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**Working Paper**

## An introduction to Participatory Value Evaluation

Tinbergen Institute Discussion Paper, No. TI 2019-024/V

**Provided in Cooperation with:**

Tinbergen Institute, Amsterdam and Rotterdam

*Suggested Citation:* Mouter, Niek; Koster, Paul; Dekker, Thijs (2019) : An introduction to Participatory Value Evaluation, Tinbergen Institute Discussion Paper, No. TI 2019-024/V, Tinbergen Institute, Amsterdam and Rotterdam

This Version is available at:

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TI 2019-024/V  
Tinbergen Institute Discussion Paper

# An introduction to Participatory Value Evaluation

**Revision: May 2019**

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## An introduction to Participatory Value Evaluation

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**Abstract:**

Cost-Benefit Analysis (CBA) for public policies assumes ‘consumer sovereignty’, implying that impacts of government projects can be expressed in monetary terms by aggregating individuals’ willingness to pay. However, individuals’ willingness to pay might not accurately reflect preferences towards public policies. Participatory Value Evaluation (PVE) is a novel evaluation framework specifically designed to rectify this issue by going beyond the paradigm of ‘consumer sovereignty’. PVE infers the social welfare effects of public policies through eliciting individuals’ preferences over the allocation of public budgets (‘citizen sovereignty’) as well as their private income (‘consumer sovereignty’). In a PVE, individuals are asked to choose the best portfolio of projects with corresponding impacts for society and themselves subject to governmental and private budget constraints. This paper positions PVE relative to past innovations in applied welfare economics and illustrates the potential of the approach through a case study on projects to mitigate flood risks at locations along the Dutch river ‘Waal’. In total 2,900 citizens participated in this PVE. The main result of the case study is that citizens have a preference for projects that combine strengthening dikes and giving the river space to flood safely, particularly when such projects positively influence biodiversity and recreational opportunities.

**Keywords:**

Participatory Value Evaluation; Cost-Benefit Analysis; Benefit-Cost Analysis; Citizen Participation; Environmental Valuation; Flood Protection; Biodiversity.

**1. Introduction**

In western countries, Cost-Benefit Analysis (CBA) is nowadays considered the gold standard for supporting public decision-making (e.g. Boardman et al. 2013). In virtually all western countries CBA is mandatory when national funding is required for large transport projects (Mackie et al., 2014). CBA is widely applied to governmental decisions on environmental, health and safety regulation (e.g. Hahn and Tetlock, 2008) and the instrument is also adopted in other policy domains examples being energy and water management (e.g. Dehnhardt, 2014; Persky, 2011). The theoretical foundations of CBA are rooted in welfare economics which is a branch of economics that investigates the social desirability of alternative economic outcomes (e.g. Boadway and Bruce, 1984). A CBA is built on the Kaldor-Hicks efficiency criterion (e.g. Boadway, 2006), which recommends projects where the sum of monetary gains outweighs the sum of monetary losses and winners can potentially compensate the losers. In a CBA, positive and negative social impacts of government projects are converted to monetary units using willingness to pay (WTP) estimates. This paradigm – also called ‘consumer sovereignty’ (e.g. Boadway, 2006) – is fiercely criticized in the literature (e.g. Ackerman and Heinzerling, 2004; Sagoff, 1988). Several scholars argue that ‘consumer sovereignty’ takes a too narrow perspective when evaluating government projects because choices individuals make with their private income might not accurately reflect their preferences towards public policy (e.g. Ackerman and Heinzerling, 2004; Sen, 1995).

Participatory Value Evaluation (PVE) is a novel evaluation framework specifically designed to rectify this issue by combining the paradigm of ‘consumer sovereignty’ with ‘citizen sovereignty’. PVE infers the social welfare effects of public policies through eliciting individuals’ preferences over the allocation of public budgets (‘citizen sovereignty’) as well as their private income (‘consumer sovereignty’). In a PVE, individuals are asked to choose the best

portfolio of projects with corresponding impacts for society and themselves subject to governmental and private budget constraints. Hence, individuals are conceptualized both as co-owners of the government and consumers of public goods. PVE establishes the social welfare effects of government projects through advanced behavioural choice modelling (Dekker et al., 2019). This paper highlights the contributions of PVE and positions PVE relative to past innovations in applied welfare economics (Section 2). The potential of PVE is further illustrated by means of a case study evaluating the social welfare effects of projects to mitigate flood risks at locations along the Dutch river ‘de Waal’ (Section 3). Finally, Section 4 provides a discussion which, amongst other things, highlights directions in which PVE can be further developed.

## **2. Participatory Value Evaluation: the next step in the evolution of applied welfare economics**

The first examples of CBA can be found in the work of French engineers whose cost-benefit computations stretch back to before the French Revolution and flourished in the mid-nineteenth century with contributions of Jules Dupuit (Persky, 2001). In the early years, a CBA only investigated social costs and benefits of government projects based on the private WTP of affected individuals (Persky, 2001). Over the course of time, also the WTP of citizens who are not directly affected by a government policy was included in CBA (Arrow et al., 1993). For instance, a recent CBA regarding regulation involving building access for people who use wheelchairs, also includes the WTP of nondisabled Americans for such access (Posner and Sunstein, 2017). Ideally, analysts derive estimates of the monetary impacts of government projects directly from market behaviour. Impacts of government projects are, amongst other things, evaluated through investigating the private decisions people make when buying a house. For example, Koster and van Ommeren (2015) estimate the impact of earthquakes on housing prices and use these estimates to draw conclusions about the non-monetary costs of being exposed to the risk of earthquakes resulting from gas extraction. When such market information is absent, the value of public goods can be estimated using survey techniques such as contingent valuation (e.g. Carson, 2012; Sardana, 2019; Wiser, 2007).

