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The Willingness to Pay for (Environmental) Collective Goods

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To Edina and to my family

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List of Abbreviations

ACBC	Adaptive choice based conjoint
BYO	Build-Your-Own
CBC	Choice-based conjoint analysis
CV	Contingent valuation
FCHR	First choice hit-rate
HB	Hierarchical Bayes
MAE	Mean absolute error
MPCR	Marginal per capita return
MRS	Marginal rate of substitution
MRT	Marginal rate of transformation
NMCK	No male chick killing
VCM	Voluntary contribution mechanism
WTP	Willingness to pay

1 Introduction

In the last decades, there has been extensive research on environmental collective goods, such as climate, animal welfare or air quality, to name a few. But also in our day-to-day life, we see news segments full of articles on companies wanting to reduce their ecological footprint, the popularity of organic food or the sustainability of various products. Recently, there is an increased interest in privately contributing to the preservation, protection and provision of collective goods (e.g. Arıkan and Günay 2021; Gellrich et al. 2021; Minelgaitė and Liobikienė 2021). Unfortunately though, these publicly stated intentions often do not translate into action. This is sometimes referred to as an attitude-behaviour gap (Ajzen and Fishbein 1977; Follows and Jobber 2000; Carrigan and Attalla 2001).

Most people engaged in ecological issues of course realize that their own impact may be insignificant, as great expenditures are needed to influence a collective good at a large scale. Thus, an individual's opportunity cost of contributing to a collective good is relatively high, as individuals are restricted in their budget and would have to give up consuming other goods, if they were to contribute. But even if the impact of an individual isn't marginal, early economic work on this topic (see e.g. P. A. Samuelson 1947; Olson 1971; Hardin 1982) suggests that individuals do not have an incentive to contributing towards collective goods, even though having a marginal positive impact. Still, individuals are constantly being asked to cooperate to reach a common goal (see e.g. the Fridays for Future movement for the case of climate change). This cooperation of multiple people with the goal of improving a collective good is called collective action.

Collective action is a widely discussed topic. There are many different strands of thought on how to determine the conditions under which collective action emerges. The problem, however, is that knowing the attitudes of a group of individuals towards a collective good alone is not enough to understand whether this group will engage in collective action due to not taking opportunity costs into account. With opportunity costs, it is at least possible to focus on whether collective action takes place at all. But only knowing whether collective action generally exists, might not be enough as well. E.g. for policy makers, the more important question is: Which level of a collective good will be provided without governmental intervention? And if that level is below the social optimum, is it possible to reach the optimum? Thus, what is the maximum an individual is willing to pay for a specific collective good? Despite a plethora of experiments on this question, the results are mixed (Meyer and Liebe 2010; Löschel et al. 2013; Yoeli et al. 2013; Weimann et al. 2019). It may be that people are more willing to pay for a collective good, if it is provided by a public institution (e.g. via taxes). However, it may also be that individuals are willing to privately, and on a voluntary basis, contribute significant amounts towards a collective good.

An individual's willingness to pay for collective goods is the main subject of this thesis, as it is key to understanding the above questions. We study the topic in three parts: First, we review and discuss relevant strands of literature on why and how willingness to pay for collective goods arises (Chapter 2) and how it may be measured in practice (Chapter 3). After a short interim conclusion (Chapter 4), we introduce in Chapter 5 a theoretical model to measure the willingness to pay for a collective good while controlling for possible confounding factors, such as payments for reputational reasons. Subsequently in Chapter 6, the model is tested on empirical results from our survey on the willingness to pay for animal welfare – in this specific case for chicken eggs. In the final part of the thesis, we summarize our results and give an outlook on further research (Chapter 7).

2 The Willingness to Pay for Collective goods

On a daily basis, we are confronted with the decision whether or not to pay for a good – either consciously or subconsciously. In economics, such decisions are modelled with the concept of marginal utility, which is the utility gained by spending one additional unit of money. A purchase is executed if its marginal utility is larger than for all other alternatives. Hence, the marginal utility determines the willingness to pay for a good. It can also be understood as the maximum amount of money, an individual would be willing to pay for a certain good. However, in reality the willingness to pay is obviously not constant over time. For instance, it could depend strongly on the mood of the individual.

For most goods, it is relatively easy to calculate and measure these willingness to pay. This is especially true for perfectly divisible goods (Hardin 1982). These are goods for which every unit of a good can only be consumed once (e.g. an apple) and are typically referred to as private goods. Excludability also follows from perfect divisibility, which means, that an individual can be excluded from consuming a good.

For other goods, defining the willingness to pay is not as straightforward. For example, even though an individual gains utility from walking through a forest, she might not be willing to pay for the maintenance of the forest, if she can't be hindered from walking through it for free. Such behaviour is called free-riding. At first glance, free-riding is the optimal strategy from an individual's perspective for goods that are non-excludable and in some form indivisible (Olson 1971; Brubaker 1975; Hardin 1982; Sandler 1992), which we summarize as collective goods in this thesis. Collective goods are by definition non-excludable, which means, that it is impossible or "prohibitively costly" (Taylor 1987, p. 6) to exclude an individual from consumption, as in the example of a walk through a forest.

Additionally, economists also often take the rivalry of consumption into account (Taylor 1976). If a good inhibits some degree of rivalry, one individual's consumption of the good changes its utility for other individuals. Non-excludable goods are then either classified as common goods (rivalry in consumption) or as public goods (no rivalry in consumption). To make things easier, this thesis will use the term collective goods, if both of these types of goods are described. Rivalry in consumption and indivisibility, though closely linked, are not identical. Rivalry is present when the utility of an individual changes, if another individual consumes a good. Some degree of divisibility, on the other hand, relates to how the availability of a good reduces with consumption. Let us consider the example of a beach, to which individuals are not barred from entering (i.e. non-excludable): While open spaces at a beach are (up to a point) available for additional individuals (a degree of indivisibility), each additional entrant may either increase, decrease or have no effect on the utility of the other beach-goers. Some might prefer an empty beach, others might prefer a semi-crowded beach or might be indifferent, etc. Because of this, rivalry is sometimes considered to be a property of the utility function of an individual rather than a property of the good itself (Taylor 1987). For the purpose of this thesis we exclude the possibility that rivalry may increase the utility of a good, and always assume that the consumption of one unit of a good reduces the remaining amount of consumable units and the utility for other individuals.

There is one other important categorization of collective goods (Hardin 1982): A park or a bridge (public good) will be built, if there is enough money available, i.e. a certain threshold is reached. Similarly, the utility of fishing boats diminishes significantly, once the fish stock (common good) decreases below the level at which the fish stock can regenerate. Before these thresholds are reached, a public good will not be provided and a common good will still be consumed with only slight decreases in marginal utility. Goods displaying such a threshold behaviour are called step collective goods. Collective goods might also continuously increase or decrease with each additional unit of money spent, as is the case for national defence. We define such goods as continuous public goods. These distinctions are crucial for the purposes of our thesis and oftentimes overlooked in economic literature.[1]

Some collective goods cannot or will not be provided by a single individual. This necessitates that individuals cooperate to some degree in order to provide the collective

[1]In practice, the transition between continuous and step collective goods is fluid, e.g. in the case of national defence there are lots of different small projects, which might all increase the level of the collective good. These small projects are only implemented once a certain threshold is reached (e.g. the cost of a cannon). But, the probability that one additional monetary unit actually improves the collective good is very high for continuous collective goods.

good. The cooperation of at least two individuals towards a common goal, which would not be achieved alone, (here: the provision of the collective good), is called collective action. As individuals collectively acting pay in one form or another, they have a positive willingness to pay for the collective good. Collective action is therefore interpreted in a way, that if individuals have an incentive to act collectively, they also have a non-zero willingness to pay for the respective collective good. To understand willingness to pay for collective goods, we will separately investigate the four different types of collective goods introduced above. In particular, we differentiate between different degrees of rivalry and whether a threshold behaviour exists or not. In the following subsections, we first consider step public goods, followed by step common goods, continuous public goods and finally continuous common goods.

2.1 Step Public Goods

While early economic literature suggests (see e.g. A. Smith 1776) that actions of self-interested individuals always improve the collective well-being as well, starting with P. A. Samuelson (1947, p. 203-252) many authors have argued the opposite for the case of collective goods (see e.g. P. A. Samuelson 1954; Downs 1957; Olson 1971; Brubaker 1975; Sandler 1992). One of the most important works in this field is the book *The logic of collective action* by Olson (1971). Olson proposes that collective action can only be understood by examining the incentives of individuals, rather than just assuming the collective always profits from an individual's actions. 50 years later, the question whether, and in which ways, individuals cooperate in order to provide a collective good is still highly relevant.

The incentives of individuals depend greatly on the size of the collective good. In small groups, which Olson calls "privileged", an individual i might value a good at a price v_i that is larger than its cost c (in the case of a step good, the cost is fixed to a certain threshold of c). This is based on the assumption that small groups are typically concerned with small collective goods (e.g. a garden in the neighborhood), while larger groups – which Olson (1971, p. 53-65) calls "latent" – consider large collective goods. While this relationship between group size and size of the respective collective good may break down for specific examples, we will assume that there is a high correlation in general. This assumption is discussed further in Section 2.5.1.

The importance of group size can be shown in a model for the case of a step public good. In small groups, a wealthy individual i could just pay for the public good with total cost c and an individual valuation of v_i on her own, if the advantage a_i of providing this public good was $a_i = v_i - c > 0$. This is not limited to one individual. Multiple individuals could have a positive advantage $a_i > 0$ and therefore would profit from providing the public good. More formally, such situations can be represented by n-player games, which we explain in the following (see e.g. Diekmann 1985; Diekmann 1993; Osborne 2004, p. 289-291):

Players	A set of n individuals.
States	Individual $i = 1, 2, \cdots, n$ values a fixed public good at v_i. We assume that the valuations can be uniformly bounded above and below by $\underline{v} \leq v_i \leq \overline{v}$ for $i = 1, 2, \cdots, n$.
Actions	Each individual can either contribute a fixed amount c or not contribute at all. Therefore the set of actions of each player is $\{0, c\}$.
Beliefs	Every player only knows her own valuation v_i. Every player i assigns a probability of $F(v_1)F(v_2)...F(v_{i-1}) \times F(v_{i+1})...F(v_n)$, that every other player j has at most a valuation of v_j.
Payoffs	The payoffs of a player i in the state $(v_1, ..., v_n)$ are:

$$\begin{cases} 0 & \text{if no one contributes} \\ v_i & \text{if } i \text{ does not contribute, but some other player does} \\ v_i - c & \text{if } i \text{ contributes} \end{cases}$$

Let us additionally assume that the cost c satisfies $0 \leq \underline{v} < c < \overline{v}$. It is sufficient for one player to pay the cost c for the public good to be provided.

The game above possesses a symmetric Nash equilibrium given by the strategy in which each player i pays for the public good when $v_i > v^*$ and not otherwise. Recall that a strategy is called a Nash equilibrium, if no single player's payoff can be improved by only changing the own choice of strategy. We briefly outline here why such a Nash equilibrium exists. The interested reader may find a more detailed explanation in Osborne (2004, p.

290-291). First note that for a continuous and uniform $F(v_i)$, there exists a certain v^* such that

$$v^* - c = (1 - F(v^*)^{n-1})v^* \tag{1}$$

or after rearranging

$$v^* F(v^*)^{n-1} = c. \tag{2}$$

Then the expected pay-off of player i is equal to

$$\begin{cases} v_i - c & \text{if she pays for the public good} \\ \left(1 - F(v^*)^{n-1}\right) v_i & \text{if she does not pay} \end{cases} \tag{3}$$

Note that $1 - F(v^*)^{n-1}$ is the probability that at least another person values the public good at a value greater than v^*. Now, if $v_i - c > (1 - F(v^*)^{n-1})v_i$ the player i has an incentive to pay for the public good, which is exactly at the point where $v_i \geq v^*$. We see that any deviation from the strategy is not in the interest of an individual. Hence, contribution is optimal.

As the group size n increases, the probability of at least one person's valuation surpassing the critical threshold v^* increases. For equation (2) to hold, v^* must increase ceteris paribus, which means, that the critical valuation v^* must increase with a higher n. In this example individuals act strategically, but not cooperatively, as only one willing individual is needed to provide for the public good in full. There exists a non-zero willingness to pay for the public good, if at least one person has a high enough valuation v_i and assumes, that the probability of another person having a $v_i > v^*$ is sufficiently low. For a large enough n, no person might have a $v_i > v^*$, if $v^* > \overline{v}$, which means, that the public good would not be provided as $F(v) = 1$. Then, no individual would pay the cost c. There would be no willingness to pay for the public good.

The game above can be extended in multiple ways. Otsubo and Rapoport (2008) discuss dynamic threshold games with multiple rounds, where the game ends when either a player volunteers to pay or the maximum number of rounds is reached. Weesie (1993), Weesie (1994) and Bilodeau and Slivinski (1996) introduce similar games, however with an infinite number of rounds. Diekmann and Mitter (1986), Diekmann (1993), Franzen (1995) and Goeree et al. (2017), amongst others, have tested threshold games in experimental studies. We do not go into more detail on such games at this point as they do not provide too much additional insight or intuition beyond that of the example above.

2.1.1 Prisoner's Dilemma

If one volunteer is not sufficient for a public good to be provided, collective action is necessary. The problem in this situation is that if individuals know they cannot be excluded from consuming a public good, they may not be willing to pay for it. From an individual's point of view it would always be optimal to enjoy the public good without paying – in other words to free-ride. This phenomenon can be visualized with a standard Prisoner's Dilemma game.[2]

Individual 1 / Individual 2	Cooperate	Not cooperate
Cooperate	10/10	0/20
Not cooperate	20/0	5/5

Table 1: One-shot Prisoner's Dilemma

If this game is only played for one period and without communication between the players, neither of them has an incentive to choose the strategy "Cooperate". Instead, they always have an incentive to choose "Not cooperate", if the other player cooperates, as the payoff in this situation is higher. As this is true for both individuals, the Nash equilibrium is "Not cooperate/Not cooperate".

