the model could have used equivalent variation to measure willingness-to-accept. In this case, the Benefit Condition would be set up based on the Hicks (1940) compensation test (Boadway, 2016). Due to the linearity in scale of costs and benefits in Equations 1, 2 and 4, the results are identical for both approaches. In Equation 8 that can be shown by moving the tC term to the righthand side which represents the equivalence of utility with and without the public good. The same approach can be used for WTP (Social) and WTP (Citizen) by shifting all tC term to the right hand side in Equations 11 and 15.

WTP (Private) is the product of the individual's tax share and the cost they would not like society to surpass which equals the individual's benefit from the project.

To test if WTP (Private) meets the Benefit Condition, aggregate WTP (Private) is entered into Equations 6 and 7 to replace the costs, which requires the assumption of homogenous preferences over others, giving Equation 10.

$$\sum_{p}^{N}\left[\Delta U_p\right]=\sum_{p}^{N}\left[\left(1+(N-1)\alpha_p\right)x_p\right]-\sum_{p}^{N}\left[\left(1+(N-1)\beta_p\right)t_p\right]\cdot\sum_{p}^{N}x_p \tag{10}$$

Equation 10 is not always equal to zero and therefore the Benefit Condition required for BCA to correctly identify projects that are potentially Pareto improving is not met. Reassuringly, Equation 10 will equal zero in the special case of self-interest. WTP (Private), therefore, meets the Benefit Condition when all individuals in society are self-interested.

Equation 10 will be negative when altruistic preferences for the private good are sufficiently strong (large beta terms). That is $\sum_{p}^{N}\left[\Delta U_p\right]<0$ when $C=\sum_{i}^{N}WTP^{i}(Private)$. This could result in a BCA incorrectly recommending a project that is not potentially Pareto improving because, at a total cost equal to aggregate WTP (Private), those who gain cannot adequately compensate those who lose.

Equation 10 will be positive when altruistic preferences for the project are sufficiently strong (large alpha terms). That is $\sum_{p}^{N}\left[\Delta U_p\right]>0$ when $C=\sum_{i}^{N}WTP^{i}(Private)$. This could result in a BCA incorrectly rejecting projects that are potentially Pareto improving because, at total costs greater aggregate WTP (Private), those who gain can still adequately compensate those who lose.

4. WTP (Social)

The individual's WTP (Social) for the project is derived from the social utility function (Equation 2). An individual's WTP (Social) is the adjustment in income required for social utility with the project to return exactly to the level of social utility without the project.

Equation 11 denotes indifference between having and not having the project based on the social utility of Individual i who is in Position p.

$$x_p+w_p-t_pC+\sum_{q\neq p}^{N}\left[\alpha_q^i x_q+\beta_q^i\left(w_q-t_qC\right)\right]=w_p+\sum_{q\neq p}^{N}\left[\beta_q^i w_q\right] \tag{11}$$

When equality holds, C is the total cost to society at which the individual's social utility with the project returns exactly to the level of social utility without the project. C is the cost to society the individual would prefer not to pass. WTP (Social) is found by isolating C and multiplying each side of the equality by t_p to give t_pC which gives the CV.[7] The first step is given by Equation 12.

[7] Simply isolating t_pC, as was done with WTP (Private), would amount to Bergstrom (2006)'s "naïve benefit–cost analyst" problem where the individual takes into account the benefits to others but not the costs. We have avoided the problem by isolating C and multiplying by t_p.

$$C = \frac{x_p + \sum_{q \neq p}^{N} \alpha_q^i x_q}{t_p + \sum_{q \neq p}^{N} \beta_q^i t_q} \tag{12}$$

Individual WTP (Social) is given by Equation 13.

$$WTP^i(Social) = t_p C = t_p \frac{x_p + \sum_{q \neq p}^{N} \alpha_q^i x_q}{t_p + \sum_{q \neq p}^{N} \beta_q^i t_q} \tag{13}$$

Equation 13 states that WTP (Social) is a ratio of benefit and cost share terms which is multiplied by the individual's cost share. The benefit terms are the individual's benefit plus the altruism-weighted benefits to others and the cost share terms are the individual's cost share plus the altruism-weighted cost shares of others. When preferences are self-interested, the private and social utility functions are identical and therefore WTP (Social) equals WTP (Private) because the alpha and beta terms in Equation 13 are all zero and the cost share terms cancel.

To test if WTP (Social) meets the Benefit Condition, aggregate WTP (Social) under the assumption that $\alpha_q^i = \alpha_q$ and $\beta_q^i = \beta_q \ \forall i$ is entered into Equations 6 and 7 to replace the costs given in Equation 14.

$$\begin{aligned} \sum_{p}^{N} \left[\Delta U_p\right] = & \sum_{p}^{N} \left[\left(1 + (n-1)\alpha_p\right) x_p\right] \\ & - \sum_{p}^{N} \left[\left(1 + (n-1)\beta_p\right) t_p\right] \cdot \sum_{p}^{N} \left[t_p \frac{x_p + \sum_{q \neq p}^{N} \alpha_q x_q}{t_p + \sum_{q \neq p}^{N} \beta_q t_q} \right] \end{aligned} \tag{14}$$

Equation 14 is not always equal to zero and therefore the Benefit Condition required for BCA to correctly identify projects that are potentially Pareto improving is not met. As with WTP (Private), a BCA using WTP (Social) could incorrectly reject a project that would be potentially Pareto improving ($\sum_p^N \left[\Delta U_p\right] > 0$ when $C = \sum_i^N WTP^i(Social)$) or incorrectly accept a project that would not be potentially Pareto improving ($\sum_p^N \left[\Delta U_p\right] < 0$ when $C = \sum_i^N WTP^i(Social)$).