The most prominent critique on the private WTP approach is that individuals’ private WTP may not reflect how they want public policies to change (e.g. Ackerman and Heinzerling, 2004; Alphonse et al., 2014; Kelman, 1981; Lusk and Norwood, 2011; Mill et al., 2007; Tienhaara et al., 2015; Sen, 1995). For instance, in the case of animal welfare, people may not be willing to contribute individually to the public good because they view the impact of their individual contribution as negligible. People may, however, be willing to contribute when the whole community contributes because the impacts of coordinated efforts can be substantial (Ivehammar, 2009; Kling et al., 2012; Sen, 1995). An example is provided by Lusk and Norwood (2011) who describe how 63% of Californians voted in favour of a ballot prohibiting battery-produced eggs, which at the time of the vote were the most popular type of eggs purchased and consumed in California. Scholars also argue that individuals’ private consumer choices might not reflect their preferences towards public policy because moral considerations might be more salient in the latter context (e.g. Sagoff, 1988; Sunstein, 2005). Sunstein (2005, p.355) states: *“willingness to pay is sometimes an inappropriate basis for environmental policy. Human beings are citizens, not merely consumers, and their consumption choices, as measured by willingness to pay, might be trumped by their reflective judgments as citizens.”* Sagoff (1988, p. 48) asserts that: *“many of us are concerned, for example, that the workplace be safe and free of carcinogens; we may share this conviction, even if we are not workers. And so, we might*

*favour laws that require very high air-quality standards in petrochemical plants. But as consumers, we may find no way to support the cause of workplace safety. Indeed, if we buy the cheapest products, we may defeat it. We may be concerned as citizens, or as members of a moral and political community, with all sorts of values – sentimental, historical, ideological, cultural, aesthetic, and ethical – that conflict with the interests we reveal as consumers, buying shoes and choosing tomatoes. The conflict within individuals, rather than between them, may be a very common conflict. The individual as a self-interested consumer opposes himself as a moral agent and a concerned citizen.”*

In an attempt to ameliorate this issue, impacts of government projects have been evaluated through individuals’ collective WTP. Nyborg (2000, pp. 311) describes the valuation question in such experiments as: “*what is the maximum amount, that I believe, everybody should pay, to ensure this government project?*” Collective WTP maintains the notion of ‘consumer sovereignty’ as the utility individuals derive from effects of government projects can be measured through the number of euros that they are (collectively) willing to pay from their after-tax income (e.g. Boadway, 2006; Sugden, 2007). Various authors recommend inferring collective WTP through referendum-style experiments, where the implied implementation criteria would be the majority rule (e.g. Arrow et al., 1993). These referendum-style experiments concern impacts for the entire community which solves the coordination problems from which private WTP suffers. Moreover, such experiments facilitate people to include (moral) considerations regarding the way government should trade off burdens and benefits of public policies because they are asked to answer the WTP question in a voting booth setting. The ‘democratic valuation’ approach of Schläpfer (2016, 2017) goes one step further by arguing that respondents who participate in referendum-style experiments should be provided with external information that is usually available in public referendum decisions such as the issue positions of political parties or interest groups representing a broad range of interests.

Despite its virtues, the shift from private WTP to collective WTP does not solve all criticism regarding WTP-based CBA. A remaining criticism concerns the implicit assumption within WTP-based CBA that private euros and public euros cannot have a different purpose (Mouter et al., 2017a). This principle is also known as the ‘a euro is a euro’ principle or ‘complete fungibility’ (Hess et al., 2012). Under complete fungibility, it is possible to establish the social welfare effect of a public good that is financed with government funds (public euros) through aggregating the number of euros that individuals are (collectively) willing to pay from their after-tax income (private euros). However, a crucial issue is that ‘complete fungibility’ does not fit with what is observed in reality (e.g. Thaler, 1999; Tversky and Kahneman, 1981). For instance, Thaler (1999) shows that euros contained within a given budget can indeed have a specific goal or purpose; as such, they are at best imperfect substitutes for euros from other budgets, even for the same individual. From this point of view, a more defensible notion is to assume that individuals might view their own money and government funds as being from two separate budgets; even if individual A is measurably willing to pay X euros from their own budget for government project Z, we cannot then simply conclude that this individual also believes that X euros should be taken from the government budget. When it indeed makes a difference whether public projects are paid for by private euros (e.g. private or collective WTP) or public euros, WTP-based valuation (i.e. consumer sovereignty) is no longer useful for the evaluation of government projects financed from public revenues.<sup>1</sup> Instead, the welfare effects of

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<sup>1</sup> Importantly, government policies which only impose costs on the private sector (and not on public revenue) should still be evaluated using WTP-based valuation. One example is the Dolphin Protection Consumer Information Act

such projects should be inferred from individuals' preferences regarding the expenditure of public euros thereby replacing the postulation of 'consumer sovereignty' by 'citizen sovereignty' which could be elicited in a context in which individuals make choices when faced with effects accruing from alternative allocations of government budget (e.g. Anand and Wailoo, 2000; Dolan and Tsuchiya, 2005; Johannesson and Johansson, 1997; Johansson-Stenman and Martinsen, 2008; Mouter et al., 2017ab, 2018). Importantly, experiments conducted in this so-called 'willingness to allocate public budget' (WTAPB) context do not directly impact the respondent's disposable income and the provision of other public goods (other than those considered in the choice experiment).<sup>2</sup> One can use such experiments to measure the extent to which citizens support the allocation of taxes towards a government project from which the effects accrue that are object of the analysis (Mouter et al., 2017a). Mouter et al. (2017a) empirically establish that individuals' indeed can have substantially different preferences in a WTAPB setting and a collective WTP setting. Their estimation results show that in a WTAPB setting individuals assign substantially more value to safety than travel time compared to the valuations individuals have in a collective WTP setting.