Still, the Nash equilibrium is not pareto optimal. Recall that an outcome is pareto optimal, if there is no other outcome, where one individual is better off, without decreasing the payoff of another individual. Both players would be better off, if they played the strategy "Cooperate", i.e. if they acted collectively. The probability of a pareto inferior Nash equilibrium occuring is even higher when large groups face the decision of whether

[2]As the following game theoretical examples shall only indicate a direction of strategic behaviour, the examples are stated numerically instead of generally for giving a better intuition.

to provide a collective good. Individual rationality is not sufficient to ensure collective rationality (Sandler 1992). Thus, in these cases a collective good won't be provided – even though it might be possible for a single individual to bear the costs. A medium sized group could still be small enough, so that individuals choosing to "Not Cooperate" can easily be pointed out. Group pressure, sanctions, etc. – in other words informal institutions – could induce collective action by altering individuals' pay-off in such a way that it becomes optimal for an individual to cooperate. We will discuss these kinds of games in Section 2.4.1. The Prisoner's Dilemma is a common model (institutional) economists use to study and gain intuition for many public good problems (Lichbach 1996). In turn, the results imply, that the state or another trustworthy entity has to intervene in order for the public good to be provided, because individuals cannot solve these types of collective action problems on their own. The role of public provision will be introduced in Section 2.5.2.

While a larger body of literature in game theory follows Olson's method of representing strategy profiles in a Prisoner's Dilemma, they loosen some of the strict assumptions of the one period 2-player game. Their models broadly fall into two categories: In the first one, players interact with more than one person. Therefore, the strategies are modeled via n-player games. In the second one, two individuals play a game with multiple periods, rather than a static one-shot-game.

Below we give some more background and examples of models of the first category. First note that Hardin (1971), Hardin (1982), Barry and Hardin (1982) and Taylor (1987) argue among others that collective action is better modelled by an n-person Prisoner's Dilemma, because an individual faces all other players simultaneously, instead of pairwise interactions with other players one at a time.

Let us a give a specific example: Assume we are in a game with $n = 5$ players, as in Hardin (1982), and the step public good costs $c = 5$ which has to be collectively paid for (i.e. $c = 5$ is the threshold of the public good). If player i decides to contribute, her share of the cost c_i depends on the number k of the other contributing players. In particular, the costs are assumed to be shared equally and therefore $c_i = \frac{c}{1+k}$. Each player has a fixed valuation of $v_i = 3$ of the public good. If the player does not cooperate, the public good might not be provided, resulting in a payoff of 0. This game can be visualized as follows:

Number of players k other than i cooperating	4	3	2	1	0
Payoff to i, if i pays	2	1.75	1.33	0.5	-2
Payoff to i, if i doesn't pay	3	3	3	3	0

Table 2: One-shot N-player Prisoner's Dilemma

With symmetric players, the strategy for every player to not pay for the public good is strictly dominant, as every payoff in the second row of Table 2 is greater than the corresponding payoff in the first row. Thus, from an individual player's perspective it is optimal to not cooperate, irrespective of the other players' choices. However, this Nash equilibrium's payoff of 0 is smaller than the one, when 2 or more players (including player i) cooperate. Hence, from that point on any form of cooperation would be pareto superior. Yet, as in the situation with only two players, the n-player game leads to no collective action in the case of step public goods.

The generalizing of the 2-person Prisoner's Dilemma to n-persons is not the only way to more realistically model collective action. One could also model this with multi-period games. While Olson (1971) formally only introduces a static one-shot game, he already alluded to a more dynamic, interactive model by introducing social sanctions, etc., that lead to collective action over time. Taylor (1976) and Axelrod (1984) added the element of time mathematically into the two-person Prisoner's Dilemma, which in Taylor (1987, p. 28) is called the "Prisoner's Dilemma supergame". This addition was a crucial step in improving the understanding of collective action, as it makes the addition of reciprocity possible as well.

Let us now give an example of a multi-round 2-person game and how the strategies differ for a finite and infinite number of rounds. Assume each player's payoffs are fixed to the values given in Table 1 and that this 2-player game is repeated for multiple periods.

If the game is played for a finite number of rounds and the players know which round is the last round, the player's strategies are the same as for the one-shot game – they do not cooperate. To see why, consider the case when the number of rounds is set to three and each player knows the third round is the final round. Then clearly a player cannot be punished for not cooperating in the final round, and hence it is always optimal for both players to "Not cooperate" in the final round. Knowing this, both players will also choose "Not cooperate" in the penultimate round, as they cannot be punished in the final round, where both players will "Not cooperate" either way. Inductively, we see that the players will choose to not cooperate in all rounds. In fact, this holds true in more generality: If a one-shot game has a unique Nash equilibrium (which is true for the game in Table 1), the corresponding finitely repeated game will possess the same Nash equilibrium (see e.g. Gibbons 1992, p. 82-88). In other words, as long as the game has a fixed finite number of rounds, each player will choose to "Not cooperate" in every round, despite both being better off had they chosen to "Cooperate" in every period.

This result changes if games are repeated infinitely or – and this is the more realistic assumption – if games are repeated finitely, but no player is aware of the ending point of the game. In the case of collective action, it is of course reasonable to assume that interactions happen more than once. Players meet repeatedly and therefore are able to punish bad behaviour. For example, when two individuals meet regularly and can change strategies after each period. Players in this setting have multiple possible strategy profiles:

- Always defect and choose to "Not cooperate".
- Always "Cooperate".
- "Cooperate" in the first period and from then on in each round match the strategy of the other player in the preceding round (*Tit-for-Tat strategy*).
- "Cooperate" until the other player defects. From then on always choose to "Not Cooperate" (*Grim-trigger strategy*).

This list of course is not exhaustive. There are multiple other imaginable strategy profiles. In a two player game, apart from mutual defection, the result will always be mutual cooperation, if you consider the introduced strategy profiles (Taylor 1987). All strategies apart from the "Always defect" strategy lead to stable cooperation, in which no player has an incentive to unilaterally deviate from her choice. If one player plays the "Always defect" strategy, the other player has the unilateral incentive to change to "Always defect" as well, if she did not play this strategy from the beginning.

This framework can be generalized to n-players that meet in various different constellations of 2-player games and has been tested experimentally multiple times, most famously by Axelrod (1984), who invited a number of social scientists and philosophers to a tournament. The winner of Axelrod's tournaments (the strategy with the highest payoff) employed the *Tit-for-Tat* strategy described above. According to Axelrod (1984, p. 173) three conditions must hold for this strategy to be stable: future potential payoffs must be sufficiently large, the strategy "Cooperate" must be reciprocally matched by at least a small percentage of other players, and finally players must not discount future payoffs too highly. The last point is to avoid immediate payoffs from offsetting future gains. If these conditions hold true, *Tit-for-Tat* strategy is stable even in games where all players simultaneously participate in one large game instead of multiple 2-player games (Taylor 1987, p. 31-43). Multiple other papers arrived at similar conclusions (see e.g. Lichbach 1992; Duersch et al. 2014; Dixit et al. 2015).

According to Taylor (1987, p. 107) even this n-person Prisoner's Dilemma supergame does not realistically model collective action. For instance, payoffs, the available strategies and the number of players, to name a few variables, can change over time. We will not delve into these approaches here, but there is a fair amount of literature introducing so called "nested games" and their implications (see e.g. Heckathorn 1984; Tsebelis 1990). For the purpose of this thesis it is worthwhile mentioning that, due to the changing variables, behaviour of such games cannot be generalized and there is no particular take-away for collective action.

Some authors (often unfairly) criticize Olson's *Logic of Collective Action* for not being generally applicable (Frohlich and Oppenheimer 1970; Chamberlin 1974; Sandler 1992; Udehn 1993; Dougherty 2003; Pecorino 2015). While it is true that Olson's claims do not hold true for every potential collective good, they still provide a very good intuition for understanding the willingness to pay for collective goods. Moreover, they generally hold for situations with homogeneous individuals[3] and symmetric equilibria, if each unit is equally added to the level of a public good and if the costs per unit are higher than the benefits per unit (Sandler 1992, p. 194-198). This is the case for some continuous public goods, which we will discuss in Section 2.3.1.

Unlike Olson's theory discussed above, symmetric game theory on the other hand predicts that if (i) future payoffs are (partly) unknown, (ii) future payoffs are not discounted too highly and (iii) players believe they will repeatedly meet and their actions are observable by other players, then stable strategy profiles exist which lead to collective action in a Prisoner's Dilemma situation. This implies that in such situations the cooperating players are in fact willing to pay for a public good. If one of these conditions is not met, the default strategy is to defect and choose a non-cooperating strategy, i.e. there is no willingness to pay. Whether all of the conditions are met in practice often deserves further discussion. For instance, a high discount factor can potentially lead to no willingness to pay for a public good, even though cooperation would be possible. Especially for large groups, it is also unclear, whether an individual's actions really are observable by others, without which neither reciprocity nor a system of sanctions is feasible (see Section 2.4.1).

2.1.2 Assurance Games

Unlike the Prisoner's Dilemma case, where a public good will not, but might theoretically be provided by a single individual, there are public goods whose costs are too large for one person only. In those cases, no or only a low level of a public good can be provided when not all players are cooperating. Consider the example of two people sharing a garden (Taylor 1987, p. 38-40). Assume that if both tend to the garden, vegetables worth a payoff of 5 to each of them will grow. Further assume that the gardening work comes at a cost of 2 for each player. Now let us consider two scenarios: In the first (shown in the left panel of Table 3) both players participate in the gardening work in order for the vegetables to grow, otherwise the garden yields nothing. In the second (shown in the right

[3]Homogeneous individuals typically are identical in their preferences and their budget restrictions.

panel) both players reap a small benefit of 1, if either of the players tends to the garden.

	C	$\overline{C}$
C	3/3	−2/0
$\overline{C}$	0/ − 2	0/0

	C	$\overline{C}$
C	3/3	−1/1
$\overline{C}$	1/ − 1	0/0

Table 3: One-shot Assurance Games

In both scenarios there are two Nash equilibria: "Cooperate (C)"/"Cooperate" and "Not Cooperate ($\overline{C}$)"/"Not Cooperate". As "Cooperate"/"Cooperate" is the pareto superior equilibrium, neither player expects the other to "Not Cooperate", since neither of them has an incentive to unilaterally deviate from cooperating. This leads to full cooperation being the unique outcome. These types of assurance games are straightforward in the sense that willingness to pay for the public good, and hence collective action, will always arise as long as the provision costs are smaller than the payoff.

It is also possible that step public good games take the form of Stag Hunt games.[4] Then full cooperation of every individual is required to provide a public good. Cooperation is only possible, if each individual's valuation of the public good is higher than the individual's cost of provision. Full cooperation is typically a stable Nash equilibrium in this situation, if players are able to coordinate accordingly.

2.1.3 Threshold Games

A public goods game of more than two individuals, who cannot provide the public good on their own, is typically modelled by so called threshold games. In the easiest setting threshold games can be interpreted as voting games, which goes back to Downs (1957), Tullock (1967) and Riker and Ordeshook (1968).

As an instructive example consider an election, where two parties vote on whether or not to provide a public good. Party A, with an overwhelming majority, wants a public good to be provided, whereas party B opposes the measure. Since a simple majority is

[4]See e.g. Osborne (2004, p. 20-21) for an introduction into Stag Hunt games.

sufficient to secure the provision of the public good, members of Party A have an incentive to not go to the election until the potential available voters are close to but still above the number of members of Party B.

There are two potential mechanisms at play here: Communication and risk taking. If the members of party A can communicate, some members will pre-commit to not vote and hence others know whether or not their vote is important. On the other hand, if members of party A cannot communicate, players will decide whether or not to vote depending on their assessment of how important their vote is. If a member reckons that with a high probability her own vote will be the deciding factor, she will participate in the vote. Risk-averse members of Party A could attend the vote, even though they would have an opportunity to pre-commit. This might even lead to all members appearing, if the vote was very crucial. Oppositely, risk-loving members of Party A might find not enough members appearing at the vote, which would lead to the public good not being provided.

The above situation can be modelled as a game with n players, where a public good is only provided if k players cooperate, similar to the vote above, where a certain amount of votes is needed to achieve simple majority (see e.g. Palfrey and Rosenthal 1983; Palfrey and Rosenthal 1984; Bagnoli and Lipman 1989). In particular, if the benefit of the good is b to every player and the cost of participating is c, then the payoff structure for player i can be written as follows (see Taylor 1987, p. 46):

	Less than $k-1$ others cooperate	$k-1$ others cooperate	More than $k-1$ others cooperate
Payoff to i, if i cooperates	$-c$	$b-c$	$b-c$
Payoff to i, if i does not cooperate	0	0	b

Table 4: N-player Threshold Game

Let $p_{<k-1}$, p_{k-1} and $p_{>k-1}$ be the probabilities player i assigns to the events that less than $k-1$, k and more than $k-1$ other players, respectively, cooperate. Therefore, the expected difference d of payoffs between cooperating and not cooperating for player i is equal to

$$d = p_{<k-1}(-c-0) + p_{k-1}(b-c-0) + p_{>k-1}(b-c-b) \tag{4}$$

which, using the fact that $p_{k-1} + p_{k-1} + p_{>k-1} = 1$, can be simplified to

$$d = -c + p_{k-1}b \tag{5}$$

Player i will cooperate as long as $d \geq 0$, which is precisely the case when

$$p_{k-1} \geq \frac{c}{b} \tag{6}$$

or in other words when the probability p_{k-1} of a coalition of size $k-1$ is greater or equal than $\frac{c}{b}$.

Let us assume that the probability that a player cooperates is equal to p. To compute the probability p_{k-1}, first note that for $n-1$ players there are $\binom{n-1}{k-1}$ different ways to form a coalition of size $k-1$. Therefore, the probability that a coalition is exactly of size $k-1$ equals $p_{k-1} = \binom{n-1}{k-1}p^{k-1}(1-p)^{n-k}$. Let us assume some specific numbers for our inequality, and take $n = 20$, $k = 7$ and $p = 0.5$). Then $\binom{n-1}{k-1}p^{k-1}(1-p)^{n-k} \approx 0,05 > \frac{c}{b}$. Hence as long as b is more than 20 times larger than c, it is optimal for player i to cooperate. Vice versa, when b is not more than 20 times larger than c, defection becomes the optimal strategy. Note, however, that this conclusion does not hold for all combinations of n, k and p, as there are some choices which lead to player i not cooperating.