5. WTP (Citizen)

An individual's WTP (Citizen) for the project is based on their expected social utility (Equation 4). Equation 15 denotes indifference between having and not having the project based on the expected social utility of an Individual i who is uncertain of their position.

$$\frac{1}{N}\sum_{p=1}^{N}\left[\left(1+(n-1)\alpha_p^i\right)x_p+\left(1+(n-1)\beta_p^i\right)\left(w_p-t_pC\right)\right] = \frac{1}{N}\sum_{p=1}^{N}\left[\left(1+(n-1)\beta_p^i\right)\left(w_p\right)\right] \tag{15}$$

When the equality holds, C is the cost at which expected social utility with the project returns exactly to the level of expected social utility without the project. Individual i's WTP (Citizen) is found by rearranging Equation 15 to isolate C as shown in Equation 16.

$$C=\frac{\sum_{p=1}^{N}\left[\left(1+(n-1)\alpha_p^i\right)x_p\right]}{\sum_{p=1}^{N}\left[\left(1+(n-1)\beta_p^i\right)t_p\right]} \tag{16}$$

C is the total cost to the society that Individual i would prefer the society to not surpass. For use in BCA, WTP equals the cost, C, divided by the number of positions, N, as shown in Equation 17.

$$WTP^i(Citizen)=\frac{1}{N}C=\frac{1}{N}\left[\frac{\sum_{p=1}^{N}\left(1+(n-1)\alpha_p^i\right)x_p}{\sum_{p=1}^{N}\left(1+(n-1)\beta_p^i\right)t_p}\right] \tag{17}$$

WTP (Citizen) equals a ratio of altruism weighted benefit and cost share terms multiplied by 1/N. The multiplier 1/N is the individual's expected cost share behind the VoI. WTP (Citizen) is similar to WTP (Social) (Equation 13) except for two characteristics: 1) the ratio is not multiplied by a cost share and 2) no additional weight is given to the position that the individual is in.[8] In other words, in WTP (Citizen) personal preferences have become impersonal.

To test if WTP (Citizen) meets the Benefit Condition, aggregate WTP (Citizen) under the assumption that $\alpha_p^i=\alpha_p$ and $\beta_p^i=\beta_p\ \forall i$ is entered into Equations 6 and 7 giving Equation 18.

$$\sum_{p}^{N}\left[\Delta U_p\right]=\sum_{p}^{N}\left[\left(1+(n-1)\alpha_p\right)x_p\right] -\sum_{p}^{N}\left[\left(1+(n-1)\beta_p\right)t_p\right]\cdot\sum_{i}^{N}\left[\frac{1}{N}\cdot\frac{\sum_{p}^{N}\left(1+(n-1)\alpha_p\right)x_p}{\sum_{p}^{N}\left(1+(n-1)\beta_p\right)t_p}\right] \tag{18}$$

Which simplifies to give Equation 19.

[8] The additional relative weight given to the benefit (cost) to the individual in a position is only determined by the alpha (beta) term.

$$\sum_{p}^{N}\left[\Delta U_p\right] = \sum_{p}^{N}\left[\left(1+(n-1)\alpha_p\right)x_p\right] - \sum_{p}^{N}\left[\left(1+(n-1)\beta_p\right)t_p\right]\cdot\frac{\sum_{p}^{N}\left(1+(n-1)\alpha_p\right)x_p}{\sum_{p}^{N}\left(1+(n-1)\beta_p\right)t_p} = 0 \tag{19}$$

Equation 19 will always equal zero. WTP (Citizen) therefore meets the Benefit Condition required for BCA to correctly identify potentially Pareto-improving projects in a consistent manner.

6. Illustrative BCA simulations

The results of the previous three sections showed that WTP (Citizen), WTP (Social), and WTP (Private) can differ. While WTP (Citizen) met the Benefit Condition, WTP (Private) and WTP (Social) did not. In this section, we use an illustrative simulation of a BCA to show how WTP and aggregate net benefit differ between WTP (Citizen), WTP (Social), and WTP (Private). We simulate a society of pure altruists with an efficiency motive but for comparison, the results for five alternate preferences specifications are presented in the Appendix.

Consider a society with three individuals ($N = 3$) called Alice, Bob, and Chioma who are respectively in Positions 1, 2, and 3 with incomes w_p of $w_1 = £2000, w_2 = £3000, w_3 = £5000$. Each individual is a pure altruist with an efficiency motive where all alpha and beta terms equal 0.2.[9]

The society can enact one of four projects that differ in their distributional impacts described in Table 1 or maintain the status quo. A BCA is used to evaluate the projects.

Table 1. *Simulation parameters*

Parameter		Project 1	Project 2	Project 3	Project 4
w_p	w_1	£2000	£2000	£2000	£2000
	w_2	£3000	£3000	£3000	£3000
	w_3	£5000	£5000	£5000	£5000
x_p	x_1	£100	£100	£300	£300
	x_2	£200	£200	£200	£200
	x_3	£300	£300	£100	£100
t_p	t_1	0.333	0.2	0.333	0.2
	t_2	0.333	0.3	0.333	0.3
	t_3	0.333	0.5	0.333	0.5

The society has three individuals ($N = 3$) each with an income (w_p) and can choose one of four projects defined by the distribution of benefits (x_p) and cost shares (t_p).