The extent to which and the underlying reasons why individuals may have different preferences in these two settings are underexplored in the literature. However, Mouter et al. (2018) provide some first empirical evidence as the respondents participating in this study argued that the government has a special duty of care when it comes to road safety and none of the respondents insisted that the government has any special duty (of care) when it comes to reducing travel times. For instance, respondents argued that the government has a greater responsibility in terms of taking care of people's safety than reducing travel times. When individuals feel that the government has a special obligation in terms of the provision of a specific public good it is plausible that they assign a high value to the provision of this public good in WTAPB experiments in that they support a (re)allocation of government funds towards road safety (at the cost of allocating public budget towards the provision of another public good such as travel time reduction). However, at the same time individuals' collective WTP in a referendum style experiment for a special duty of the government can be relatively low or even zero as they might believe that an important public good (in this example: road safety) should be financed from (a re-allocation of) governmental budget. The phenomenon that individuals who actually value a public good report a zero WTP for this good because they believe that the government should pay for this from expected or previously collected taxes is identified as an important category of 'protest votes' (e.g. Howley et al., 2010; Jorgensen et al., 1999; Ovaskainen and Kniivila, 2005; Stevens et al., 1991). In a WTAPB experiment, respondents are asked to make choices when faced with effects accruing from alternative allocations of governmental budgets. Hence, the problem that respondents protest because they think that the government should pay from (a re-allocation of) expected or previously collected taxes is non-existent. To re-iterate: an individual may be unwilling to pay for an environmental preservation project from his after tax income in a private or collective WTP setting, and yet believe that the

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which provides labelling standards by which companies may label their tuna products "dolphin safe" (Posner and Sunstein, 2017).

<sup>2</sup> There is a subtle difference between WTAPB experiments (in which the provision of other public goods than those respondents could choose in the choice experiment is not affected) and 'willingness to re-allocate tax experiments' in which the financing of the public good under scrutiny is to be paid for by a decrease in the amount of a household's taxation money that was previously spent on public goods that are not considered in the choice experiment (e.g. Bergstrom et al., 2004; Ivehammar, 2009; Kontoleon et al., 2007; Mouter and Chorus, 2016; Nunes and Travisi, 2009).



government should finance the very same project from existing public budget at the cost of allocating public budget towards the provision of other public goods, since they see the protection of nature as an important government task. Similarly, this individual may be willing to support a referendum for organizing a major sports event using a one-time tax increase (collective WTP setting), while fiercely opposing a re-allocation of taxes from environmental preservation to organizing the same event out of the belief that environmental preservation is a more important government responsibility than organizing sports events.

The WTAPB approach also alleviates three other critiques regarding WTP-based valuation. A first criticism is that WTP-based valuation violates the democratic principle of one-person-one-vote (OPOV) involving that every citizen receives the same weight in public decision-making (Nyborg, 2014; Schläpfer, 2016; Söderbaum, 1999; van Wee, 2012). A WTP-based CBA requires that everything is counted in money resulting (all else being equal) in a higher weight for people with higher incomes if the marginal utility of income is decreasing in income (Layard et al., 2008; Nyborg, 2014). Posner and Sunstein (2017) reply to this critique through arguing that this one-euro-one vote (OEOV) aggregation schedule aligns with how a market economy works. Nyborg (2014) states, however, that OEOV is an acceptable principle in the market place, but in her view, the fact that OEOV may result in a systematic bias in favour of those with high incomes is a rather strange ethical position in democratic societies, especially when redistribution of the net benefits of public policies does not take place. Theoretically, this problem can be rectified within a WTP-based framework through the inclusion of distributional weights in the analysis, but this is almost never done in practice, except in climate change economics where weights have been used to account for different income levels across countries (see Nurmi and Athianen, 2018 for a recent overview). A virtue of the WTAPB approach is that individuals' preferences regarding the allocation of government funds towards (impacts of) government projects are measured using OPOV (Mouter et al., 2017a). Second, WTAPB bypasses the concerns that WTP-based valuation is an unsuitable way to value impacts of government projects that are incommensurable with private income (Aldred, 2006; Clark et al., 2000). For instance, Sunstein (1993) argues that values that are not traded in a real-life market setting, such as free speech, biodiversity and landscape might be valued in the wrong way when they are expressed in private income. Raz (1986) argues that values such as friendship and our relationship with the natural world, cannot be valued in terms of private income without somehow corroding or degrading them. Crucially, WTAPB does not require translation of government project impacts into private income. Instead, an impact of a government project is valued through the extent to which individuals are willing to sacrifice other impacts of government projects. For instance, in a WTAPB experiment, individuals are asked to trade-off environmental impacts against other impacts of governmental policy (e.g. reduction of mortality risk) which contrasts the WTP approach in which individuals are asked to trade-off environmental impacts against private income. Third, the WTAPB approach might decrease hypothetical bias which is a longstanding issue of stated preference studies (Hausman, 2012; Kling et al., 2012). There is an increasing literature which establishes that hypothetical bias can be circumvented when respondents believe that their choices in a survey might have consequences in real life (e.g. Vossler and Evans, 2009; Zawojska and Czajkowski, 2017). In our view, it is easier to convince respondents that the results of WTAPB experiments will be used by the government in their decisions concerning the (re)allocation of public budget than that government policy will be influenced by filling-out a questionnaire based on private or collective WTP with (hypothetical) payments from their after-tax income.