In general, the decision of player i depends on a number of factors and therefore the above form of cooperation is often referred to as "Conditional Cooperation" (Ostrom 1990). Note that conditional cooperation can go two ways. It applies to either the situation where a minimum or a maximum number of other players need to cooperate to achieve success. The n-person Prisoner's Dilemma is an example of the former and the n-person Chicken Game, which shall be discussed in Section 2.2.1, is an example of the latter. Most of the literature studies the case where a minimum number of players have to cooperate – as for instance in crowdfunding projects.

Also, cooperation is more stable when there is a (partial) refund of insufficient or excess contributions. Then, Bagnoli and Lipman (1989) show, that there is an efficient result, if only pure strategies are possible. The probability of cooperation is also higher when contributions are not made simultaneously, but instead sequentially. Multiple experimental papers arrived at similar results corroborating these theoretical models (see e.g. Dawes et al. 1986; Erev and Rapoport 1990; Croson and Marks 2000; Rose et al. 2002; McEvoy 2010).

There are cases, when collectively providing step goods, where agreeing to cooperate is not enough, but in addition everyone needs to agree on how to divide the costs amongst themselves. Because of differing valuations of the collective good, the modeling approach has to be slightly adapted. Examples of such can be found in Suleiman and Rapoport (1992), Asch et al. (1993), Rapoport and Suleiman (1993), Croson and Marks (2001), Suleiman et al. (2001) and Au (2004). In most of these studies the stability of cooperation is reduced. Note also that various studies (Nitzan and Romano 1990; Suleiman 1997; Suleiman et al. 2001; McBride 2010) suggest that when the value of the threshold is uncertain, and thus players do not know how high the total contribution has to be, the probability of cooperation is further reduced.

The above discussion shows that the willingness to pay for public goods is highly dependent on the specifics of the game and the public good considered. For many forms of step public good provision, clear incentives to free-ride exist. In a Prisoner's Dilemma game, cooperation will only emerge, if reciprocity is possible, which is true for infinitely repeated games. Depending on the risk aversion of players, collective action is more likely to occur in threshold games, when contributions are refunded in the case that the threshold is not reached. But when only considering economic incentives, full defection is often a stable outcome.

2.2 Step Common Goods

Up until now we have discussed step public goods, which can only be obtained when players cooperate to carry their costs. In addition to this they have the property that everyone can consume these goods without decreasing others' utility, or in other words there is no rivalry in consumption. For step common goods, however, the more consumption the more the value of the common good is reduced. Even though public and common goods are both non-excludable, the difference in rivalry of consumption leads to differing incentives for individuals. Many economic papers do not adequately differentiate between step public and step common goods (see e.g. Dawes 1980; Fleishman 1988), even though the willingness to pay is significantly different. Therefore, we discuss the willingness to pay for step common goods in the next Section.

2.2.1 Chicken Games

Let us start with a simple example (see e.g. Taylor 1987, p. 37-38) to illustrate the effects at play. Assume that there are two firms deciding whether or not to pump sewage into a small lake. As in the Prisoner's Dilemma, they can either deviate and not filter their sewage ("Not Cooperate") or install a filter system ("Cooperate"). The environment has the capacity to absorb at most the amount of one firm's sewage, but not both. If both firms pump their sewage into the lake, the consequences are so severe that both firms would rather refrain from polluting the lake, even if only unilaterally. However, if one firm is certain that the other will refrain from dumping sewage, it will choose to not cooperate and release its sewage into the lake, as then its payoff is higher. This discontinuity can be found with many environmental common goods. Many ecological systems (e.g. lakes, air or fisheries) can be exploited up to some critical point after which its value deteriorates rapidly. An example game for the above setting is given by Table 5.

At first glance the structure looks similar to a Prisoner's Dilemma. However, unlike a Prisoner's Dilemma, this game – which is called "Chicken game" in economic literature – has in fact two Nash equilibria. To see this, first note that the states in which one player unilaterally has an incentive to play another strategy are full cooperation and full

Individual 1 / Individual 2	Cooperate	Not cooperate
Cooperate	10/10	5/20
Not cooperate	20/5	0/0

Table 5: One-shot Chicken Game

defection (no cooperation). If both players play “Not Cooperate”, they have the incentive to filter the sewage, which improves the payoff from 0 to 5. Similarly, if both players play “Cooperate”, they have the incentive to deviate from cooperation. The remaining two states “Cooperate”/“Not Cooperate” and “Not Cooperate”/“Cooperate” can now easily be seen to be stable pure strategy Nash equilibria.

If there are three firms instead of the two in the above game, all firms have the incentive to believably bind themselves to the defecting strategy. The firm that does so the fastest will play “Not Cooperate”. However, to understand the behaviour of the remaining two firms, we need to know whether the lake can deal with only one or two firms amount of sewage. In the former case the remaining two firms will both “Cooperate” as the consequences of defecting would be too dire. This outcome is comparable to the 2-player assurance game introduced in Table 3 above.

In the latter case, these two firms play a 2-player Chicken Game as in Table 5, where both firms would prefer to be the defecting firm. Again, the firm that binds itself the fastest (pre-commitment) will secure the “Not Cooperate” strategy. The remaining firm will have to cooperate, as their overall payoff is still larger with this choice of action compared to the dire environmental consequences they would have to face if they chose to not cooperate as well. This is true as long as the benefits outweigh the costs for pre-commiting to the defective strategy. In reality pre-commitment can be costly as well, especially in the case where imperfect information is involved (Taylor 1987; Rob 1989; Konrad and Thum 2014; Hoffmann et al. 2015). In an n-firm example, there might not be enough firms left to cooperate, if too many firms rush to pre-commit to play “Not Cooperate”. In such circumstances risk-averse firms might be willing to always cooperate, even though they could be better off defecting as well.

Of course, there are also examples of games that are a mixture of Prisoner's Dilemma, Chicken and Assurance Games. Such games can arise when one of the players has a higher preference for the collective good or can provide the good more cheaply than the other player. For such asymmetric games the willingness to pay may also be asymmetric. Since there is not much more additional insight to be gained from these games we do not further study them here. The interested reader may however find some examples in Taylor (1987), Gibbons (1992), Osborne (2004), Ahn et al. (2007) and Beckenkamp et al. (2007).

2.2.2 Threshold Games

As for step public goods games, an n-player step common goods game can be modeled as a threshold game as well. If the game above were played with imperfect information, firm i would decide to either cooperate or defect, depending on the probability of being the firm that over-pollutes the lake. Since the mathematics is essentially the same to the step public good threshold game discussed in Section 2.1.3 we do not review the theory here again. Experimentally, however, there are a few differences between step public goods and step common goods due to the differences in the goods themselves. With step public goods, if a certain threshold is reached, players gain utility, whereas for step common goods they lose utility. This in turn implies – as losing utility is considered to be worse according to prospect theory – that the willingness to pay in threshold games of step common goods is ceteris paribus higher than in the case of step public goods (see e.g. Kahneman and Tversky 1979; Sonnemans et al. 1998). Still, the same effects as in the case of step public goods influence the willingness to pay. The willingness to pay decreases the larger the uncertainty of the threshold (Nitzan and Romano 1990; McBride 2006; Dannenberg et al. 2011; Barrett and Dannenberg 2012; Barrett and Dannenberg 2014; Kotani et al. 2014). This is demonstrated by the example of global warming where the threshold is very unclear, which could lead to very little or no cooperation at all.

Other factors, for instance modelling time in step common good threshold games, also have interesting implications. In particular, it may take a certain amount of time for coordination amongst the players to emerge and hence until a stable equilibrium is found. If, in a game with a finite number of periods, players learn from the outcomes of previous iterations, they can adapt their strategy accordingly (Ockenfels and Selten 2005; Selten and Chmura 2008). If the group composition remains fixed, which is a condition for reciprocal behaviour to emerge, some studies suggest that convergence to a stable willingness to pay is possible (Cadsby and Maynes 1999; Croson and Marks 1999). Other studies conclude the opposite and state that the result is a zero willingness to pay after some periods (Isaac et al. 1989; Guillen et al. 2007; Feige et al. 2014). In other words, economic incentives for both step public goods or step common goods are not sufficient alone to imply full cooperation in every framework. As shown previously, for step common goods the likelihood of cooperation increases with the probability of falling below a threshold, under which the common good deteriorates sharply and the utility of all the players is drastically reduced. For step public goods, on the other hand, reciprocity is a necessary condition for stable cooperation. However, the smaller the probability that a single player is the deciding factor, the smaller the likelihood of cooperation.

2.3 Continuous Collective Goods

When a collective good is provided continuously, the theory implies a slightly different outcome compared to step collective goods. As before, we need to differentiate between continuous public goods, where each additional unit improves the level of the public good and continuous common goods, which deteriorate with each additional unit of individual consumption. Due to the differences in rivalry, for continuous public goods the level of the stock defines the utility (a clean beach or the quality of a road), whereas for continuous common goods the utility typically arises from the flow of (renewable) resources (a pasture or an orchard), which leads to different optimization strategies (Ostrom 1990).

2.3.1 Continuous Public Goods

Recall that for continuous public goods, for example national defence, each additional monetary unit provided increases the level of the public good. Individuals are not necessarily able to influence the level of the collective good as we discuss in Section 2.5.1 and 2.5.2. For now, however, we assume that their influence is not negligible. Willingness to pay for continuous public goods are modelled via a best response function or a voluntary contribution mechanism (VCM). While in both formulations players have a fixed budget they can spend either on a private or a public good, they differ in how they take other players' choices into account.

In basic best response models, marginal returns from additional private goods are constant. This assumption in turn implies that for a single period game it is optimal to not contribute towards a public good when others are already contributing (see e.g. Cornes and Sandler 1985; Bergstrom et al. 1986; Gibbons 1992; Osborne 2004, p. 42-44; Cornes 2016). In a 2-player game, depending on the specific production function of the public good, the player contributing more initially in fact becomes the sole player contributing towards the public good. In other words, one player has a positive and the other player has a willingness to pay of zero. These expected utility approaches can be extended in various ways. For example, simple models, where all individuals are homogeneous, can be generalized by allowing for differing unit costs (Ihori 1996). Another generalization can be found in Cornes and Hartley (2007) where decreasing returns for private goods are assumed, which in turn leads to a stable non-zero willingness to pay for the public good.

In VCM models, on the other hand, the optimal willingness to pay is not linked to other players' responses as the optimal response is a Nash Equilibrium. Let us consider a simple, linear version of a VCM experiment: There are n players with an endowment of e each. Player i ($i = 1, 2, \cdots, n$) can spend a certain amount x_i on the public good and saves the remaining $e - x_i$ (see Asch et al. 1993; Croson et al. 2005). The choices of all other players are unknown to player i. An expenditure of x_i by player i on the public good returns $x_i m$ to all players, where m is the marginal per capita return. Typically, m is assumed to be between 0 and 1. The level of the public good q is defined as:

$$q(x_i) = m \sum_{i=1}^{n} x_i \tag{7}$$

The utility function $u_i(x_i)$ of player i is equal to

$$u_i(x_i) = a(e - x_i) + m \sum_{i=1}^{n} x_i, \tag{8}$$

where $a \geq 1$ is some constant. Clearly all players aim to maximize their utility. Assuming $a > m$, the optimal choice for all players is to always free-ride as the marginal return of one additional unit of private consumption is higher than the marginal return per capita of the public good. Hence, in this case there is total defection. If, on the other hand, $m \geq a$ there is no incentive to free-ride.

But the prediction of no contributions in the case $a \geq m$ is not consistent with experimental research results, where a willingness to pay for a continuous public good was found (see e.g. Bohm 1972; Scherr and Babb 1975; V. L. Smith 1980; Marwell and Ames 1981; Asch et al. 1993; Ledyard 1995). This is mainly due to assuming linear returns on private goods consumption in equation (8). If one assumes a concave utility function for private goods the optimal strategy changes.

The easiest way of introducing this non-linear utility function for private goods is by using a quadratic payoff function (see e.g. Fershtman and Nitzan 1991; Keser 1996; van Dijk et al. 2002; Laury and Holt 2008; Lappalainen 2018). Then the utility function of the private good reads

$$u_i^p(x_i) = b(e - x_i) - \frac{c}{2}(e - x_i)^2, \tag{9}$$

where b and c are constant parameters. The quadratic form of the utility function ensures that the marginal utility of consuming $e - x_i$ decreases with each additional unit of private goods consumed. Each player's utility deriving from the public good is still assumed to equal m times the total contribution of all n players, i.e.

$$u_i^c(x_i) = m \sum_{i=1}^{n} x_i \tag{10}$$

This means that each player, independent of her contribution, receives the same benefit from the level of the public good. Hence the total utility function of individual i reads

$$u_i(x_i) = a(e - x_i) - \frac{b}{2}(e - x_i)^2 + m\sum_{i=1}^{n} x_i \tag{11}$$

A simple calculation shows that the maximum utility is achieved at

$$x_i^* = \frac{m - a}{b} + e, \tag{12}$$

which is independent of the responses of the other players. It is important to note that the larger the return (m) on her contribution and the higher her endowment e, the larger the optimal contribution x_i^* of player i is. Moreover, if m is sufficiently small, in particular $m < a - eb$, the willingness to pay is 0.

In the search for theoretical models with a more stable interior Nash equilibrium, the above VCM models were generalized in various ways:

- Introduction of asymmetric endowments and payoffs (Chan et al. 1999; Laury et al. 1999; Kleine et al. 2018),
- Modifications to the production function of the public good q (Ballester et al. 2006; Belhaj et al. 2014; Lappalainen 2018)
- Assuming sequential order of play (Hermalin 1998; Vesterlund 2003; Potters et al. 2007; Kleine et al. 2018),
- Assuming incomplete information (Isaac and Walker 1998; Laury et al. 1999; Healy 2006) or
- Considering dynamic models with multiple periods (Page et al. 2005; Healy 2006; Reischmann and Oechssler 2018).

Each of the above generalizations leads to a higher willingness to pay in the case of continuous public goods. There are other studies that find opposite effects and a decreasing willingness to pay, depending on how cooperation is rewarded for incomplete information

(Iida 1993; Isaac and Walker 1998) and multiple periods (Fershtman and Nitzan 1991; Ledyard 1995; Burger and Kolstad 2009).

To sum up the results: In the continuous public good case willingness to pay is typically smaller than in the step case (Asch et al. 1993; Rondeau et al. 1999; Rose et al. 2002). However, if one assumes decreasing returns to private goods, it may still be positive and non-zero. Without these latter assumptions free riding is the optimal strategy.