[9] While the choice of 0.2 was arbitrary, the general result from Sections 3–5 holds for any set of parameters that follow the assumptions set out in Section 2.

Each project delivers a total benefit of £600 but differs by the distribution of the benefits among the three positions (x_1,x_2,x_3). Projects 1 and 2 deliver a benefit distribution of (£100, £200, £300) and Projects 3 and 4 deliver a benefit distribution of (£300, £200, £100). Each project has a total cost of £600 but projects are funded by different tax systems (t_1,t_2,t_3). Projects 1 and 3 are funded through a uniform tax ($0.\dot{3}$,$0.\dot{3}$,$0.\dot{3}$) whereas Projects 2 and 4 are funded through a proportional income tax (0.2, 0.3, 0.5).

Table 2 presents the results of the BCA in two steps. First, for each individual, WTP (Private), WTP (Social), and WTP (Citizen) are calculated using Equations 9, 13, and 17, respectively and WTP is aggregated for the three individuals. Second, aggregate WTP is used as a measure of benefits in a BCA. The BCA test is passed when aggregate WTP equals or exceeds the total cost of £600. If multiple projects pass the BCA test, the project with the greatest WTP is chosen.

We then test the Benefit Condition described in Section 2. To do so, the net benefit of each individual is calculated using Equation 5 and aggregate net benefit is calculated using Equation 6 by replacing cost with aggregate WTP from the first step. The Benefit Condition (Equation 7) is met if aggregate net benefit equals zero as those who gain can *exactly* compensate those who lose when the total cost equals aggregate WTP.

Table 2 shows that WTP (Private) equals the individual benefit and aggregate WTP (Private) equals the sum of individual benefits which is equal to £600 for all projects. All four projects pass the BCA test. As each project has the same aggregate WTP, a choice cannot be made between the projects based on a BCA alone. The aggregate net benefit is zero for all projects which means the Benefit Condition is met. While the results from Section 3 showed that WTP (Private) in general does not meet the Benefit Condition, the case of a purely altruistic society with an efficiency motive is shown here to be an exception.[10] This result aligns with the results of Bergstrom (1982) and Jones-Lee (1991). As expected, WTP (Citizen) also meets the Benefit Condition.

Using WTP (Social), Projects 1, 2, and 3 pass the BCA test. Project 2 is preferred as it has the highest aggregate WTP of £602. Project 2 provides a greater benefit for the higher income position and tax is proportional to income. The aggregate net benefit is negative and therefore does not meet the Benefit Condition. Even though a BCA using WTP (Social) would recommend Project 2 to be funded at a total cost of £602, a potential Pareto improvement could not be achieved. Project 4 is the least preferred as it has the lowest aggregate WTP. The aggregate net benefit is positive and WTP (Social) therefore does not meet the Benefit Condition, as expected. In this example, the consequence is that a BCA using WTP (Social) rejects Project 4 at any cost over £558 despite Project 4 being potentially Pareto improving up to a cost of £600. The only difference between Projects 1 and 2 and between Projects 3 and 4 is the tax shares. As WTP (Social) is in part determined by the tax shares (see Equation 13), the change in the progressivity of the tax system causes changes to both the individual and aggregate WTP (Social). The overall change is positive from Project 1 to 2 but negative from Project 3 to 4, which results in WTP (Social) not meeting the Benefit Condition.

Appendix Tables 2–6 show the results for alternate societies with different underlying preferences described in Appendix Table 1. This includes two types of paternalistic altruism:

[10] Another exception is the case of self-interest.

Table 2. *Simulation results: WTP, the benefit–cost test, net benefit, and the Benefit Condition*

	WTP(Private)				WTP(Social)				WTP(Citizen)			
Project	1	2	3	4	1	2	3	4	1	2	3	4
WTP												
Alice	100	100	300	300	143	111	257	200	200	200	200	200
Bob	200	200	200	200	200	191	200	191	200	200	200	200
Chioma	300	300	100	100	257	300	143	167	200	200	200	200
Aggregate	600	600	600	600	600	602	600	558	600	600	600	600
BCA test												
Passed	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
Chosen	✓	✓	✓	✓		✓			✓	✓	✓	✓
Net benefit												
Alice	−80	−16	80	144	−80	−17	80	159	−80	−16	80	144
Bob	0	16	0	16	0	15	0	35	0	16	0	16
Chioma	80	0	−80	−160	80	−1	−80	−135	80	0	−80	−160
Aggregate	0	0	0	0	0	−3	0	59	0	0	0	0
Benefit condition												
Met	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓

WTP: WTP (Private), WTP (Social), and WTP (Citizen) are calculated for Projects 1–4 (Table 1) using Equations 9, 13, and 17, respectively. Aggregate WTP is the sum of Alice, Bob, and Chioma's WTPs. **BCA test**: The BCA test is passed when aggregate WTP equals or exceeds the cost of £600. Of the projects that pass the BCA test, the project with the greatest aggregate WTP is chosen. **Net Benefit:** To evaluate each WTP against the Benefit Condition, the net benefit for each individual at a cost equal to the aggregate WTP is calculated using Equation 5. The aggregate net benefit is calculated using Equation 6. **Benefit Condition:** The Benefit Condition is met if aggregate net benefit equals zero as set out in Equation 7.

benefits-focused altruism ($\forall p, \alpha_p = 0.2, \beta_p = 0$) where social utility is derived from others' benefits from the project, and wealth-focused altruism ($\forall p, \alpha_p = 0, \beta_p = 0.2$) where social utility is derived from others' benefits from consuming the private good. We also include the maximin motive (only $\alpha_1 \geq 0$, $\beta_1 \geq 0$) where social utility is derived from the worst-off individual (Position 1) and the efficiency motive ($\forall p, \alpha_p = \alpha$, $\beta_p = \beta$) where all other individuals are given equal weight in the social utility function.