Even though WTAPB solves a range of critiques, one clear downside of the approach is that respondents are forced to make a choice between two or three alternative allocations of public budgets (e.g. Anand and Wailoo, 2000; Johansson-Stenman and Martinsson, 2008; Mouter et al., 2017ab). In case respondents believe that it is better to do nothing instead of allocating public budgets to one of the proposed alternatives, they do not have the opportunity to express this preference. Participatory Value Evaluation (PVE) rectifies this issue by allowing respondents to allocate public budgets and by giving them the opportunity to choose the null portfolio resulting in a shift of public budget to the next year. In a ‘flexible budget PVE’ participants are also allowed to adjust the public budget (and their after tax income) by changing taxes. This set-up gives individuals who believe that it is better to reduce taxes (and increase private income) instead of choosing any of the government projects from which they have to choose in the PVE as well as individuals who think that taxes should be increased to facilitate the implementation of more than one of these projects the opportunity to express their preference. The innovation of the introduction of flexible PVEs is that ‘citizen sovereignty’ and ‘consumer sovereignty’ are combined in one economic evaluation framework. That is, the social welfare effects of government projects are established through the elicitation of individuals’ preferences over the allocation of public budgets (‘citizen sovereignty’) as well as their collective willingness to pay from their private income (‘consumer sovereignty’). The economic framework of PVE rests on standard microeconomic principles such as the assumption that individuals are utility maximisers (Dekker et al., 2019). Table 1 illustrates the relevant differences between PVE and the other approaches addressed in this section in terms of the valuation question for the respondent and the (economic) questions that can be answered.

**Table 1: Valuation questions and economic questions addressed by PVE and other approaches**

<b>Approach</b>		<b>Valuation question</b>	<b>Economic question</b>
I.	Private willingness to pay	What is the amount that I am willing to pay, on top of the taxes I already pay, from my private income to finance this public good?	Should we finance a public good through (voluntary) private contributions of individuals?
II.	Collective willingness to pay	What is the amount that all individuals should pay from their private income, on top of the taxes they already pay, to finance this public good?	Should we finance a public good through a collective tax increase?
III.	Willingness to allocate public budget	To which extent do individuals support the allocation of public budget towards a preferred public good at the cost of allocating public budget towards the provision of other public goods that are part of the experiment?	Given that the government decided to allocate a certain amount of public budget; which public goods should be financed?
IV.	Fixed budget PVE	To which extent do individuals support the allocation of government funds towards a public good at the cost of allocating government funds towards the provision of other public goods that are object of the experiment or public goods that can be financed in the next year (which are not part of the experiment)?	Given that the government decided to allocate an earmarked amount of public budget in this year or in the next year; which public goods should be selected in this year or should we shift budget to the next year?
V.	Flexible budget PVE	To which extent do individuals	Should the government allocate an

	<p>support the allocation of government funds to a public good at the cost of allocating government funds towards the provision of other public goods that are object of the experiment, at the costs of public goods that can be financed in the next year (which are not part of the experiment) or at the costs of their private income?</p>	<p>earmarked public budget to a set of proposed public goods, and if yes, to which public goods? Or, should the government shift the budget to the next year? Or, should the government amend the earmarked public budget through a tax increase/decrease that changes private income?</p>
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**3. Case study: A PVE for the Dutch Ministry of Infrastructure and Water Management**

The first application of PVE worldwide investigates the societal costs and benefits of a flood protection scheme of the Dutch Ministry of Infrastructure and Water Management. The scheme focused on a trade-off between two types of projects to mitigate flood risks at locations along the Dutch river ‘de Waal’ which do not meet the prescribed safety standards. The first type of project is simply strengthening the dikes (henceforth: ‘classical project’). The second type of project involves strengthening the dikes to some extent combined with measures to give the river space to flood safely (henceforth: ‘combination project’). The two types of projects have an equal impact on mitigating flood risks and are characterized by several societal impacts (e.g. costs, impact on biodiversity, impact on recreation and number of households that need to relocate). The combination project increases recreation opportunities and biodiversity but is more expensive. In the PVE, citizens are asked to allocate a budget of 700 million euros. On four locations alongside the river ‘de Waal’ citizens must choose between a ‘classical project’ and a ‘combination project’ (Figure 1 depicts these four locations). A demo version of this PVE can be found online: [pve.splicedgene.com/pve-flood-protection](http://pve.splicedgene.com/pve-flood-protection). In case there is governmental budget left, they can spend it on six other projects that fall within the remit of the Dutch Ministry of Infrastructure and Water Management (two road projects, two projects mitigating damage from heavy rainfall, and two projects reducing flood risks beyond current safety standards).