2.3.2 Continuous Common Goods

Continuous common goods (also called common property resources) lead to similar phenomena as for continuous public goods, though there are some differences. These are based on the fact that continuous public goods derive their utility from the level of the collective good, whereas continuous common goods derive theirs from the flow of the collective good. The differing utilities are fundamentally based on the differences in rivalry between continuous common and public goods. A classic example of a continuous common good is the "Tragedy of the Commons" (Hardin 1968). If multiple farmers must choose how many goats to graze on the same pasture, they will over-graze the common good (here: the pasture) up to a point where an additional goat does not provide any additional benefit. Note the difference to step common goods (recall the sewage example from Section 2.1.2). If the pasture were a step common good and over-grazing had very dire consequences, some cooperation could emerge beforehand.

Consider n farmers (as in Gibbons 1992, p. 27-29 or Osborne 2004, p. 62-63) thinking of how many goats to purchase for this summer's grazing period. Let g_i be the number of goats the i-th farmer purchases. Assume that the utility a farmer receives from a single grazing goat is equal to $v(G)$, where v is some function of the total number of goats $G = g_1 + \cdots + g_n$. As each additional goat grazes on a finite pasture, $v(G)$ must satisfy $v'(G) < 0$ and $v''(G) < 0$. If the cost of keeping a single goat is c, the payoff to farmer i is

$$u_i(g_i) = g_i v(G) - cg_i. \tag{13}$$

A strategy g_i^* is optimal, if for each i the g_i^* maximizes the utility $u_i(g_i)$ when holding the choices of all other farmers $j = 1, 2, ..., i-1, i+1, ..., n$ constant to the strategy g_j^*. For brevity let us write $g_{-i}^* = g_1^* + ... + g_{i-1}^* + g_{i+1}^* + ... + g_n^*$. The first order condition for g_i^* to be a maximum of (13) reads

$$u_i'(g_i^*) = v(g_i^* + g_{-i}^*) + g_i^* v'(g_i^* + g_{-i}^*) - c = 0 \tag{14}$$

This implies that farmers add goats until the cost c of adding an additional goat is greater than the average benefit $v(g_i + g_{-i}^*)$ and the marginal negative impact $g_i v'(g_i + g_{-i}^*)$ of an additional goat combined. Given a specific form of $v(G)$ it is easy to solve for g_i^*. In general, one can show when $v'(G), v''(G) < 0$ that the pasture will be exploited to the maximum, i.e. to the point that the pasture cannot profitably sustain an additional goat, because it is not in the interest of any farmer to reduce her own number of goats g_i.

Common property resource problems can also be constructed in a way that a player has to choose between investment into a private good (with a quadratic utility function) or a common good (Ostrom et al. 1994; Keser and Gardner 1999; Beckenkamp 2002; Casari and Plott 2003). This leads to a relatively higher willingness to pay compared to a continuous public good resource problem (Apesteguia and Maier-Rigaud 2006).

Again, there are multiple experimental studies that suggest at least some form of cooperation arising (Walker et al. 1990; Ostrom et al. 1994; Sell and Son 1997; Keser and Gardner 1999; Gardner et al. 2007), even though theoretical models predict full defection. Therefore, multiple papers try to modify common property resource models hoping that their theoretical properties match the empirical results.

Similar to the case of continuous public goods, communication (Messick et al. 1983; Kreps 1990; Cardenas et al. 2004), reciprocity, the form of the regeneration function (Messick and Brewer 1983; Kramer et al. 1986; Brewer and Kramer 1986; C. D. Samuelson 1991; Sell and Son 1997), or just simple trial-and-error strategies (Osborne and Rubinstein 1998; Cardenas et al. 2015) can lead to a higher willingness to pay for a common good. It is also important to note that cooperation seems to be higher in the continuous common good case. This is especially true in the dynamic case, where the lower the level of the common good the greater cooperation is (Roch and Samuelson 1997; Sell and Son 1997; Apesteguia and Maier-Rigaud 2006). But there are other characteristics, as uncertainty, that reduce cooperation. For example, if players are unaware of the remaining size of the common good, they are even more likely to over-consume the common good (Budescu et al. 1990; Wit and Wilke 1998; Gustafsson et al. 1999).

2.4 Mixed Motivations

Even though the above discussed approaches aiming at explaining experimental results with economic incentives are very relevant, there is a large body of literature arguing that the main reasons for the different findings in experimental and theoretical papers are either based on a problematic experimental design or the omission of very important factors of the willingness to pay in theoretical models of collective goods.

In the previous section, we showed that when rational players face a situation in which cooperation promises a higher payoff, they generally decide to behave reciprocally. On the other hand, if the payoff for defection is higher they choose to defect. This assumption of rational egoists correctly predicts outcomes in auctions and competitive market situations (Selten 1991; Kagel and Roth 1995; Ostrom 2000). Still, there are a plethora of explanations, why players sometimes do not choose an (at first glance) optimal strategy (see e.g. Barry 1970; Sen 1977; Ostrom 1990; Udehn 1993; Moreh 1994). When this happens – for example, when a player chooses to cooperate in a 2-person one-shot Prisoner's Dilemma – such behavior is often defined as "irrational" (see e.g. Sen 1977; Hardin 1982; Frank 1987). "Irrational" behaviour plays a very important role in determining the willingness to pay. As we argue in Chapter 5, we do not consider such behaviour to be irrational. Instead, we posit that after adding payoffs of additional non-economic incentives (e.g. reputation or conscience) and reciprocity, which leads to a more realistic representation of the strategic options faced by an individual in a collective action problem, such "irrational" behaviour can in fact be explained and found to be rational.

Despite of this, many economists ignore these so-called selective incentives completely in their models. As Olson (1971, p. 60-65) already states, some form of collective action can be observed in Prisoner Dilemma situations, even though the theory based on economic incentives alone suggests other behaviour. Olson argues for instance that if the other player were a close friend, then the first player would in most cases also take social incentives into account. Other selective incentives might be prestige, respect, friendship, fairness, morality, etc. These kinds of incentives can be grouped into two categories: Internal and external motivations. Motivations are internal if an individual acts due to intrinsic beliefs, alignments or attitudes. External motivations on the other hand could be for instance the possibility of receiving social rewards or preventing social sanctions. Below, we delve deeper into these two types of motivation.

2.4.1 External Motivations

External motivations can potentially explain the gap between theoretical and experimental results on free-riding in collective goods games (Olson 1971; Kreps and Wilson 1982; Ostrom 1990; Bornstein et al. 1990; McCabe et al. 1996). Introducing social sanctions or rewards alters the optimal strategy in such a way that it becomes rational for the players to cooperate. Let us give a specific example. Assume we are in the setup of an 2-person Prisoner's Dilemma, where being spotted as deviant leads to a sanction of s. For now, we take s to be equal to 12, which is sufficiently costly to make players choose to cooperate. Subtracting 12 from the payoffs in Table 1 yields the following game:

Individual 1 / Individual 2	Cooperate	Not cooperate
Cooperate	10/10	0/8
Not cooperate	8/0	$-7/-7$

Table 6: One-shot Game with Social Sanctions

With these payoffs cooperation is the optimal strategy and in fact a stable Nash equilibrium. Hence, there is a positive willingness to pay for the collective good and collective action arises. One can also consider the following two variants of this game. One, where there is only a probability $p < 1$ of being exposed or two, where sanctions are only implemented against a non-cooperating player when the other player cooperates. The latter game has the following payoffs:

Individual 1 / Individual 2	Cooperate	Not cooperate
Cooperate	10/10	0/8
Not cooperate	8/0	5/5

Table 7: One-shot Game with Situational Sanctions

This game now possesses two Nash equilibria. If either both players "Cooperate" or both do "Not Cooperate", neither has an incentive to defect. So for this game, the outcome may or may not be collective action, depending on how well both players coordinate. As for the assurance game in Table 3, we assume that in the presence of two Nash equilibria the one with a higher pay-off is chosen. We therefore assume the outcome of this game is full cooperation. The result also holds true for an n-person Prisoner's Dilemma Supergame (see e.g. Kreps et al. 1982; Fehr and Gächter 2000). As in Table 7, sanctions, group pressure, etc. change the players' payoffs in such a way that there are two Nash equilibria.

Let us now consider the variation where a non-cooperating player is only caught with a certain probability $p < 1$. In particular, we assume that p increases with the number of players k cooperating and is given by $p = \theta k$ where $\theta < 1$ is a constant. When caught, a player's payoff v_i is reduced by a sanction s. Therefore, the expected payoff function P_i of a non-cooperating player is $P_i = (1 - p)v_i + p(v_i - s)$. To intuitively understand the payoff structure, let us take $s = 5$, $\theta = 0.2$ and keep all other variables defined as in Table 2. There, we assumed n=5 players, total cost of the public good of c=5, the valuation of each player $v_i = 3$ and equally shared costs among contributors. This results in the following payoff Table 8 for player i:

Number of players k other than i cooperating	4	3	2	1	0
Payoff to i, if i pays	2	1.75	1.33	0.5	-2
Payoff to i, if i does not pay	-1	0	1	2	0

Table 8: One-shot N-player Game with Sanctions

In this situation no dominant strategy exists, because when $k \geq 2$ players cooperate, player i is best off also cooperating, whereas when $k < 2$ she is better off not cooperating. We also see that the strategies all players and no players cooperating are both Nash equilibria, since in both cases no player has a one-sided incentive to deviate from her strategy, due to the expected cost of defection. Therefore an n-player Prisoner's Dilemma becomes a coordination game in the presence of sanctions, and once three or more players cooperate collective action is the stable outcome.

It is not unreasonable to assume that the group size is a relevant factor in the probability of finding a deviating player. The larger the group the less likely cooperation might be, up until a size threshold after which no cooperation is possible (see Section 2.5.1). In our example one could model this by taking θ to be a decreasing function of n.

Even in two-person Prisoner's Dilemma Supergames, which we discussed above – games are repeated infinitely many times and people randomly meet – it may be optimal to cooperate without knowing, if the same player is met again. If a player always cooperates and therefore builds up a good reputation, other players, despite perhaps never have met said player before, will chose to cooperate based on the reputation only. This is defined as "indirect reciprocity" (Nowak and Sigmund 2005; Ule et al. 2009; Mani et al. 2013). Additionally, the more salient the benefit of cooperation is for each individual, the larger the participation (Rege and Telle 2004; Ariely et al. 2009; Pfeiffer et al. 2012).

A very interesting question is how much an individual's behavior is determined by external motivations. Yoeli et al. (2013) introduce an experiment where they try to nudge players into cooperating in a blackout prevention program. Success of such saving programs could reduce the need to install additional energy production capacity by at least

38 percent according to Yoeli et al. (2013) and therefore significantly lower electricity costs for everyone. Depending on whether or not they helped by reducing their air conditioning use during periods of high electricity demand, participants were rewarded by being listed either anonymously or publicly. Previously, the utility company, with which Yoeli et al. (2013) cooperated, had offered a monetary incentive of 25 dollars for cooperating electricity consumers. Despite the monetary incentive the participation was low – a classical collective action problem.

Yoeli et al. (2013) found in their experiment that compared to the 25 dollar monetary incentive, participation increased four times with anonymous listing. With a public list, the participation rate increased by another three times compared to the anonymous listing. Of course, it is not possible to directly compare the monetary incentive to the utility of being publicly listed due to multiple biases. For instance, being listed anonymously should not change the incentive of cooperation compared to the original monetary incentive. Still, the participation increased, which might be mainly based on the active advertisement and the experimental situation. The difference in cooperation between the anonymous and public listing experiments, however, can be considered as solely due to the different levels of external motivation. This shows that taking external motivations into consideration can significantly impact individual's optimal strategic choices and lead to a (higher) willingness to pay for a collective good, that otherwise theoretically would be non-existent.

All of the above results, even though very interesting, are based on laboratory settings. Laboratory experiments might still suffer from various biases, which we will cover in Section 3 (Levitt and List 2007). It is therefore unclear how well these experiments translate into reality, though some research has been conducted to answer this question (Feeny et al. 1990; Baland and Platteau 2000; Lacetera and Macis 2010; Ashraf et al. 2014; Karlan and McConnell 2014). Still, the theoretical and empirical results are a stark contrast to Olson's original argument (Olson 1971, p. 61-62) that mixed motivations should not be included in modeling approaches, as their effect is hard to identify and measure. At least for external motivations the influence on the willingness to pay is relatively clear and fairly straightforward to model.

2.4.2 Internal Motivations

It is more difficult to capture internal motivations in an individual's payoff function. Individuals' decision-making processes are influenced by different, inconsistent variables such as guilt, sympathy, altruism, a preference for fairness or moral behaviour based on social norms. Altruistic persons, for example, may participate in improving a collective good even if they do not directly benefit from it (see e.g. Margolis 1983; Taylor 1987; Guagnano et al. 1994). They may for instance reduce their consumption of a good deemed harmful to a collective good even without personal profit from the level of the collective good or reputational gains. Such behaviour is often called "irrational", as it is not directly driven by the altruist's more obvious payoff components (Olson 1971; Sen 1977; Taylor 1987; Frank 1987). Because of this, many economic models do not include social incentives into individuals' utility functions.[5]

Of course one can argue that an altruist's payoff should increase as well when she acts according to her preference for altruistic behaviour, similar to the case of external motivations, as e.g. Becker (1996), Fehr and Fischbacher (2003) and Bicchieri (2004) propose. This would mean that in theory any kind of individual preference should be added into utility functions as e.g. Schwartz (1977), Margolis (1981), Stern et al. (1993), Guagnano et al. (1994) and Blamey (1998) do in their modeling approaches. We argue in a similar manner in Chapter 5.

Acting altruistically without considering the impact of one's contribution – so called "pure altruism" – is hard to find empirically though. Instead, altruistic willingness to pay appears to be linked to the expected effect of the contribution on others, which in the literature is called "impure or participation altruism" (Margolis 1983; Andreoni 1990; Kahneman and Knetsch 1992). The less perceived impact an individual has on the collective good, the lower her willingness to pay (Andreoni 1988). This suggests that individuals' willingness to pay for collective goods depends highly on the size of the group and the collective good.

[5] The preference for altruistic behaviour is sometimes termed as the "warm glow of giving" (Andreoni 1990; Kahneman and Knetsch 1992).