Across the different societies and projects, WTP (Private) consistently equals £600, the sum of the individual benefits, and never meets the Benefit Condition. WTP (Citizen) varies between societies and projects and consistently meets the Benefit Condition. WTP (Social) varies between societies in a similar manner to WTP (Citizen) but does not consistently meet the Benefit Condition. The case of benefit-focused altruism is shown to be an exception for WTP (Social).[11]

7. WTP and democratic principles

We have assessed WTP (Private), WTP (Social), and WTP (Citizen) against our Benefit Condition. Here we consider WTP in relation to democratic principles. Jones-Lee (1989, pg. 11) observes that when WTP is aggregated for use in a conventional BCA, the preference aggregation mechanism delivers the principle of "one pound, one vote" which can be criticized for being undemocratic. Jones-Lee goes on to argue that while "one person, one vote" is more democratic, WTP is still preferable over referenda for allocative decision-making as WTP gives a measure of the strength of preference. In referenda, an individual votes for the project if the total cost is less than or equal to their preferred maximum C. Aggregating votes gives the principle of "one person, one vote," but not a strength of preference.

Using WTP (Private) or WTP (Social) in a BCA delivers the undemocratic principle of "one pound, one vote." Each individual has a preference for the maximum total amount the society should spend on a project, C[12] which is multiplied by their cost share to give their WTP. When cost shares are determined by income, for example, a proportional income tax, the preference of the individual in Position 1 (poorest) is given less weight than the preference of the individual in position N (richest) because $t_1 < t_N$. In other words, the principle of "one pound, one vote."

WTP (Citizen), when used in a BCA, simultaneously achieves the democratic principle of "one person, one vote" and gives a measure of strength of preference. For WTP (Citizen), an individual's preference for C (Equation 16) is weighted by $1/N$, which is constant, to give Equation 17. Each individual's preference for the maximum total amount the society should spend on a project is given equal weight in the preference aggregation process and is therefore democratic. As such, the additional weight an individual places on the benefits and/or costs of particular positions in society are endogenous weights that reflect the individual's distributional and ethical preferences.

[11] Benefit-focused altruism is conceptually equivalent to purely safety-focused altruism in Jones-Lee (1991). The exception described here allows us to draw the same conclusion as Jones-Lee (1991).

[12] For WTP (Social), C is given in Equation 12 and for WTP (Private), Equation 9 is divided by the individual's cost share to give C.

8. Discussion and Conclusions

In this paper, we set out the theoretical underpinnings for a new citizen-based WTP, WTP (Citizen). Our model extends the standard social utility model (Bergstrom, 2006) of WTP for a public good when individuals are altruists by incorporating a VoI (Harsanyi, 1955). We have shown theoretically and illustrated empirically (using simulations) that, for such a society, WTP (Citizen) meets the Benefit Condition where WTP (Social) and WTP (Private) do not. Only if the Benefit Condition is met will BCA consistently reject projects that are not potentially Pareto improving and accept projects that are potentially Pareto improving. We conclude that for a BCA when individuals have altruistic and distributional preferences, WTP (Citizen) is the best of the three measures considered.

To demonstrate this result, a simple framework sufficed but of course, this came with a number of assumptions. The utility function is such that it encompasses a broad set of altruistic preferences over goods (public and private) and distribution. It is however possible that individuals have different distributional and ethical preferences than our assumed functional form covers. We assume linearity in the scale of costs and benefits and a marginal utility of income of one. Due to the assumption of constant marginal utility of income, the result that WTP (Social) does not meet the Benefit Condition is a result of the progressivity of the tax system rather than caused by different marginal utilities of income for richer and poorer individuals. To allow for interpersonal comparisons of utility when applying the Benefit Condition we also assume homogenous preferences over others. Future research could consider the impact of relaxing these assumptions. Nevertheless, the model is general enough to capture most of the preferences we might reasonably assume to exist in a society that enjoys—but must pay for—public goods. The exposition in this paper is by necessity (space constraints) limited to the theoretical model of WTP (Citizen) but an empirical application can be seen in Beeson et al. (2019) in which the WTP (Citizen) has been operationalized in an incentivized experiment.

We now turn to some additional ethical considerations that arise from the application of our WTP (Citizen). Starting with the principle of consumer sovereignty which according to Lerner (1972) is defined as "letting each member of society decide what is good for himself, rather than have someone else play a paternal role" (Lerner, 1972 pg. 258). When discussing consumer sovereignty, Lerner (1972, pg. 258) goes on to argue that economists "must be concerned with the mechanisms for getting people what *they* want, no matter how these wants were acquired." We regard WTP (Private, Social, or Citizen) as being consistent with Lerner's definition of consumer sovereignty if WTP: (1) lets an individual "decide what is good" by reflecting the individual's altruistic and distributional preferences in their social utility function, and (2) meets the Benefit Condition making WTP, when aggregated for use in a BCA, a mechanism "for getting individuals what they want" based on the individuals' social utility functions. Both WTP (Social) and WTP (Citizen) are consistent with the first part of Lerner's definition as each reflects individuals' altruistic and distributional preferences in their social utility function. WTP (Private) is not consistent with this definition of consumer sovereignty as it limits preferences to self-interest. Neither WTP (Private) nor WTP (Social) meets the Benefit Condition which means that a project may be recommended even though the cost exceeds the benefit to society, or a project may be rejected even though it is not beneficial. Only WTP (Citizen) meets the

Benefit Condition and therefore is consistent with both parts of Lerner's definition of consumer sovereignty.