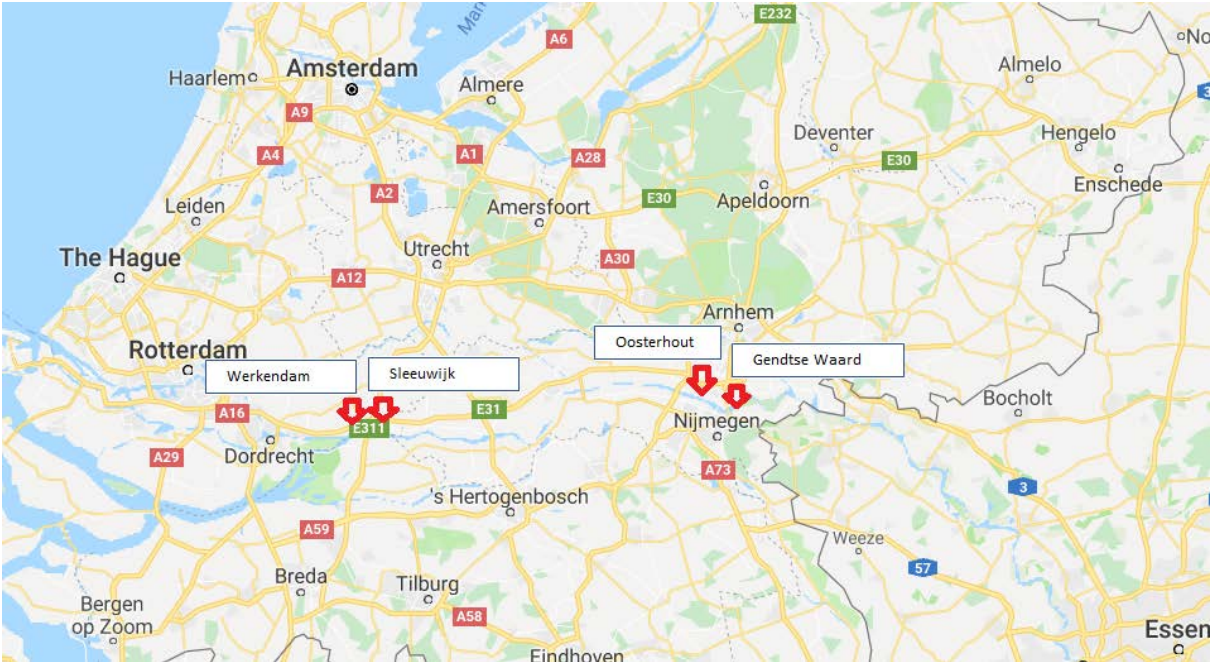


Figure 1: The four locations on which respondents have to choose between a ‘classical project’ and a ‘combination project’.

Two PVE experiments were conducted. First, a ‘fixed budget PVE’ in which respondents were asked to choose the optimal portfolio of projects given a governmental budget constraint of 700 million euros. Any remaining budget was shifted forward to the next year. Second, a ‘flexible budget PVE’ in which respondents could adjust the governmental budget by increasing the tax per household or by selecting a rebate. A tax increase (decrease) of 8 million euro of the budget in the PVE resulted in an increase (decrease) of taxes of 1 euro per household in 2019.

Both the fixed and the flexible PVE were conducted in a web-based environment (see the demo version). In this environment, respondents could sort and compare the projects by one of the impacts, and find out more about the (impacts of) projects through clicking on an information button. Respondents could delegate their decision to an expert. In the flexible budget PVE respondents could also delegate their choice to a representative group of Dutch citizens or a group of representative citizens from the villages at the four locations. In case respondents delegated their choice, they received a lower financial compensation from the survey company. The delegates also conducted the experiment. When citizens delegated, their choice was replaced by the choice of the selected delegate.

2,900 respondents participated in the experiments out of which 937 respondents were specifically recruited in the areas adjacent to the river ‘de Waal’. Around 20% of the respondents delegated their choice. Figure 2 presents the market shares of the different projects for the other 80% of the sample. To check for spatial differentiation in project choices, both the market shares for the sample (The Netherlands), and for the respondents recruited in the Waal area are reported. For each alternative the average project costs of the sample are displayed.