Of course, there are other internal motivations, apart from altruism, that can influence the willingness to pay for a collective good. Social norms, which are typically defined as a generally accepted catalogue of behaviour, can affect cooperative choices of players (see Elster 1985; Coleman 1986), either directly or dependent on the cooperation of others. For instance, an individual might consider cooperation in a specific situation to be fair, whereas in another situation, e.g. when playing with an uncooperative other individual, she will defect as well (Elster 1989; Rabin 1993; Fehr and Schmidt 1999; Ostrom 2000; Charness and Rabin 2002). So, whether the social norm of fairness drives cooperation is conditional on the behaviour of others. Other social norms, like morality, are not dependent on the actions of others, but apart from that work in the same way as fairness (Elster 1989).

Another strand of literature argues that it is too complex for individuals to always maximize their utility (Hayek 1976; Heiner 1983; Sen 1985; Vanberg 2008), and therefore including social incentives into their utility functions still does not appropriately represent their decision-making process. Instead, individuals follow a specific set of rules and social norms without concerning themselves with the effects on their utility (rule-guided behaviour). Only in exceptional circumstances, when it is very clear that just following the rule leads to a low utility, an individual will attempt to maximize said utility. Vanberg (2008) calls this case-to-case maximization. In other words: Individuals have a preference over actions as well, instead of only a preference over outcomes. An individual can sometimes even be better off by following rule-guided behaviour, especially if the optimal choice is not clear or the computational costs are too high. What these rules are and how they come about is a very interesting topic, however we will not study this in any depth here. According to Denzau and Douglass (1994), they might not only be based on social norms, but also on ideas and the communication of these ideas (shared mental models).

What is considered to be good or bad behaviour, or what leads to social benefits or sanctions, is of course highly dependent on the social norms of a society. Externally motivated willingness to pay can only exist if the actions of other players are observable. Otherwise, the social incentives of players are clearly not externally motivated. Without observable actions it is of course still possible that players cooperate based on internal motivations (fairness, conscience, etc.), even though it would not be optimal in the original Prisoner's Dilemma introduced in Section 2.1.1. However, these internal motivations appear to be weaker than external incentives (List et al. 2004; Seinen and Schram 2006).

2.4.3 Conditional Cooperation

The above discussion on social norms shows how much a player's willingness to cooperate depends on the environment she finds herself in. Moreover, whether or not cooperation arises depends on the payoff reciprocal behaviour promises. Ostrom (2000) investigates collective good games with a mix of three player profiles and shows how these can explain experimental findings on collective action. In her setup, there are rational egoists, which always play a defective strategy as long as the potential payoff of defection is higher. But there are also conditional cooperators, which are players that are willing to cooperate under the right circumstances. These players receive some benefit from acting in accordance to social norms. A third type of players is called "willing punishers". They are willing to give up their own resources in order to punish defective behaviour. Punitive actions may also take the form of non-economic actions (e.g. strong verbal rebukes). It is possible that players exhibit both traits of conditional cooperators and willing punishers.

Information is key to the emergence of cooperation amongst players. Observable actions (see e.g. Boyd and Richerson 1985; Güth 1995; Börgers and Sarin 1997), face-to-face communication (Frank et al. 1993; Sally 1995; Ostrom 1998) or just seeing other players (Bohnet and Frey 1999) may increase cooperative behaviour. With enough cooperation it might even be optimal for some rational egoists to cooperate in the first periods in order to improve their total payoff (Kreps and Wilson 1982). Some authors argue that as long as players are allowed to communicate, these results also hold in the case of incomplete information. Then, conditional cooperators can coordinate collective action based on trust, if enough other players have a positive willingness to pay for the collective good (see Sen 1967; Shaw 1984; Sabia 1988). According to Elster (1985) it is not even necessary to communicate with every player. A close circle of friends, family, etc. may be sufficient.

Then multiple groups of peers, who all cooperate amongst themselves, can lead to high overall cooperation to obtain larger collective goods.

Depending on the social norm defining good and bad behaviour, different strategies for playing against defective individuals can be optimal in repeated games. For some social norms it might be optimal to cooperate with players, who have cooperated sufficiently in the past, while disregarding their behaviour in the last game only. This is often referred to as "image scoring" (Nowak and Sigmund 1998; Wedekind and Milinski 2000). For other social norms, however, it might be optimal to take these previous games into account when judging other players' cooperation. The "standing norm" allows for bad behaviour against players with a bad reputation (Leimar and Hammerstein 2001; Ohtsuki and Iwasa 2006). As this discourse leads too far from our original question on how willingness to pay arises – a willingness to pay exists in both of these strategies – we will not delve any deeper. A good starting point for further reading can be found in Sugden (1986), Nowak and Sigmund (1998), Lotem et al. (1999) and Milinski et al. (2001).

Some economists believe that individuals are mostly self-interested and that whenever this is not found in practice it is because the experiment was in some form biased. They argue that individuals are only boundedly rational and need some time to learn the games in experiments. This leads them to cooperate too heavily in the first iterations of collective goods games, because they do not understand the game well enough. This cooperation is not stable and reduces with learning in every additional iteration (see e.g. Andreoni 1995; Gale et al. 1995; Roth and Erev 1995; Palfrey and Prisbrey 1997; Cooper and Stockman 2002; Guillen et al. 2007; Feige et al. 2014). So, they argue, economic incentives are the most important factor in the long run. This branch of thought can be summarized under the term "learning hypothesis" (Andreozzi et al. 2020).

On the other side of the argument are economists who support the conditional cooperation hypothesis. They believe that mixed motivation leads to at least partial cooperation amongst the participants. In particular, various studies estimate that around 40 to 60 percent of all participants will fully cooperate (at least in the first period), as in a random group of people this is usually the proportion of conditional cooperators (see e.g. Ostrom

2000; Fischbacher et al. 2001; Kurzban and Houser 2005; Gächter and Herrmann 2009; Fischbacher and Gächter 2010). They argue that experiments in which cooperation declined over time can be explained by the composition of players. If there are too many rational egoists, conditional cooperators will stop cooperating as well, as they do not want to become the cooperating "suckers" (Fischbacher and Gächter 2010). This leads to lower, but rarely zero cooperation (Güth 1995; Keser and van Winden 2000; Burlando and Guala 2005; Gächter and Thöni 2005). If the group consists of a large proportion of conditional cooperators, collective action remains stable.

However, the decreasing cooperation might also be explained by a selfish-bias. Fischbacher et al. (2001) and Neugebauer et al. (2009) suggest that while conditional cooperators wish to cooperate, they also want to pay less than other cooperators at the same time. This might explain why cooperation is an unstable strategy in multi-period games.

These two contradicting theories make willingness to pay for collective goods such an interesting and still highly researched topic. And most importantly, it is impossible to tell who is right in general. Collective action depends greatly on the collective good, the composition of the players and the game being played (Fehr and Schmidt 1999; Bolton and Ockenfels 2000). The latter depends on the type of good (step or continuous collective good) and many other properties (information asymmetry, level of endowment, repetition, etc.), as discussed in the previous sections.

2.5 Other Influencing Factors

Apart from social incentives, there are many other properties of collective goods that influence the willingness to pay which we have not yet covered in depth. In this section, we focus on the two most important factors: The size of the collective good and the source of its provision.

2.5.1 Size of the Collective Good

Following Olson (1971), we believe that group size is a hindering factor in the provision of collective goods. The larger the group of individuals – that are not excludable from consumption – the harder it is to coordinate cooperation. These groups are from now on just called "larger groups". We have already discussed a few implications of increasing group sizes. In the case of step collective goods, for instance, the probability of being the player that is the deciding factor in the provision of a collective good decreases as the size of the group increases. This in turn leads to cooperation being less stable in equilibrium.

For rivalrous goods the effect of crowding plays an important additional role. The more other players profit from a player's contribution, the lower her marginal utility of contributing. Therefore, the incentive to contribute decreases with increasing group size. This is even true in heterogeneous groups, where some players have a high willingness to pay for a collective good (Esteban and Ray 2001; Pecorino and Temimi 2008). For larger groups social incentives also play less of a role, as the probability of being detected decreases or monitoring becomes more costly (Agrawal and Goyal 2001; Carpenter 2007). Hence, defective behaviour and non-cooperation can be punished less effectively. In addition to this, communication becomes harder, which in turn leads to lower levels of trust. In heterogeneous groups social norms will potentially vary widely (Jagers et al. 2020). Moreover, there is a greater uncertainty for larger collective goods – e.g. the total contribution threshold in the case of step collective goods. All of these factors lead to cooperation being less stable and to a reduction in the willingness to pay (Budescu et al. 1990; Rapoport and Suleiman 1993; Hine and Gifford 1996; Wit and Wilke 1998; Gustafsson et al. 1999).

Although the above argument holds true for many situations it cannot be completely generalized (Isaac et al. 1984; Isaac and Walker 1988). There are multiple ways in which larger groups may be superior in providing a collective good – for instance in the presence of different aggregation technologies of contributions (Hirshleifer 1983, Cornes and Sandler 1984, Vicary 1990, Cornes 1993), which we will introduce in the next paragraph, or increasing marginal costs of providing the collective good (Esteban and Ray 2001; Pecorino and Temimi 2008; McGinty 2014). In such cases the willingness to pay may be constant or even increase, as the group size increases. An introduction to other effects of group size, which we unfortunately cannot discuss here, can be found in e.g. Udehn (1993), Pecorino (2015), Sandler (2015) and Jagers et al. (2020). Below, we give some examples of collective goods where the willingness to pay may increase with group size.

Typically, the aggregation technology is considered to be additive. An additive aggregation technology describes a situation, where the marginal benefit of one unit provided is constant for each individual. However, there are instances where only the strongest or the weakest player defines the level of the collective good. The marginal benefit of units provided by all other individuals are zero.

Consider for example a country close to the ocean, where each individual has to maintain her own dike. If one of the dikes breaks, the efforts of all other individuals are in vain and the country will be flooded. So, in this case of a so-called "weakest-link" collective good, the smallest willingness to pay defines the overall level of the collective good. An increase in group size – i.e. more ocean-front properties – only decreases the level of the collective good if the lowest willingness to pay decreases with increasing group size. This, however, is not necessarily true (Harrison and Hirshleifer 1989; Sandler 1992; Mueller 2003).

On the other hand, a best-shot collective good is defined by the property that the highest contribution determines the level of the collective good. An example would be a race to develop a new vaccine where often the winner takes all. In this example, though, the larger the group size, e.g. a local disease outbreak versus a global pandemic, the more probable it becomes that one or more groups of scientists discover a new vaccine, as the amount of research funding increases with group size (Hirshleifer 1983; Cornes 1993).

For some types of collective goods, one finds that the marginal benefit of spending one additional monetary unit to increase a collective good decreases for each player. Then, it would be easier for larger groups to provide a collective good, as the marginal costs of provision on average are lower for each individual. This is especially true for step collective goods. Thus a larger group has the advantage of being able to reach a certain level of a collective good with lower per capita costs, provided everyone participates in financing the collective good (Chamberlin (1974) and McGuire (1974)). Therefore, a step public good can be provided the easier, the larger the size of a group and a continuous public good would have a higher level as before.

As we do in this thesis, Pecorino (2015) argues that the total contribution should not be the object of discussion, but rather the individual willingness to pay. If, as Chamberlin (1974) and McGuire (1974) assume, individual contribution decreases with larger groups, lower contributions will in the end lead to players believing that cooperation is relatively low, which results in the conditional cooperators cooperating less as we discussed above. Hence, for a game repeated over a longer period of time, cooperation would go down significantly and, quite paradoxically, an increasing group size could in fact lead to a lower level of the collective good.

In contradiction with these arguments, there are recent experimental studies that suggest a higher willingness to pay with increasing group size (Diederich et al. 2016; Lappalainen 2018). Weimann et al. (2019) even propose that cooperation is possible, if the effect of a player's contribution is negligibly small. They argue that the more obvious the benefits of cooperation are, the higher the resulting cooperation. Note that this was already suggested by e.g. Isaac et al. (1984) and Isaac et al. (1994). Of course, the higher the marginal per capita return (MPCR) the more obvious the benefits of cooperation. In other words, if players understand that cooperation is worthwhile they are more likely to cooperate. Weimann et al. (2019) propose that this effect is not constant but decreasing with group size. This would mean that the larger the group size, the smaller the values of MPCR needed in order for players to understand that cooperation is worthwhile. Then, with increasing group size, cooperation could still be possible (or even go up), as the threshold MPCR goes down accordingly. Therefore, they argue, that the most important factor for determining cooperation is actually the interaction of group size and MPCR.

In summary, the group size effects have not yet been fully understood and there is a lot of research remaining to be carried out in the future. To the author's knowledge there is only one study (Pereda et al. 2019) investigating the effect of group size in an experiment with more than 100 participants. What has become clear in our discussion above is that there are some factors that encourage and others that hinder cooperation. Therefore, some (see e.g. Jagers et al. (2020)) even wonder, whether it is possible to make general statements or if each collective action problem must be viewed and analyzed separately.

2.5.2 Private and Public Provision

Even though private coordination amongst players can lead to some level of provision of a collective good, many economists argue that full cooperation can only be achieved via the state (Cornes and Sandler 1984; Bergstrom et al. 1986; Andreoni 1988). Only if the state "forces" its citizens, e.g. via collecting taxes, everyone has to cooperate.[6] This is mainly due to the fact that an individual only takes the marginal effect on her own utility into account, but not the positive effect that her contribution has on other individuals' utility. The optimal level of a collective good, which is usually not achievable by private cooperation only, can be defined by the following first order condition (see P. A. Samuelson 1954): At the optimum, the marginal cost of an increase of the collective good (Marginal rate of transformation (MRT)) is equal to the sum of all individual i's marginal benefits of one additional unit of the collective good (Marginal rate of substitution (MRS)) (Samuelson condition). In mathematical terms, for an economy with n consumers, the condition reads:

$$MRT = \sum_{i=1}^{n} MRS_i \tag{15}$$

Social welfare is maximized when this condition holds. This does not mean that the state should always intervene in collective goods problems (Varian 1993). Instead, it highly depends on the capabilities and the transaction costs of the public sector.

Homogeneous individuals in a Prisoner's Dilemma, where the net benefit of a public provision is zero, are indifferent to whether there is state intervention or full defection given a certain threshold tax. Therefore, the tax at this point is the maximum willingness to pay for the collective good.[7] Only if the state manages to provide the collective good with at most this level of taxes, all players are at least indifferent in comparison to the original

[6] This is of course not limited to the state or a public entity, as any entity with similar power can achieve the same.