Next, we consider democratic principles in relation to BCA. According to Jones-Lee, (1989 pg. 11): "what is needed is a variant of the 'one person, one vote' principle which will reflect the strength of individual preferences, bearing in mind the constraints imposed by the overall scarcity of resources" (Jones-Lee, 1989 pg. 11). The traditional democratic principle of 'one person, one vote' does not measure strength of preference. Conventional BCA using WTP (Private) or WTP (Social) will measure people's strength of preference but follows the principle of "one pound, one vote" which gives the poor less votes in the allocative decision-making process than the rich. We have shown that WTP (Citizen) is democratic whilst measuring the strength of preference and bearing in mind individual income constraints.

Traditionally, BCA focuses on efficiency with the possibility of applying exogenous weights to benefits and costs to reflect equity concerns (Robinson & Hammitt, 2011). Ultimately, both the use and setting of distributional weights require a normative judgment (Hammitt, 2021) but so does the decision to not use distributional weights (Adler, 2016). While it is often prescribed that these normative judgments are left to the decision-maker, our discussion of the principle of consumer sovereignty and democratic principles would indicate that if an individual's welfare is in part determined by the distribution of benefits and costs in society, then the WTP values used in BCA should reflect this. Indeed, many policies such as climate change mitigation cannot be considered independently of the distributional consequences (Cai *et al.*, 2010). This type of independence would be required for WTP (Private). By adopting WTP (Citizen), the additional weight that individuals place on the benefits and costs of particular positions in society are endogenous weights that reflect the public's distributional and ethical preferences.

Our results show that while WTP (Social) does reflect an individual's preference over distribution, it is not the correct approach to include those concerns in a BCA. Care should therefore be taken when considering the use of these values in a BCA. This is particularly important as stated preference studies have demonstrated that WTP does indeed depend on the distributional consequences of a project (Cai *et al.*, 2010) and altruism (Gyrd-Hansen *et al.*, 2016; Simonsen *et al.*, 2021). Notably, our theoretical findings are independent of the elicitation method and not confined to the stated preference literature. If the choices reflected in revealed preference studies suffer from the problem of WTP (Social) described here, then the WTP values from revealed preference studies will be similarly affected.

In closing, we note that so far, an empirical 'citizen' approach such as those deployed by Blamey et al. (1995) and Curtis and McConnell (2002) have only to a very limited extent been underpinned by a formal utility model. In this paper we have addressed this gap by laying the foundations for eliciting a theoretically consistent WTP (Citizen) in a future, hypothetical empirical survey – one that is based on an individual's social utility function and therefore reflects people's preferences over others, and when aggregated for use in a BCA gives equal weight to each person's preferences. Furthermore, it assures that potential Pareto-improving projects are correctly identified in a consistent manner.

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Symbols. N is the number of individuals and positions in society.

i denotes an individual i.

p denotes a position p.

w is income.

x is the benefit of the project to an individual.

C is the total cost of providing the project.

t is the cost share paid by an individual.

u is a private utility.

U is social utility.

α is the altruistic weight placed on another individual's benefit from the project.

β is the altruistic weight placed on another individual's benefit from consuming a private good.

q denotes a position q.

EU is expected social utility.

$WTP^i(Private)$ is the individual's CV based on their private utility function (Equation 1),

$WTP^i(Social)$ is the individual's CV based on their social utility function (Equation 2), and.

$WTP^i(Citizen)$ is the individual's CV based on their social utility function in expectation (Equation 4) as the individual is placed behind a VoI.

ΔU is the net benefit.

Competing interest. The authors have no competing interests to declare.

References

Adler, Matthew D. 2016. "Benefit–Cost Analysis and Distributional Weights: An Overview." *Review of Environmental Economics and Policy*, *10*(2): 264–285.

Beeson, Morgan, Susan Chilton, Michael W. Jones-Lee, Hugh Metcalf, and Jytte Seested Nielsen. 2019. "Can a 'Veil of Ignorance' Reduce the Impact of Distortionary Taxation on Public Good Valuations?" *Journal of Risk and Uncertainty*, *58*: 245–262.

Bergstrom, Theodore C. 1982. "When Is a Man's Life Worth More than His Human Capital?" In Jones-Lee, Michael W (Ed.) *Geneva Conference on the Value of Life and Safety, 1981, Geneva, Switzerland*, pp. 3–26. Amsterdam: North Holland.

Bergstrom, Theodore C. 2006. "Benefit-Cost in a Benevolent Society." *American Economic Review*, *96*(1): 339–351.

Blamey, Russell K., Mick S. Common, and John C. Quiggin. 1995. "Respondents to Contingent Valuation Surveys: Consumers or Citizens?" *Australian Journal of Agricultural Economics*, *39*(3): 263–288.

Boadway, Robin. 2016. "Cost-Benefit Analysis". In Adler, Matthew D., and Marc Fleurbaey (Eds.) *The Oxford Handbook of Well-Being and Public Policy, Oxford Handbooks*; (online edn, Oxford Academic, 2 Nov. 2016). 10.1093/oxfordhb/9780199325818.013.2, accessed 3 Sept. 2024.