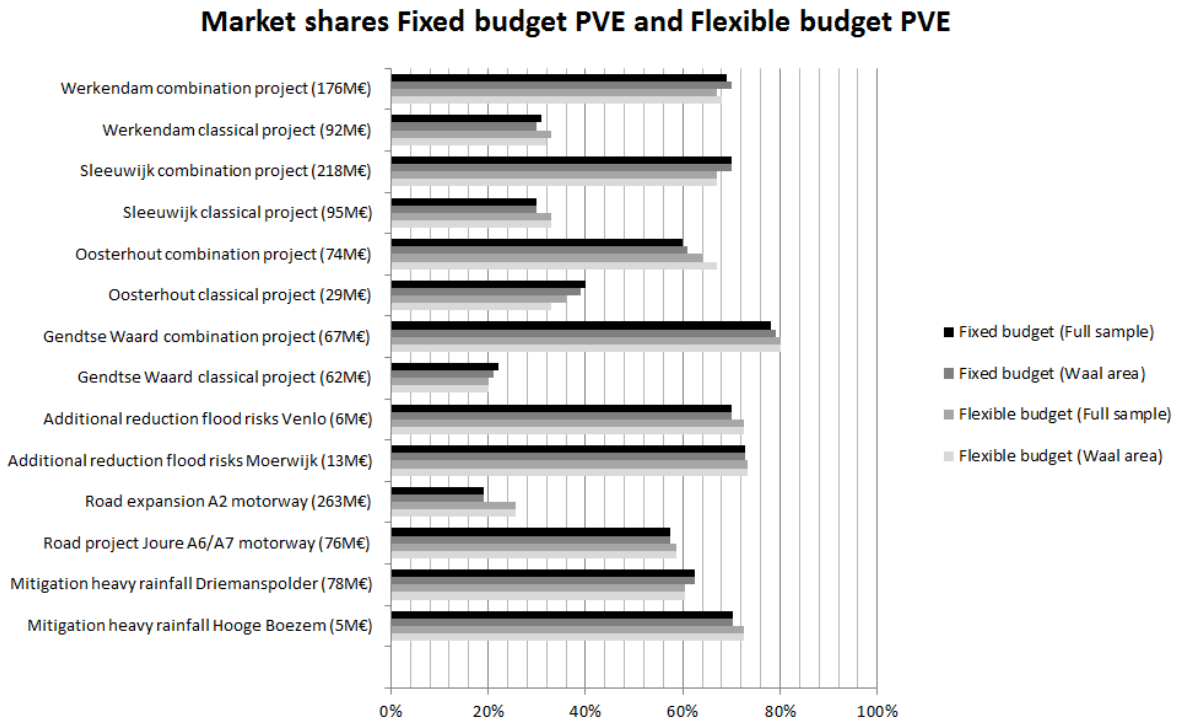


Figure 2: Percentage of respondents which selects the classical projects, the combination projects and the six other projects.

In all four locations the majority of respondents selected the ‘combination project’. Strikingly, the results did not differ very much between the respondents living close to the river ‘Waal’ and the full sample. After respondents submitted their preferred portfolio, they were asked to

motivate their choices for each project they selected. These qualitative responses show that improved recreational opportunities and variety in biodiversity are the main reasons for choosing the combination projects. This is a surprising result as these impacts generally only play a marginal role in the Dutch CBA practice (Mouter et al., 2015). A substantial number of respondents argues that they choose the classical project at the location ‘Oosterhout’ because households need to relocate in case the government pursues the combination project at this location.

Participants were also asked to evaluate the PVE on four items. Figure 3 presents the results. Figure 3 shows that respondents positively evaluated all four items. Interestingly, more than 80% of the respondents believed that it is good that the government involves citizens in policy decisions and less than 10% of the respondents disagreed with the proposition: ‘the experiment provides the government with relevant information for making choices between projects’.

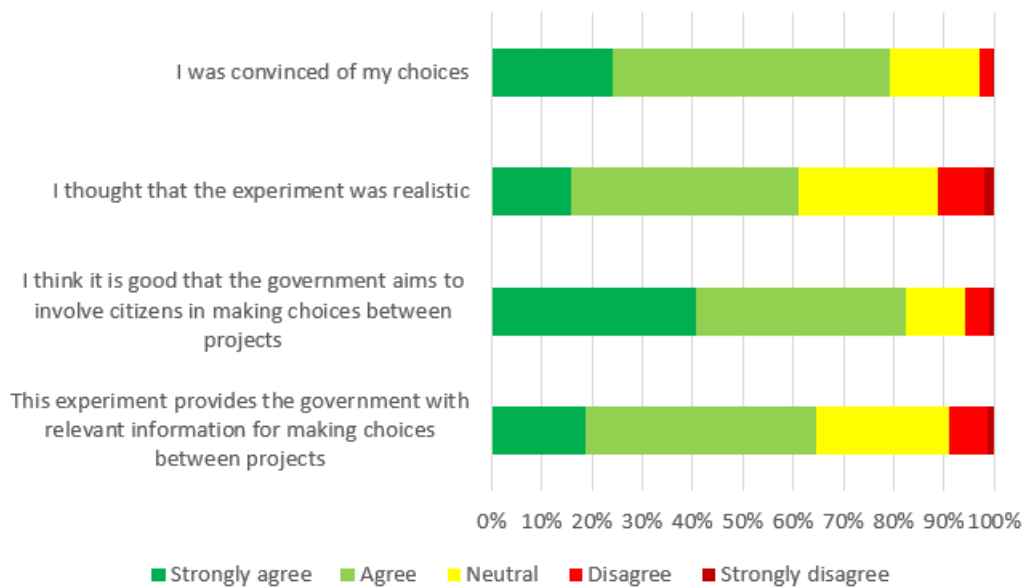


Figure 3: Answers of respondents to the four items rated at the end of the PVE

To establish how citizens value the portfolios, the choices are quantitatively analysed using discrete-continuous choice models.<sup>3</sup> We estimate taste parameters in order to derive the relevance of societal impacts for which participants received explicit information in their choices. This analysis revealed that participants particularly preferred the combination projects over the classical projects when the former projects would positively influence biodiversity and recreational opportunities. From the qualitative motivations we inferred that participants also favour combination projects because they believe that this solution to mitigate flood risk is aesthetically superior and is more ‘future proof’. Hence, we estimate project specific valuations for each project which captures the utility individuals derive from a project irrespective of the level of the impacts included explicitly in the PVE.

<sup>3</sup> We model portfolio utility as the sum of random project utilities and assume citizens choose the best portfolio given the governmental and private budget constraints using multiple discrete-continuous modelling approaches in the spirit of Bhat (2008, 2018). More information on modelling can be found in Dekker et al (2019).