[7] If endowments are distributed heterogeneously amongst individuals, their maximum willingness to pay will also differ. In these situations, the public sector might levy taxes conditional on the endowment of individuals.

Nash equilibrium of full defection – assuming that the citizens consider the provision to be fair (Rothstein 1998; Rothstein 2005).

There are other economists who argue that the state crowds out private contributions, if it intervenes too much in the provision of collective goods (Warr 1982; Roberts 1984; Montgomery and Bean 1999; Ostrom 2000). This is particularly true for local communities, where cooperation is higher without any public provision (Schlager et al. 1994; Baland and Platteau 2000; Varughese and Ostrom 2001; Dietz et al. 2008). Bergstrom et al. (1986) and Andreoni (1988) on the other hand argue that this crowding out can only be partial and is more than offset by the additional collected taxes of previously non-cooperating citizens. Hence, the important question is always: at what cost (cost of provision and transaction cost) can the public sector provide the collective good (Anomaly 2015)?

Jagers et al. (2020) proposes a middle ground between both arguments on the basis of experimental research, which suggests that when enough conditional cooperators are present, high levels of cooperation can be sustained. If a third party – especially for large collective goods – can enable facilitators and lessen hindering factors, then collective action might be possible without levying taxation (Ensminger 1992; Greif 2006; Ostrom 2010; Mansbridge 2014). How one can achieve this effectively is a highly relevant question, yet too little studied.

Still, public provision of collective goods can force individuals to cooperate to circumvent a potential attitude-behaviour gap.[8] The main argument is that individuals have two kinds of willingness to pay. One, where the collective good is provided privately and individuals might have an incentive to free-ride. And another, where the state prohibits free-riding by imposing a collective tax, which leads to a non-zero willingness to pay of individuals, knowing that everyone is forced to cooperate. Of course in some societies, free-riding can be prevented via other entities, where institutions are similar to the one of a state and might even be more efficient on a smaller scale (see e.g. Warr 1982; Roberts

[8]For literature on the attitude-behaviour gap see e.g. Ajzen and Fishbein (1977), Follows and Jobber (2000), Carrigan and Attalla (2001), Auger and Devinney (2007) and Carrington et al. (2010).

1984; Montgomery and Bean 1999; Ostrom 2000).

The first part of this thesis aimed to provide an intuition for the theoretical willingness to pay for collective goods by introducing different strands of economic literature and reviewing various experimental studies. However, often it is not enough to only predict whether a willingness to pay will or will not arise. Rather the specific level of the willingness to pay is needed to provide founded policy recommendations. In the next section, we therefore focus on strategies economists employ to measure the willingness to pay for collective goods.

3 Measuring the Willingness to Pay for Collective Goods

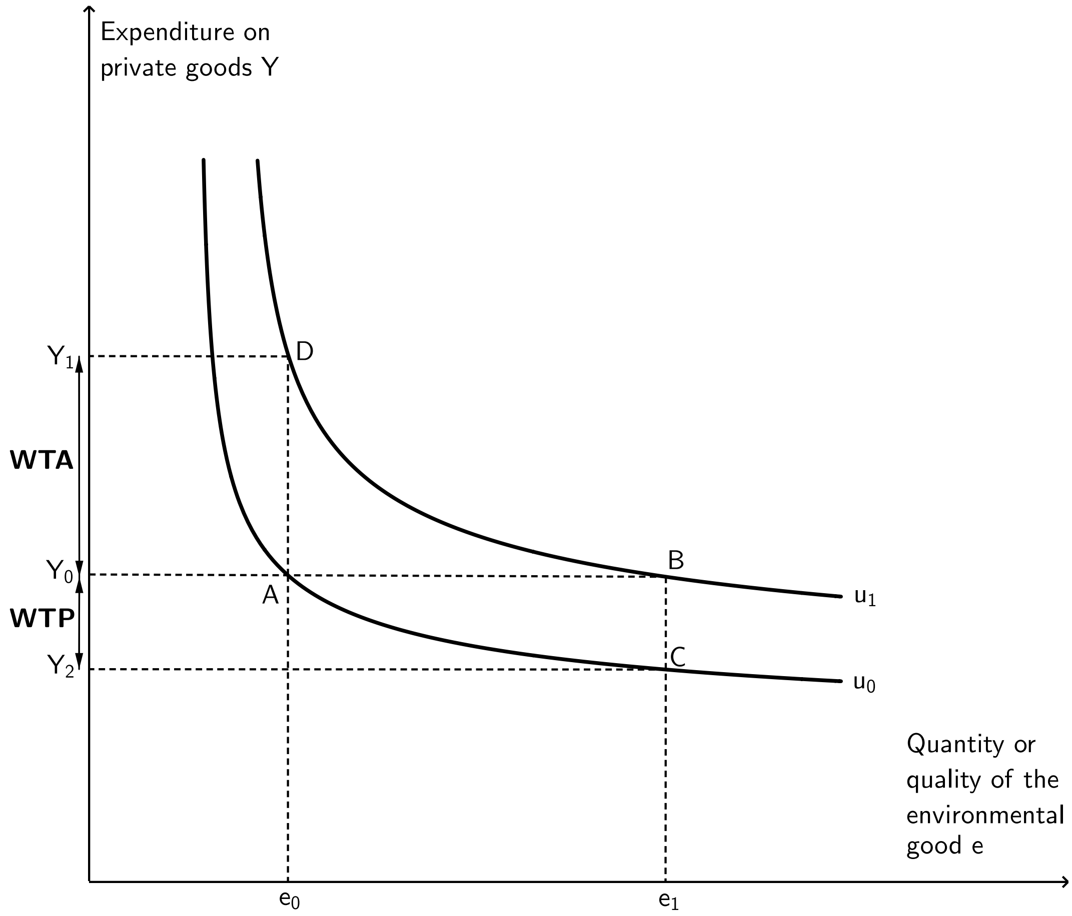
Economists broadly classify methods to measure the willingness to pay for a collective good into two categories: The revealed willingness to pay and the stated willingness to pay (Louviere et al. 2000; Perman et al. 2011; Freeman et al. 2014). For the former method, economists collect real data of market transactions to measure the willingness to pay, whereas in the latter method they aim to discover the hypothetical willingness to pay with sophisticated surveys and questionnaires. Often the stated willingness is considered as the upper bound and the revealed willingness as the lower bound of an individual's real willingness to pay. It is important to note that both, the stated and revealed willingness to pay, derive from economic reasons and social incentives.

3.1 Stated Willingness to Pay

Stated willingness to pay can take two forms: Willingness to pay and willingness to accept. As this distinction plays a very important role in questionnaires, let us proceed by analyzing their difference. Consider an individual who can only choose between either receiving an income Y, she can spend to buy private goods, or maintaining the level of an environmental good e (as in Perman et al. 2011, p. 413-415). The marginal rate of substitution is diminishing with a Cobb-Douglas type utility function of the form $u(e, Y) = e^{\alpha} Y^{\beta}$ and $\alpha, \beta > 0$. The qualitative shape of the utility's indifference curves are depicted in Figure 1.

Starting on u_0, imagine that it was possible to raise the level of the environmental good e from e_0 to e_1. The maximum willingness to pay for the improvement of e is $Y_0 - Y_2$, as the point C is still on the same indifference curve as A and therefore she is indifferent between bundles A and C. If the utility of an individual was to be raised by increasing the level of the environmental good from e_0 to e_1 (to point B), but the individual was instead offered compensation for accepting the current level e_0, the compensation would have to be equal to $Y_1 - Y_0$ in order for her to still be on the same indifference curve at point D compared to point B. This is called minimum willingness to accept.

Figure 1: Willingness to Pay and Willingness to Accept



Source: Perman et al. (2011, p. 414)

The same holds true if the initial endowment is Y_0 and e_1 (point B) instead. If the environmental good was in danger of being decreased from e_1 to e_0, the individual would need to be compensated by $Y_1 - Y_0$ for her to be indifferent to the deterioration (point D). This again is the same willingness to accept as when starting from point A. To halt this reduction of e, however, the individual would be willing to give up $Y_0 - Y_2$ of income, since A and C lie on the same indifference curve. Here, $Y_0 - Y_2$ again is equal to an individual's willingness to pay.

So, the willingness to pay and the willingness to accept can be measured for both an increasing and a decreasing environmental good. One can also distinguish between these two cases by whether the change occurs (compensating surplus) or does not occur (equivalent surplus), but we will not study this more deeply here. For our purposes, the distinction between willingness to pay and accept suffices. It is important to note that in our example the willingness to accept is larger than the willingness to pay, but this need not be the case. Depending on the starting point it may be the other way around, for instance when starting from levels where e is much larger than Y. Only with linear indifference curves the willingness to pay and accept are always equal.

The goal of the stated willingness to pay approach is to measure the willingness to pay or accept. For this purpose, there are several valuation techniques. In this thesis, we focus on two – contingent valuation (CV) and choice experiments.

3.1.1 Contingent Valuation

In CV studies, (hypothetical) scenarios are created to measure either the willingness to pay or accept of a representative sample of the total population. Since their introduction by Ciriacy-Wantrup (1947), Randall et al. (1974) and Brookshire et al. (1976), CV studies have become one of the most widespread methods of measuring valuations of collective environmental goods. The advantage of CV studies over the revealed willingness approach is that it can also be applied to investigate non-use values. These are values individuals assign to goods (including collective goods) which they may or will never be able to use (Krutilla 1967; Freeman et al. 2014). Clearly, they cannot be captured in market transactions. There are many examples of non-use values that can, for instance, be based on

- wanting to have the option of using the good in the future (option value),
- valuing its existence (existence value),
- wanting to preserve the good for future generations (bequest value).

Other examples can be found in Fisher and Raucher (1984) and Sutherland and Walsh (1985). At least for some environmental goods these non-use values appear to be a significant part of their overall value. It is, however, difficult to measure them in isolation, as they are hard to distinguish from indirect use values, as e.g. being able to view a scenic landscape in a documentary (Randall and Stoll 1983; Boyle and Bishop 1987). This is why including non-use and indirect values in general theoretical models is often considered to be too challenging (Freeman et al. 2014). But (some part of) these values can be measured during a CV study.

One of the most prominent CV studies was conducted after the Exxon Valdez disaster, when an American oil tanker hit a reef in 1989 leading to 41 million liters of crude oil contaminating the sensitive environment of Prince William Sound off the coast of Alaska. The damages caused by this accident were vast, with serious impacts on wildlife and contamination along more than 2000 km of coast line (National Transportation Safety Board 1990). The Government of Alaska commissioned a team of economists to determine the damage of the oil spill, which led to Carson et al. (2003) conducting a CV study. The CV study was later repeated with a larger sample, but without significant changes in their findings.

Keeping the above discussion in mind, our first intuition in this setting would be to examine people's willingness to accept: Starting from bundle B, how large does the compensation need to be for one's utility to remain unchanged at bundle D (recall Figure 1). In many CV studies, the stated willingness to accept is much higher than the willingness to pay (see e.g. Knetsch and Sinden 1984; Hanemann 1991; Dubourg et al. 1994; Brown and Gregory 1999). This may be the case because either the loss of utility when reducing the environmental good by δ is larger than the gain in utility when increasing it by δ (i.e. the second derivative of the utility with respect to the environmental good is negative) or because respondents have difficulty imagining an appropriate compensation in the case of loss compared to gain of an environmental good. It is, however, very difficult to determine whether one needs to measure the willingness to accept or pay – in surveys the former may have a positive estimation bias whereas the latter has a negative.

Counter to our first intuition, Carson et al. (2003) designed a survey to measure the willingness to pay, arguing that it provides a lower bound on the incurred damage. Therefore, respondents were asked if they would agree to pay a one-off tax to prevent future oil spills. In the hypothetical scenario of their survey the prevention of future accidents would have been accomplished by two coastguard vessels accompanying oil tankers, ensuring their safe passage and in the case of an oil spill acting as first responders. The survey was conducted as follows: First the consequences of the Exxon Valdez accident where explained to everyone. Then, the participants were randomly separated into four groups A to D and presented with different one-off tax plans. They were first asked on whether they would be willing to pay for tax plan “A-15”. Depending on whether they answered yes or no, they would subsequently be presented with either “A-16” or “A-17”, tax plans of higher and lower costs, respectively. In Figure 2 below, we display the different tax-plan costs shown to groups A to D:

Figure 2: Program Cost by Version and Question

Version	A-15	A-16	A-17
A	$10	$30	$5
B	$30	$60	$10
C	$60	$120	$30
D	$120	$250	$60

Source: Carson et al. (2003, p. 269)

The results of the survey are shown in Figure 3.

Figure 3: Questionnaire Version by Type of Response

Version	Yes-Yes	Yes-No	No-Yes	No-No
A ($10, $30, $5)	45.08%	22.35%	3.03%	29.55%
B ($30, $60, $10)	26.04%	26.04%	11.32%	36.60%
C ($60, $120, $30)	21.26%	29.13%	9.84%	39.76%
D ($120, $250, $60)	13.62%	20.62%	11.67%	54.09%

Source: Carson et al. (2003, p. 271)

As one would expect the proportion of Yes-Yes responses decreases with the initial cost and vice versa the opposite is true for the No-No responses. Note that in the case of

Yes-No and No-Yes responses we obtain a lower and an upper bound on the willingness to pay, whereas in the Yes-Yes and No-No cases we only get a lower or upper bound, respectively. Interestingly, the initial value of the tax massively influences the willingness to pay of respondents. For example, only 26.04% of group B have a willingness to pay of $60 or higher (Yes-Yes), whereas 21.26% + 29.13% (Yes-No) of group C are willing to pay at least $60, almost double that of group B.

This effect, where respondents anchor on the first value presented, is called the starting point bias and is one of the many biases that skew surveys of stated willingness to pay. Various potential techniques to remove the starting point bias are discussed in the literature. In the above example we see that Carson et al. (2003) implemented multiple starting points. Others try first estimating an appropriate starting point (see Mitchell and Carson 1981; Welsh and Poe 1998; Blamey et al. 1999) or simply using open-ended questions (see e.g. Hammack and Brown 1974; Boyle et al. 1985; Loomis 1990; Whittington et al. 1992).