Cai, Beilei, Trudy Ann Cameron, and Geoffrey R. Gerdes. 2010. "Distributional Preferences and the Incidence of Costs and Benefits in Climate Change Policy." *Environmental and Resource Economics*, *46*: 429–458.

Curtis, John A., and Kenneth E. McConnell. 2002. "The Citizen Versus Consumer Hypothesis: Evidence from a Contingent Valuation Survey." *Australian Journal of Agricultural and Resource Economics*, *46*(1): 69–83.

Engelmann, Dirk, and Martin Strobel. 2007. "Preferences Over Income Distributions: Experimental Evidence." *Public Finance Review*, *35*(2): 285–310.

Flores, Nicholas E. 2002. "Non-paternalistic Altruism and Welfare Economics." *Journal of Public Economics*, *83*(2): 293–305.

Gyrd-Hansen, Dorte, Trine Kjær, and Jytte Seested Nielsen. 2016. "The Value of Mortality Risk Reductions. Pure altruism–a confounder?" *Journal of Health Economics*, *49*: 184–192.
Hammitt, James K. 2021. "Accounting for the Distribution of Benefits and Costs in Benefit–Cost Analysis." *Journal of Benefit-Cost Analysis*, *12*(1): 64–84.
Harsanyi, John C. 1955. "Cardinal Welfare, Individualistic Ethics, and Interpersonal Comparisons of Utility." *Journal of Political Economy*, *63*(4): 309–321.
Hicks, John R. 1940. "The Valuation of the Social Income." *Economica*, *7*(26): 105–124.
Hicks, John R. 1942. "Consumers' Surplus and Index-Numbers." *The Review of Economic Studies*, *9*(2): 126–137.
Johansson, Per-Olav, and Bengt Kriström. 2021. "On Misrepresentation of Altruistic Preferences in Discrete-Choice Experiments." *Journal of Agricultural and Resource Economics*, *46*(1): 126–133.
Jones-Lee, Michael W. 1989. *The Economics of Safety and Physical Risk*. Oxford: Basil Blackwell.
Jones-Lee, Michael W. 1991. "Altruism and the Value of Other People's Safety." *Journal of Risk and Uncertainty*, *4*: 213–219.
Jones-Lee, Michael W. 1992. "Paternalistic Altruism and the Value of Statistical Life." *The Economic Journal*, *102* (410): 80–90.
Kaldor, Nicholas. 1939. "Welfare Propositions of Economics and Interpersonal Comparisons of Utility." *The Economic Journal*, *49*(195): 549–552.
Lerner, Abba P. (1972) "The Economics and Politics of Consumer Sovereignty." *The American Economic Review*, *62*(1/2): 258–266.
McConnell, Kenneth E. 1997. "Does Altruism Undermine Existence Value?" *Journal of Environmental Economics and Management*, *32*(1): 22–37.
Milgrom, Paul. 1993. "Is Sympathy an Economic Value? Philosophy, Economics, and the Contingent Valuation Method." In *Contingent Valuation: A Critical Assessment*, Amsterdam; New York: North-Holland, pp. 417–441.
Orr, Shepley W. 2007. "Values, Preferences, and the Citizen-Consumer Distinction in Cost-Benefit Analysis." *Politics, Philosophy & conomics*, *6*(1): 107–130.
Rawls, John. 1972. *A theory of justice*. Oxford: Clarendon Press.
Robinson, Lisa A., and James K. Hammitt. 2011. "Behavioral Economics and the Conduct of Benefit-Cost Analysis: Towards Principles and Standards." *Journal of Benefit-Cost Analysis*, *2*(2): 1–51.
Simonsen, Nicolai Fink, Trine Kjær, and Dorte Gyrd-Hansen. 2021. "Pure Altruism and Misjudgement: A Bad Combination?" *Journal of Health Economics*, *80*: 102550
Sugden, Robert. 1981. *The political economy of public choice: An introduction to welfare economics*. Oxford [Oxfordshire]: M. Robertson.

Appendix A – Steps from Equation 5 to Equation 6

Equation 5 is the net benefit of Individual i who is in Position p which found by differencing social utility (Equation 2), which reflects the individual's full set of preferences, with and without the project.

$$\Delta U_p^i = x_p + \sum_{q \neq p}^{N} \alpha_q^i x_q - C\left(t_p + \sum_{q \neq p}^{N} \beta_q^i t_q\right) \tag{5}$$

We apply the assumption of homogenous altruistic preferences ($\alpha_p^i = a_p$ and $\beta_p^i = \beta_p \ \forall i$) and aggregate across positions to give the aggregate net benefit (Equation A1).

$$\sum_{p}^{N} \Delta U_p = \sum_{p}^{N}\left[x_p + w_p - t_p \sum_{i}^{N} WTP^i + \sum_{q \neq p}^{N}\left[\alpha_q x_q + \beta_q\left(w_q - t_q\right)\sum_{i}^{N} WTP^i\right] - w_p + \sum_{q \neq p}^{N}\left[\beta_q w_q\right]\right] \tag{A1}$$

Equation A1 can be simplified by cancelling the income terms to give Equation A2.

$$\sum_{p}^{N}\Delta U_p=\sum_{p}^{N}\left[x_p-t_p\sum_{i}^{N}WTP^i+\sum_{q\neq p}^{N}\left[\alpha_q x_q-\beta_q t_q\sum_{i}^{N}WTP^i\right]\right] \tag{A2}$$