The obtained results can be used for welfare analysis starting from the democratic one-person-one-vote assumption (see Dekker et al., 2019 for a detailed discussion of conducting such a welfare analysis). A first output of the welfare analysis is the derivation of the probability that a project improves societal value compared to shifting the money to the next period, i.e. whether the project provides value for money. This is a key step in the policy evaluation since participants in the PVE always have the fallback option to choose the null portfolio in case they think that all the projects are undesirable. To illustrate, in case all the participants in the PVE would have selected the null portfolio thereby recommending to shift the entire public budget to the next year, the probability that one of the combination projects improves societal value compared to shifting the money to the next period would be (very close to) 0%.

Figure 4 shows that all the combination projects provide value for money. For instance, choosing the combination project at Gendtse Waard has a 86% probability to improve societal value compared to choosing for the classical project at this location and shifting the difference in costs (in this case 5 million euro) to the next year. The project desirability of the road expansion of the A2 motorway is 31% which means that this project has a 31% probability to improve societal value compared to shifting public budget to the next year. This project should not be implemented, irrespective of the available budget.

<b>Combination project versus classical project</b>	<b>Project desirability</b>	
Gendtse Waard combination project (67M€)	86%	✓
Gendtse Waard classical project (62M€)	--	✗
Sleeuwijk combination project (218M€)	75%	✓
Sleeuwijk classical project (95M€)	--	✗
Werkendam combination project (176M€)	75%	✓
Werkendam classical project (92M€)	--	✗
Oosterhout combination project (74M€)	67%	✓
Oosterhout classical project (29M€)	--	✗
<b>Other projects</b>		
Additional reduction flood risks Moerwijk (13M€)	75%	✓
Additional reduction flood risks Venlo (6M€)	74%	✓
Mitigation heavy rainfall Hoozebosse (5M€)	74%	✓
Mitigation heavy rainfall Driemanspolder (78M€)	70%	✓
Road project Joure A6/A7 (76M€)	61%	✓
Road expansion A2 motorway (263M€)	36%	✗

Figure 4: Probability that a project improves societal welfare

A second output of the welfare analysis is the ranking of portfolios of projects in terms of expected social utility. When the public budget is unlimited policy makers should opt for all projects with a desirability probability of higher than 50%: the combination projects at all four locations and the projects Moerwijk, Venlo, Hoozebosse, Driemanspolder and Joure. However, in reality policy makers are faced with limited budgets and PVE allows for the

identification of the optimal selection of projects (i.e. the optimal portfolio) for a given budget. Figure 5 shows the top 10 of portfolios within a budget constraint of 688.36 million euros. We used the average budget recommended in the flexible budget PVE (688.36 million euros) as the budget constraint which implies a tax decrease of 1.5 euro per household in 2019.

	Top 10 portfolio's									
	1	2	3	4	5	6	7	8	9	10
Gendtse Waard classical project (62M€)	0	0	0	0	0	0	0	1	0	0
Gendtse Waard combination project (67M€)	1	1	1	1	1	1	1	0	1	1
Oosterhout classical project (29M€)	0	1	0	0	1	1	0	0	1	0
Oosterhout combination project (74M€)	1	0	1	1	0	0	1	1	0	1
Sleeuwijk classical project (95M€)	0	0	0	0	0	0	0	0	0	0
Sleeuwijk combination project (218M€)	1	1	1	1	1	1	1	1	1	1
Werkendam classical project (92M€)	0	0	0	0	0	0	0	0	0	0
Werkendam combination project (176M€)	1	1	1	1	1	1	1	1	1	1
Mitigation heavy rainfall Hooge Boezem (5M€)	1	1	1	0	1	0	0	1	0	1
Mitigation heavy rainfall Driemanspolder (78M€)	1	1	1	1	1	1	1	1	1	1
Road project Joure A6/A7 (76M€)	0	1	0	0	1	1	0	0	1	0
Road expansion A2 motorway (263M€)	0	0	0	0	0	0	0	0	0	0
Additional reduction flood risks Moerwijk (13M€)	1	1	1	1	1	1	1	1	1	0
Additional reduction flood risks Venlo (6M€)	1	1	0	1	0	1	0	1	0	0
<b>Costs (in millions of euros)</b>	<b>641</b>	<b>671</b>	<b>635</b>	<b>635</b>	<b>665</b>	<b>665</b>	<b>629</b>	<b>636</b>	<b>659</b>	<b>627</b>

Figure 5: 10 portfolio's which result in the highest expected social utility

Based on these results we can draw three main conclusions: 1) the large road project (road expansion A2 motorway) is not included in all the top 10 portfolio's; 2) at the locations Sleeuwijk and Werkendam the combination project is included in all the top 10 portfolio's; 3) the optimal portfolio opts for the combination project in all four locations. In order to see whether these conclusions are robust to changes in assumptions concerning the level of the social impacts included in the experiment (e.g. costs and impact on biodiversity) we performed various sensitivity analyses (see Dekker et al., 2019). These sensitivity analyses reveal that the first two conclusions are highly robust to changes in assumptions. However, when we assume a very low impact of the combination projects on biodiversity and recreational opportunities, the combination project is not included in the optimal portfolio at the location 'Oosterhout'.