Taking this starting point bias into account, Carson et al. (2003) estimated the median willingness to pay to be $30.30. Multiplying this number by the number of all English-speaking households in the US, they arrived at $2.75 billion dollars as the total willingness to pay. This estimate is taken to be a lower bound, as we discussed above.

Apart from the starting point bias, there are several other important biases that can skew CV studies. The following list, whilst not complete, covers the main biases that have to be kept in mind when conducting CV studies (see e.g. Perman et al. (2011, p. 424-425) and Freeman et al. (2014) for additional potential biases).

CV studies typically are hypothetical in nature. Hence, there are no consequences for participants stating a willingness to pay or accept that is higher than it would be in reality, e.g. because people do not keep their budget restriction in mind (Cummings and Taylor 1999). This bias can be quite substantial, ranging from 2% to 2600% according to Harrison and Rutström (2008).

Additionally, when weighing their response participants may find it difficult to focus on the specific good at question only and rather answer with a broader view of the good in mind. For instance, in a survey aiming to estimate the willingness to pay for saving a particular species of penguins, participants might actually state their willingness to pay for saving all penguins. In the literature, this is called the part-whole bias or embedding effect (Kahneman and Knetsch 1992; Bateman et al. 1997; Whitehead et al. 1998).

This is closely linked to participants, who may be insensitive to scope. Desvousges et al. (1992) find that the willingness to pay for saving 2,000, 20,000 and 200,000 birds is relatively similar, which suggests that participants have problems imagining large numbers or that saving the birds is mainly a symbolic act to e.g. satisfy one's conscience. Carson (1997) suggests that bad study design is to blame. However, multiple other studies find the same insensitivity to scope (Arrow et al. 1993; Diamond and Hausman 1994; Hausman 2012). The embedding effect is one of the key factors skewing CV studies. This does not mean that CV studies are of no value in general. There are various strategies on how to deal with the insensitivity to scope. We refer to e.g. Desvousges et al. (2012), Whitehead (2016); Burrows et al. (2017), Borzykowski et al. (2018) and Lopes and Kipperberg (2020) for further reading on this topic.

Other biases may be introduced by the interviewer conducting the study, by the tendency of "Yes-Saying" in CV studies (see e.g. Blamey et al. 1999), by the particular setup of an interview that might lead the participant to focus on a problem they normally would not (prominence bias), or by strategic answers, if participants see through the survey design. To address the latter strategy bias, a large strand of economic literature uses experiments and games based on design mechanisms. Starting with Clarke (1971) and Groves (1973), design mechanisms have become very sophisticated. These games are designed in such a way that individuals have a dominant strategy to always report their "true" willingness to pay for a collective good. Hammond (1979), Mas-Colell and Vives (1993) and Guesnerie (1995), for example, have discussed design mechanisms in the case of large collective goods.

Due to all these biases that can inadvertently creep into an experiment, some economists argue that the only reliable way of measuring the willingness to pay is via market data (see e.g. Diamond and Hausman 1994; Hausman 2012). We discuss their work in Section 3.2. But as already mentioned above, there are multiple non-market values that may be overlooked when only considering market prices. Therefore, CV studies have their place in determining willingness to pay and are widely accepted in different fields (see e.g. McLean and Mundy 1998; Carson 2000)

3.1.2 Choice Experiments

There are multiple other methods of measuring the willingness to pay with a stated approach, though in this thesis we only discuss one additional one: Choice experiments. In choice experiments the willingness to pay for a collective good is estimated by presenting participants with different choice sets (see Lancaster 1966). Let us give an example from Morrison et al. (1999), who tried to estimate the non-use values of the Macquarie Marshes, a large wetland in Australia. The following choice sets were given:

Figure 4: Example of a Choice Set

Outcome	Option 1: Continue current situation	Option 2: Increase water to Macquarie Marshes	Option 3: Increase water to Macquarie Marshes
Your water rates (one-off increase)	No change	$20 increase	$50 increase
Irrigation related employment	4400 jobs	4350 jobs	4350 jobs
Wetlands area	1000 km^2	1250 km^2	1650 km^2
Waterbirds breeding	Every 4 years	Every 3 years	Every year
Endangered and protected species	12 species	25 species	15 species

Source: Morrison et al. (1999, p. 2808)

The participants then had to state their preferred choice. The price, by which the willingness to pay is ultimately measured, is only one of several attributes in the choice sets and can be interpreted as the marginal rate of substitution between different levels of an attribute (e.g. the level of a collective good). With this, the willingness to pay for various collective goods can be determined. Choice sets have been employed in many different studies, for instance on the landscape (Mueller 2003; Horne et al. 2005; Upton et al. 2012), water and water ecosystem services (Hynes et al. 2013; Doherty et al. 2014;

Khan et al. 2019; Khan and Zhao 2019), air quality (Yoo et al. 2008; Rizzi et al. 2014; Huang et al. 2018) or noise (Daniels and Hensher 2000; Carlsson et al. 2004; Arsenio et al. 2006).

Using choice experiments over CV studies has multiple advantages, which is why they are popular in economic literature, while still allowing to include non-use values (Adamowicz et al. 1998; Hanley et al. 1998; Perman et al. 2011; Freeman et al. 2014). One advantage is that it is easier to include multiple different attributes into choice sets. For example time, comfort, reliability and price might all play a role when considering different forms of transportation. In CV studies, on the other hand, multiple surveys would have to be carried out in order to determine the willingness to pay for each of the attributes, and in some cases, it might not even be possible to measure them individually. In our example, individuals might not even know, how high their willingness to pay for a specific attribute is, e.g. being able to work in a train compared to not being able to in a car.

Another advantage is that hypothetical multi-attribute settings typically capture reality better and are hence less prone to biases. For example, yes-saying is not a problem in choice experiments, as the participant is asked on their decision between different choice sets, rather than whether or not they agree with a certain price. Additionally, choice experiments can take into account different scenarios and therefore also different forms of provision of the collective good. This, for instance, makes it possible to compare the willingness to pay for public and private provision.

Of course, choice experiments also have some disadvantages compared to CV studies. They are typically harder to process cognitively (Adamowicz et al. 1998; Perman et al. 2011). Therefore, participants might just respond to the questions without carefully weighing all options, which may introduce biases that are difficult to account for. In some studies, respondents focused on certain labels to make their choice easier. The probability of choosing the option most familiar to the participant might then be increased significantly. And while some biases might be smaller in choice experiments, multiple other biases – most importantly the hypothetical bias – still play an important role. Diamond and Hausman (1994) believe the hypothetical bias is so large that the value of attempting to measure the willingness to pay quantitatively is questionable. They argue that only from observable actions of individuals their willingness to pay can be accurately measured. This is the goal of revealed willingness to pay approaches. We find the critique of Diamond and Hausman (1994) to be too extreme. Choice experiments and contingent valuation play an important role in determining the willingness to pay, especially when non-use values are an important factor.

3.2 Revealed Willingness to Pay

There are various methods of studying the revealed willingness to pay, one of which is the travel cost method or recreational demand model: The cost of traveling to a recreational site (e.g. a lake or a mountain) can be interpreted as the implied value of the services provided there. Alternatively, the willingness to pay can be measured with the help of market data. For example, the difference in price of a house next to the train tracks versus one far away from them can be interpreted as the willingness to pay for the collective good tranquility, when controlling for all other differences. This is what hedonic pricing models aim to do. Of course, there are other methods of measuring the revealed willingness to pay, but these two suffice for the purpose of this thesis.

3.2.1 Travel Cost Method

The travel cost method goes back to Hotelling (1949) and Clawson (1959). In a letter to the US National Park Service in 1947, Hotelling proposed that the consumer surplus of a recreational site can be determined by drawing concentric zones around this recreational site and then measuring the number of trips of visitors – and their respective travel costs – from these zones to the recreational site. The main idea of the travel cost method has not changed since. Individual travel costs are interpreted as the lower bound of willingness to pay for the recreational site.

The recreational sites are collective goods by definition, as they are non-excludable. The entrance fee, that some national parks raise, is by far not sufficient to operate these national parks and therefore are typically assumed to be marginal (National Park Service

2021). Recreational sites normally also consist of more than one collective good. The reason for visiting a lake might be the landscape (public good) or to catch fish (a common good). Therefore, various collective goods with different degrees of rivalry can be present.

Only considering zonal or individual travel costs, however, has certain drawbacks as well. Firstly, it is not possible to measure the complete consumer surplus of a recreational site with such a method, because non-use values, as introduced above, cannot be captured. For example, individuals from Europe might be unable to travel to Yosemite National Park, but still have a willingness to pay for its existence. Secondly, early forms of the travel cost method did not take other recreational sites into account, which could serve as substitutes (Caulkins et al. 1986; Kling 1989; McKean and Revier 1990; Smith and Kaoru 1990). If the stock of fish at a lake, and therefore the probability of a successful catch, decreases, the willingness to pay decreases and an angler might switch to another lake. In zonal travel cost methods this would result in the angler's willingness to pay for the first lake to go to zero, even though they might still be willing to pay for the existence of the first lake. It is also difficult to take multi-purpose trips into account. For example, individuals might visit a recreational site as an intermediate stop while traveling elsewhere and would not have considered a visit otherwise.

One of the most difficult problems in travel cost methods, however, is how to value time, which is a very interesting field in itself. The value of time consists of two elements: the opportunity cost and the commodity value (DeSerpa 1971; Cesario 1976; Wilman 1980). While traveling, an individual cannot work and therefore their income is reduced. These are the opportunity costs of time. Sometimes, it is not possible to earn additional money in one's free time though – due to fixed hours for instance – and opportunity costs are given by other activities. This is why the opportunity costs of traveling time are assumed to be around 25 to 50% of the hourly wage (Cesario 1976; Radcliffe 1983; Smith et al. 1983; Englin and Shonkwiler 1995), although early literature suggested a one-to-one ratio. In addition to the opportunity cost of time, the time spent at a recreational site has utility, which is defined as the commodity value of time (Becker 1965; Wilman 1980; Bockstael and McConnell 1981). To appropriately measure the willingness to pay for traveling to a recreational site, both of these elements have to be taken into account (Chavas et al. 1989; Feather and Shaw W. Douglass 1999).

Finally, hypothetically defining the real choice sets of individuals is a challenge in itself. Consider, for instance, the following example: Due to information asymmetries a very abundant hunting spot might only be known to very few individuals, who thus might have a high willingness to pay for it. In most cases it is not feasible to look at each choice set individually – even though some authors (as e.g. Parsons et al. 1999) try to do so. Including this hunting spot into every hypothetical choice set would bias the results so that it would appear as if many hunters had a smaller willingness to pay for abundant wildlife. Conversely, if the hunting spot were known to everyone, the willingness to pay would probably be much lower. But just excluding this unknown hunting spot (Peters et al. 1995; Haab and Hicks 1997) or aggregating hunting spots (Kaoru and Smith 1990; Parsons and Needelman 1992; Kaoru et al. 1995; Lupi and Feather 1998) carries the risk of decreasing the explanatory power of the model as well. Additionally, choice sets typically evolve over time, which makes generalizations even more problematic. Hence, the magnitude of the bias is very dependent on the collective good and might be marginal for some.

Even though travel cost models have improved significantly in the last 20 years, there is still much research to be done. Modern travel cost methods can control for some of the above mentioned drawbacks and biases, but at the cost of simplifying other aspects (Morey et al. 1993; Ozuna and Gomez 1994; Phaneuf et al. 2000; Phaneuf and Smith 2005). This, however, does not mean that travel cost models are of no value. They are often drawn on in important policy decisions and frequently used to assess environmental damages by measuring willingness to pay for various collective goods (Freeman et al. 2014). We will not go into more detail at this point. A more extensive description of travel cost models can be found in Haab and McConnell (2002), Phaneuf and Smith (2005) and Freeman et al. (2014). Some more recent applications of travel cost models with respect to landscape and scenic beauty can be found in Amoako-Tuffour and Martínez-Espiñeira (2012), Bertram and Larondelle (2017), Hanauer and Reid (2017) and Voltaire et al. (2017).

3.2.2 Hedonic Pricing Method

With the travel cost method, it is of course only possible to measure the willingness to pay for a collective good that individuals travel to. One can, however, utilize real data to measure the willingness to pay for other collective goods. For example, one expects different rent prices for two properties, which only differ in e.g. noise levels with all else being equal. The difference can be used to measure the willingness to pay for a quieter environment, as they can be interpreted as the productive differences of these properties. This is what hedonic pricing methods aim to do (Ridker 1967; Ridker and Henning 1967; Garrod and Willis 1992; Nimon and Beghin 1999). A hedonic price function estimates the relation of the rent and multiple qualitative attributes of the property. Typically, these attributes are assumed to impact prices linearly or at least continuously.

However, as with all methods introduced so far, there are various potential biases when looking at the rental market, of which we list a few below: Firstly, usually the purchase price of a house on a given property is observed, instead of the annual rental price for the land itself. Therefore, the house price has to be interpreted as the discounted present value of the sum of all expected future rental values (Niskanen and Hanke 1977). Because houses are not sold very frequently, it becomes very difficult to measure dynamic changes of the level of collective goods over time. In addition to this, high transaction costs might also hinder individuals from moving to a new place when some attributes of their house deteriorate over time. This makes it tougher for researchers to capture the dynamic change of the collective good over time.

Another challenge is to account for the different house designs as these also influence the purchase price. Some of the attributes of houses (such as number of bedrooms) are discrete instead of continuous, which is why some authors implement discrete choice models (see e.g. Ellickson 1981; Lerman and Kern 1983; Cropper et al. 1993; Bayer et al. 2009; Tra 2010).

Secondly, some collective goods are highly correlated (e.g. tranquility and air quality both change in proximity to a busy street), which means that estimation methods have to either deal with multicollinearity or with an omitted variable bias (Perman et al. 2011).

Thirdly, it could also be that the housing market is more segmented than hedonic price models in their basic form predict (Straszheim 1974; Michaels and Smith 1990; Baudry and Maslianskaia-Pautrel 2016). This again could be due to high transaction costs of moving to another city or even another neighbourhood in a given city.

To tackle some of these biases, other methods aim to characterize the process of how a market equilibrium emerges instead of only focusing on the outcome of the market in equilibrium. An extensive introduction into these so-called sorting models can be found in Kuminoff et al. (2013). Some interesting applications are Epple and Sieg (1999), Klaiber and Phaneuf 2010 and Tra (2013).