Unpacking the summations and collecting terms to gives Equation A3.

$$\sum_{p}^{N}\Delta U_p=\sum_{p}^{N}\left[\left(1+(n-1)\alpha_p\right)x_p-\left(1+(n-1)\beta_p\right)t_p\cdot\sum_{i}^{N}WTP^i\right] \tag{A3}$$

Then splitting the summation up and taking $\sum_{i}^{N}WTP^i$ outside the summation gives Equation 6.

$$\sum_{p}^{N}\Delta U_p=\sum_{p}^{N}\left[\left(1+(n-1)\alpha_p\right)x_p\right]-\sum_{p}^{N}\left[\left(1+(n-1)\beta_p\right)t_p\right]\cdot\sum_{i}^{N}WTP^i \tag{6}$$

Appendix B. Additional simulations

Table A1. *Alternate preference configurations with parameter assumptions and results table*

Preference configuration	α_1	β_1	α_2	β_2	α_3	β_3	Appendix Table
Pure altruism with maximin motive	0.2	0.2	0	0	0	0	2
Benefit-focused altruism with efficiency motive	0.2	0	0.2	0	0.2	0	3
Benefit-focused altruism with maximin motive	0.2	0	0	0	0	0	4
Wealth-focused altruism with efficiency motive	0	0.2	0	0.2	0	0.2	5
Wealth-focused altruism with maximin motive	0	0.2	0	0	0	0	6

Wealth-focused altruism is defined in Jones-Lee (1992) and benefit-focused altruism is conceptually equivalent to safety-focused altruism from Jones-Lee (1991) and Jones-Lee (1992).

Table A2. *Simulation results: WTP, the benefit–cost test, net benefit, and the Benefit Condition for pure altruism with maximin motive*

	WTP(Private)				WTP(Social)				WTP(Citizen)			
Project	1	2	3	4	1	2	3	4	1	2	3	4
WTP												
Alice	100	100	300	300	100	100	300	300	188	198	212	222
Bob	200	200	200	200	183	194	217	229	188	198	212	222
Chioma	300	300	100	100	267	296	133	148	188	198	212	222
Aggregate	600	600	600	600	550	590	650	678	565	593	635	667
BCA test												
Passed	✓	✓	✓	✓			✓	✓			✓	✓
Chosen	✓	✓	✓	✓				✓				✓
Net benefit												
Alice	−100	−20	100	180	−83	−18	83	164	−88	−19	88	167
Bob	−20	16	20	56	0	19	0	30	−6	19	6	33
Chioma	80	−4	−80	−164	100	1	−100	−206	94	0	−94	−200
Aggregate	−40	−8	40	72	17	2	−17	−12	0	0	0	0
Benefit condition												
Met									✓	✓	✓	✓

WTP: WTP (Private), WTP (Social), and WTP (Citizen) are calculated for Projects 1–4 (Table 1) using Equations 9, 13, and 17, respectively. Aggregate WTP is the sum of Alice, Bob, and Chioma's WTPs. **BCA test**: The BCA test is passed when aggregate WTP equals or exceeds the cost of £600. Of the projects that pass the BCA test, the project with the greatest aggregate WTP is chosen. **Net Benefit:** To evaluate each WTP against the Benefit Condition, the net benefit for each individual at a cost equal to the aggregate WTP is calculated using Equation 5. The aggregate net benefit is calculated using Equation 6. **Benefit Condition:** The Benefit Condition is met if aggregate net benefit equals zero as set out in Equation 7.

Table A3. *Simulation results: WTP, the benefit–cost test, net benefit, and the Benefit Condition for benefit-focused altruism with efficiency motive*

	WTP(Private)				WTP(Social)				WTP(Citizen)			
Project	1	2	3	4	1	2	3	4	1	2	3	4
WTP												
Alice	100	100	300	300	200	200	360	360	280	280	280	280
Bob	200	200	200	200	280	280	280	280	280	280	280	280
Chioma	300	300	100	100	360	360	200	200	280	280	280	280
Aggregate	600	600	600	600	840	840	840	840	840	840	840	840
BCA test												
Passed	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Chosen	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Net benefit												
Alice	0	80	160	240	−80	32	80	192	−80	32	80	192
Bob	80	100	80	100	0	28	0	28	0	28	0	28
Chioma	160	60	0	−100	80	−60	−80	−220	80	−60	−80	−220
Aggregate	240	240	240	240	0	0	0	0	0	0	0	0
Benefit condition												
Met					✓	✓	✓	✓	✓	✓	✓	✓

WTP: WTP (Private), WTP (Social), and WTP (Citizen) are calculated for Projects 1–4 (Table 1) using Equations 9, 13, and 17, respectively. Aggregate WTP is the sum of Alice, Bob, and Chioma's WTPs. **BCA test**: The BCA test is passed when aggregate WTP equals or exceeds the cost of £600. Of the projects that pass the BCA test, the project with the greatest aggregate WTP is chosen. **Net Benefit:** To evaluate each WTP against the Benefit Condition, the net benefit for each individual at a cost equal to the aggregate WTP is calculated using Equation 5. The aggregate net benefit is calculated using Equation 6. **Benefit Condition:** The Benefit Condition is met if aggregate net benefit equals zero as set out in Equation 7.