#### 4. Discussion

We expect that PVE can substantially improve decision support for (environmental) policy making. In our case study policy makers could use the results of the PVE for undergirding the choices they need to make on the four locations along 'de Waal' river. A useful insight for policy makers is that citizens particularly prefer the combination projects over the classical projects when the former projects positively influence biodiversity and recreational opportunities. Moreover, policy makers learn which type of projects citizens are willing to sacrifice to enable them to choose for the more expensive combination project instead of the cheaper classical

project. For instance, citizens are willing to sacrifice the large road project (road expansion A2 motorway) to make way for more expensive combination projects which foster biodiversity and recreation. Moreover, sensitivity analyses can provide policy makers with insights regarding the conditions under which citizens prefer combination projects over classical projects. Finally, policy makers acquire new insights from the qualitative motivations of respondents for their choice for either a classical project(s) or a combination project(s). For instance, they learn that citizens also favour combination projects because they believe that this solution to mitigate flood risk is aesthetically superior and is more ‘future proof’. These insights can be used to enrich the underpinning of their policy choices.

As addressed in section 2, the most important conceptual contribution of PVE is that respondents are allowed to allocate public budgets and, at the same time, they have the opportunity to adjust this budget through a tax increase/decrease which affects their private income. PVE infers the social welfare effects of public policies through eliciting individuals’ preferences over the allocation of existing public budgets (‘citizen sovereignty’) as well as their private income (‘consumer sovereignty’).

Besides this conceptual innovation, the PVE case study included some practical improvements compared to past WTAPB experiments (e.g. Johansson-Stenman and Martinsson, 2008; Mouter et al., 2017a). We conceive these to be practical advancements as it is potentially possible to also integrate these advancements in a WTAPB framework. The first advancement is that participants in a PVE are enabled to evaluate impacts for themselves and impacts for others in one experiment. PVE gives individuals the opportunity to sacrifice own benefits for the common good. To our knowledge, WTAPB experiments that so far have been conducted do not provide this opportunity to respondents. A second advancement is that PVE experiments are much more realistic than WTAPB experiments. In WTAPB experiments respondents are asked to choose between policy options that demand the same investment of public budget. In a PVE, the options among which respondents can choose differ in terms of cost which is more realistic. A strongly related advantage of PVE is that it facilitates far-reaching participation of citizens in the evaluation of collective policies which can improve procedural justice (Frey et al. 2004). Our results indicate that there is a clear demand for public participation among Dutch citizens as more than 80% of the participants in the case study agreed that it is good that the Ministry of Transport and Water Management involved citizens in the evaluation of policy options. Possibly, PVE can be a response to this demand. Another practical advantage of PVE is that participants are not forced to make a choice, but can also delegate their vote to an expert or to other citizens. Therefore direct democratic decision making is not imposed by the researcher resulting in a mixture of direct democracy and representative democracy. Finally, participants in a PVE are asked to motivate their choices for each project they select. The qualitative statements can uncover impacts and considerations which drive citizens’ preferences regarding a project, that policy makers were unaware of prior to the completion of the PVE. Policy makers can also use citizens’ qualitative statements when communicating their decisions.

We see several directions to further develop PVE experiments. Firstly, the PVE experiments in our study are based on individual preference formation. That is, respondents are provided with information on the policy alternatives they are meant to choose from, but they study this information individually, without the opportunity to ask questions, discuss etc. (Bartkowski and Lienhoop, 2017). This approach has been criticised for implicitly or explicitly assuming that people have pre-formed preferences for quite abstract issues, such as flood protection schemes even when they do not have any experience in real life (Czajkowski et al.,



2015; Lienhoop et al., 2015; Lienhoop and Völker, 2016), or they are assumed to be able to form preferences in private on the basis of information material provided within the survey (Bartkowski and Lienhoop, 2017). This individual approach to preference formation is debatable especially for cases in which the public good under scrutiny is complex, such as in the case of environmental resources (Brouwer et al., 1999; Vatn, 2009). Various scholars argue that discussions with others and the opportunity to ask questions are decisive for preference formation as preference formation is an inherently social, dynamic process (e.g. Bartkowski and Lienhoop, 2017; Dietz et al., 2009). Hence, enriching PVE experiments with deliberative elements (e.g. group discussion, consulting expert witnesses or a forum) may contribute to well-formed preferences in the case of unfamiliar and complex environmental public goods (e.g. Bartkowski and Lienhoop, 2017; Bunse et al., 2015; Dietz et al., 2009; Szabó, 2011; Vatn, 2009). Augmenting PVE with deliberative elements will allow participating citizens to learn from each other, to form reasoned opinions and to evaluate positions thereby ironing out critiques on the individual approach to preference formation (Kenter et al., 2016). Another advantage of incorporating deliberative elements into PVE is that research indicates that this will significantly reduce the rate of protest responses (Szabó, 2011).

A second direction in which the PVE methodology can be further extended relates to the information provided to the participants in a PVE experiment. From the qualitative motivations of the participants in the PVE we inferred that they also favour combination projects because they believe that this solution to mitigate flood risk is aesthetically superior and is more ‘future proof’. These are impacts and considerations for which participants did not receive any explicit and systematic information in the PVE. Because respondents were not provided with any information they were forced to make arbitrary judgments which could result in overestimations or underestimations of these impacts (e.g. Carson, 2012). One possible solution is to transform PVE into an iterative assessment method which starts with a first round in which a relatively small group of respondents conducts the PVE. After this initial PVE the new motivations to select projects put forward by participants are further explored and contrasted with the literature. Subsequently, the new information would be integrated into a final PVE in which a larger group of citizens participates.

**Acknowledgements** the first and second author wish to thank the Netherlands Organisation for Scientific Research for financial support (NWO Responsible Innovation grant – 313-99-333). Moreover, the authors wish to thank the Dutch Ministry of Infrastructure and Water Management for financing the data collection and the design of the PVE.

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