Table A4. *Simulation results: WTP, the benefit–cost test, net benefit, and the Benefit Condition for benefit-focused altruism with maximin motive*

	WTP(Private)				WTP(Social)				WTP(Citizen)			
Project	1	2	3	4	1	2	3	4	1	2	3	4
WTP												
Alice	100	100	300	300	100	100	300	300	213	213	240	240
Bob	200	200	200	200	220	220	260	260	213	213	240	240
Chioma	300	300	100	100	320	320	160	160	213	213	240	240
Aggregate	600	600	600	600	640	640	720	720	640	640	720	720
BCA test												
Passed	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Chosen	✓	✓	✓	✓			✓	✓			✓	✓
Net benefit												
Alice	−100	−20	100	180	−113	−28	60	156	−113	−28	60	156
Bob	20	40	60	80	7	28	20	44	7	28	20	44
Chioma	120	20	−40	−140	107	0	−80	−200	107	0	−80	−200
Aggregate	40	40	120	120	0	0	0	0	0	0	0	0
Benefit condition												
Met					✓	✓	✓	✓	✓	✓	✓	✓

WTP: WTP (Private), WTP (Social), and WTP (Citizen) are calculated for Projects 1–4 (Table 1) using Equations 9, 13, and 17, respectively. Aggregate WTP is the sum of Alice, Bob, and Chioma's WTPs. **BCA test**: The BCA test is passed when aggregate WTP equals or exceeds the cost of £600. Of the projects that pass the BCA test, the project with the greatest aggregate WTP is chosen. **Net Benefit:** To evaluate each WTP against the Benefit Condition, the net benefit for each individual at a cost equal to the aggregate WTP is calculated using Equation 5. The aggregate net benefit is calculated using Equation 6. **Benefit Condition:** The Benefit Condition is met if aggregate net benefit equals zero as set out in Equation 7.

Table A5. *Simulation results: WTP, the benefit–cost test, net benefit, and the Benefit Condition for wealth-focused altruism with efficiency motive*

	WTP(Private)				WTP(Social)				WTP(Citizen)			
Project	1	2	3	4	1	2	3	4	1	2	3	4
WTP												
Alice	100	100	300	300	71	56	214	167	143	143	143	143
Bob	200	200	200	200	143	136	143	136	143	143	143	143
Chioma	300	300	100	100	214	250	71	83	143	143	143	143
Aggregate	600	600	600	600	429	442	429	386	429	429	429	429
BCA test												
Passed	✓	✓	✓	✓								
Chosen	✓	✓	✓	✓								
Net benefit												
Alice	−180	−116	20	84	−100	−59	100	161	−100	−54	100	146
Bob	−80	−64	−80	−64	0	6	0	30	0	11	0	11
Chioma	20	−60	−180	−260	100	35	−100	−132	100	43	−100	−157
Aggregate	−240	−240	−240	−240	0	−19	0	59	0	0	0	0
Benefit condition												
Met					✓		✓		✓	✓	✓	✓

WTP: WTP (Private), WTP (Social), and WTP (Citizen) are calculated for Projects 1–4 (Table 1) using Equations 9, 13, and 17, respectively. Aggregate WTP is the sum of Alice, Bob, and Chioma's WTPs. **BCA test**: The BCA test is passed when aggregate WTP equals or exceeds the cost of £600. Of the projects that pass the BCA test, the project with the greatest aggregate WTP is chosen. **Net Benefit:** To evaluate each WTP against the Benefit Condition, the net benefit for each individual at a cost equal to the aggregate WTP is calculated using Equation 5. The aggregate net benefit is calculated using Equation 6. **Benefit Condition:** The Benefit Condition is met if aggregate net benefit equals zero as set out in Equation 7.

Table A6. *Simulation results: WTP, the benefit–cost test, net benefit, and the Benefit Condition for wealth-focused altruism with maximin motive*

	WTP(Private)				WTP(Social)				WTP(Citizen)			
Project	1	2	3	4	1	2	3	4	1	2	3	4
WTP												
Alice	100	100	300	300	100	100	300	300	176	185	176	185
Bob	200	200	200	200	167	176	167	176	176	185	176	185
Chioma	300	300	100	100	250	278	83	93	176	185	176	185
Aggregate	600	600	600	600	517	554	550	569	529	556	529	556
BCA test												
Passed	✓	✓	✓	✓								
Chosen	✓	✓	✓	✓								
Net benefit												
Alice	−100	−20	100	180	−72	−11	117	186	−76	−11	124	189
Bob	−40	−4	−40	−4	−7	12	−20	7	−12	11	−12	11
Chioma	60	−24	−140	−224	93	1	−120	−207	88	0	−112	−200
Aggregate	−80	−48	−80	−48	14	1	−23	−15	0	0	0	0
Benefit condition												
Met									✓	✓	✓	✓

WTP: WTP (Private), WTP (Social), and WTP (Citizen) are calculated for Projects 1–4 (Table 1) using Equations 9, 13, and 17, respectively. Aggregate WTP is the sum of Alice, Bob, and Chioma's WTPs. **BCA test**: The BCA test is passed when aggregate WTP equals or exceeds the cost of £600. Of the projects that pass the BCA test, the project with the greatest aggregate WTP is chosen. **Net Benefit:** To evaluate each WTP against the Benefit Condition, the net benefit for each individual at a cost equal to aggregate WTP is calculated using Equation 5. Aggregate net benefit is calculated using Equation 6. **Benefit Condition:** The Benefit Condition is met if aggregate net benefit equals zero as set out in Equation 7.

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