As in the case of the travel cost method, this does not mean that the hedonic pricing method is not frequently used in the economic literature. Multiple studies measure the willingness to pay for tranquility (Dekkers and van der Straaten 2009; Chang and Kim 2013), air quality (Harrison and Rubinfeld 1978; Smith and Huang 1995; Chattopadhyay 1999) or scenic beauty (Tyrväinen 1997; Morancho 2003; Dahal et al. 2019) using hedonic price functions. But the validity and accuracy of their predictions is highly dependent on the collective good and the magnitude of the estimation biases.

4 Interim Conclusion

How to determine the willingness to pay for collective goods is a very broad and complex topic. We introduced two classes of methods: Revealed and stated willingness to pay methods. With both approaches one has to deal with certain biases of varying significance for different collective goods.

For revealed willingness to pay methods to work, it is important that an individual can actually select her preferred bundle of goods (Freeman et al. 2014), which is sometimes difficult – e.g. in the very competitive housing market. When not possible, results will not necessarily capture the willingness to pay for places, where an individual does not spend time or was not able to purchase a house, because only the actual choice is taken into account. Additionally, these methods only capture perceived differences of attributes. The individuals' choice sets might consist of other important attributes that on a market level are non-observable. Therefore, this method can only measure the minimum willingness to pay. Stated willingness to pay methods also have to deal with different biases – some substantial in size – that are mainly linked to the hypothetical nature of surveys. Thus, the best method of estimating the willingness to pay highly depends on the collective good, the circumstances of its provision, the role of non-use values and the availability of market data (Jagers et al. 2020). When choosing the best method, the collective goods and the theoretical willingness to pay have to be kept in mind, as we outlined in Chapter 2. This too is often forgotten in empirical approaches, which leads to bad study design (Carson 1997).

Another frequently overlooked point is that individuals' willingness to pay may differ quite significantly for some collective goods depending on the form of its provision. If the state or another entity can convince or force individuals to cooperate, the willingness to pay can actually increase, because it becomes more believable to an individual that the collective good can actually be improved or provided for. Without intervention, and therefore higher information asymmetries, the same individual might have no willingness to pay for the same collective good. Not taking this mechanism into account can skew the results of surveys substantially. This is the topic of the next two papers, which are co-written by the author and his colleague Felix Schlieszus. In Chapter 5, we introduce a model explaining the mechanism by which these differences in willingness to pay arise. Subsequently, in Chapter 6, we aim to measure these different willingness to pay empirically with an example from animal welfare.

5 Why Being a Frequent Flyer and an Environmental Activist is no Contradiction

5.1 Introduction

Environmental activist movements have raised the focus of media attention in recent years. Typically, these movements demand drastic changes of our present consumption patterns to improve public goods by, for example, reducing greenhouse gas emissions. One of these climate-intensive activities is flying, which is often criticized harshly. As a consequence one would expect especially those people, who are actively engaged, to reduce flights. However, the number of flights of the aforementioned group has been growing the fastest (ADV 2018). There are more examples of this kind to be found which, at first glance, seem to be contradictory behaviour. A study of the German Federal Environment agency suggests that members of the "critical-creative milieu" are prone to consuming resources at a level high above the average, and this is not compensated by buying food in organic grocery stores (Umweltbundesamt 2018). This is why some accuse environmental activists of hypocrisy, i.e. to not practice what they preach (Book 2019). But is frequent flying and being an environmental activist really hypocritical? In this paper we will argue the opposite.

The effect of one person restricting herself to a sustainable consumption is negligibly small for large public goods. Hence, just changing one's own behaviour will not improve the public good, e.g. the climate. Even though the environment may be important to an environmental activist, the individual's lower strain on the environment does not compensate for the loss of an individual's utility when flying less. Instead, free-riding is the rational choice even when having a high preference for the public good.

Following this argument, we do not expect rational individuals to spend money for improving a large public good individually. However, the increasing amount of individually compensated CO_2 emissions (Donofrio et al. 2021), provides evidence against this hypothesis. How can this behaviour be explained assuming that individuals know, that their impact on the public good is marginally small? Individuals might hope to motivate others to change their consumption patterns as well. But reciprocal behaviour of other individuals is very uncertain – especially for large public goods (Budescu et al. 1990; Rapoport and Suleiman 1993; Hine and Gifford 1996; Jagers et al. 2020). Instead, it can be explained by the individual's preference to for instance soothe one's conscience after a long-haul flight by compensating CO_2 emissions. These payments based on social incentives (e.g. conscience, reputation or morality) are linked to the willingness to pay for improving the public good, but they have to be viewed separately, because these payments do not increase the level of the public good.

Knowing that reciprocal behaviour is not feasible, the only way environmental activists can target the level of a public good is by implementing or increasing standards and rules on a societal level, for instance with the introduction of a carbon tax, which prohibits free-riding behaviour. Without state intervention, these environmental activists cannot achieve any significant change of the level of the public good. Therefore, they will not change their individual consumption pattern and still fly frequently. To show why environmental activists do not act hypocritically by flying frequently it is important to separate these two forms of willingness to pay. We achieve this by devising a simple model in this paper.

5.2 Willingness to Pay for Collective Goods

The willingness to pay for public goods has engaged economists since P. A. Samuelson (1954) and Olson (1971). Early literature suggests that, when a public good is provided for privately, individuals have the incentive to free-ride and therefore not participate in its provision (see P. A. Samuelson 1954; Olson 1971; Brubaker 1975; Sandler 1992). The currently accepted view is that one cannot make general statements on the willingness to pay for public goods, as it depends highly on the good and the framework of its provision (Dawes 1980; Fleishman 1988; Jagers et al. 2020).

Improving a public good is not the only reason why individuals would be willing to pay for it. For instance, an individual may not care about a public good at all, but for fear of social sanctions yet decides to contribute towards its provision. This individual would even cooperate in the case when her own contribution does not benefit the level of the public good, since she is motivated by social reasons only. In other words, the willingness to pay for improving a public good and the willingness to pay based on social sanctions might be linked, but they arise from different preferences. Despite this, most literature does not distinguish these two kinds of willingness to pay, even when social incentives are accounted for. In the following, we will separately discuss these two types of willingness to pay for public goods. We start with social incentives, which are the focus of our model presented later.

Social incentives

Willingness to pay based on social incentives is relatively well established in the economic literature (see e.g. Sen 1977; Udehn 1993; Moreh 1994). While there are many different kinds of social incentives, we will focus on reputation, altruism and social norms.

An individual might be willing to contribute to a public good in order to achieve some form of social benefit or avoid social sanctions – even if they are non-monetary. These reputational, external considerations potentially reduce free-riding in public goods games, as individuals would include reputational payoffs into their optimization strategy (Olson 1971; Kreps and Wilson 1982; Ostrom 1990; Bornstein et al. 1990; McCabe et al. 1996). This could, for instance, mean that consuming less of a good can be rational, when fearing social sanctions. This would imply in our example that environmental activists fly less.

Additionally, other social incentives, not linked to reactions of other individuals, potentially play a role. For example, an individual might act on the basis of altruism. The literature often describes altruistic persons as ones, who would participate in improving a public good, even when not directly benefiting from its improvement (see e.g. Margolis 1983; Taylor 1987; Guagnano et al. 1994). An altruist might for instance consider to consume less of an environmentally harmful good with the goal of increasing the welfare of another person, even if the altruist does not benefit directly and even if her own influence on the public good is negligibly small. I.e. in a situation, where it would be optimal to free-ride, an altruist might still contribute. So, altruism is considered to be the perceived obligation to cooperate in a public goods game, which is sometimes called “warm glow of giving” (see Andreoni 1990; Kahneman and Knetsch 1992). This means that even if large public goods are provided privately, i.e. without any state intervention, in the presence of altruists some level of the public good would still be provided.

Other internal social incentives may be based on social norms. Social norms are defined as a catalogue of generally accepted behaviour (see Elster 1985; Coleman 1986). Elster (1985) argues that social norms influence the willingness to pay in two ways: Firstly, some social norm (e.g. morality) may drive people to participate in the provision of a public good independently of the actions of others, if only it leads to an expected increase in overall welfare. Secondly, collective action can also arise through the norm of fairness. Contrary to morality, fairness might be conditional on the choices of other players (Elster 1989). An individual is only willing to cooperate, if enough other players do so as well (conditional cooperation). Once this threshold is reached, an individual considers the game to be fair and feels obliged to participate as well (Ostrom 2000).

Willingness to pay for public goods

The willingness to pay based on social incentives is independent on whether or not it improves the public good, as our discussion on social sanctions above shows. But there are situations when it is based on the preference for the public good itself as well. This happens when the public good can be provided by one person or reciprocity is feasible (i.e. cooperation is the dominant strategy). Reciprocal behaviour can increase the contribution of other players, which leads to a higher level of the public good (Axelrod 1984; Nowak and Sigmund 2005; Ule et al. 2009; Mani et al. 2013), though economic literature does not agree on whether it is dynamically stable (Andreoni 1995; Gale et al. 1995; Roth and Erev 1995; Palfrey and Prisbrey 1997).

A few factors can influence the probability of reciprocal cooperation, the most important of which is information. This is why Boyd and Richerson (1985), Güth (1995) and Börgers and Sarin (1997) argue that observable actions may increase cooperative behaviour, as individuals see how high cooperation actually is.[9] Cooperation can also arise in public good games where actions are hidden, but all players are allowed to communi-

[9]Conversely, more information can also decrease cooperation, if it exposes a high number of defectors (Güth 1995; Keser and van Winden 2000; Fischbacher and Gächter 2010).

cate (Frank et al. 1993; Sally 1995; Ostrom 1998). Then assurances based on trust can lead to collective action (Sen 1967; Shaw 1984; Sabia 1988).

The smaller the public good, the more feasible reciprocity is. Larger public goods are typically more costly to provide and correlated with larger groups of individuals, who are non-excludable from consumption. This decreases the marginal effect of an individual's contribution on the public good and decreases the probability of cooperation, even if the groups are heterogeneous and some players have a high willingness to pay for this public good (Esteban and Ray 2001; Pecorino and Temimi 2008).

So only if an individual believes that her own contribution has a high influence on the public good – which is the case when either the public good is very small or her influence on other individuals' contributions is high – cooperation is a stable outcome. Otherwise free-riding becomes optimal and the willingness to pay for the public good goes to zero. Note, however, there may still be some willingness to pay based on social incentives. Thus the sum of these two, the total willingness to pay, could nevertheless be non-zero. If individuals are not interested in improving the public good or reckon that their own contribution is marginal, they may still have a positive total willingness to pay for goods or services that supposedly improve the public good just to satisfy social incentives. Therefore, we propose to separately study these two kinds of willingness to pay and to consider the total willingness to pay for a public good as the sum of the two. This may also help to solve disputes in the economic literature on whether free-riding or cooperation is the dominant form of strategic action.

5.3 Model

5.3.1 Baseline Model

To keep our model as simple as possible, let us assume that an individual – in our case an environmental activist – can choose between consuming two goods x_1 (e.g. trees) and x_2 (e.g. flights) with a given budget restriction.[10] Additionally, this environmental activist is also concerned with the level of the environment e, which increases her utility

[10] x_2 can also be interpreted as the sum of all other consumption choices instead of flights.

with higher levels. Assume that good x_1 increases the level of the public good e, though insignificantly for a single individual. When planting trees (or paying someone to plant trees) the environmental activist receives some form of utility based on social incentives (e.g. conscience, social norms, reputation). x_2 negatively influences the level of the public good e. The utility is determined by the environmental activist's preferences α, β and γ for the level of the public good e, the social satisfaction derived from consuming x_1, and the consumption of x_2, respectively.[11] Assuming a Cobb-Douglas form, the utility function can then be written as

$$u(x_1, x_2) = e^{\alpha} x_1^{\beta} x_2^{\gamma} \tag{16}$$

In the next step, we have to specify the relation between x_1, x_2 and the public good e. Unlike for private goods, consumption of the public good e does not decrease its level (property of non-rivalry). We assume, that the level of the public good e in period t is dependent on its level in the previous period e_0 and the impact from all individuals $i = 1, 2, \cdots, n$, which we define as Δe_n. We assume that e can be written as

$$e = e_0 + \Delta e_n \tag{17}$$

The consumption of x_1 increases the environmental level e. x_2 has a negative impact on e.

If you consider large public goods, a single individual's consumption has either no or only a very small influence on the level of the public good, unless reciprocity plays a large role. Since cooperation based on reciprocity is unlikely for large public goods, we assume that the effect of an individual's consumption of good x_1 and x_2 on the environment e is negligibly small. A simple algebraic relationship between the consumption levels x_{1i}

[11] An individual could of course also gain utility by consuming x_1 besides social incentives and the consumption of x_2 could be negatively impacted by social incentives. To keep the model as simple as possible, we omit these extensions for now.

and x_{2i} of individuals $i = 1, 2, \cdots, n$ and the change in the environmental level Δe_n that satisfies the above assumptions is

$$\Delta e_n = \sum_{i=1}^{n} x_{1i}\theta_1 + x_{2i}\theta_2, \tag{18}$$

where θ_1 is the influence of one consumed unit of x_1 on e. We assume that θ_1 is positive, but so small that $x_{1i}\theta_1 \approx 0$ for each single $i = 1, 2, \cdots n$. The same is true for θ_2, which we assume to be negative. Hence within an individual's utility function we can consider Δe_n as an exogenous term, and therefore

$$u(x_1, x_2) = (e_0 + \Delta e_n)^{\alpha} x_1^{\beta} x_2^{\gamma} \tag{19}$$

We assume that each individual's budget constraint can be written as

$$m = p_1 x_1 + p_2 x_2, \tag{20}$$

where m is the budget and p_j the price of good x_j for $j = 1, 2$.

Deriving the optimal bundle of goods with respect to x_1 and x_2, by maximizing (19) with respect to (20) we obtain the demand functions

$$D_{x_1}(p_1) = \frac{\beta m}{p_1(\beta + \gamma)} \tag{21}$$

$$D_{x_2}(p_2) = \frac{\gamma m}{p_2(\beta + \gamma)} \tag{22}$$

The resulting demand functions are identical to the ones of the standard Cobb-Douglas utility functions. It is important to note that the willingness to pay for x_1 and x_2 is independent of the preference α for the public good. Neither does the initial level of the environment e_0 nor the consumption of others, summarized in the Δe_n term, influence the individual willingness to pay for x_1 or x_2.

Assuming that this model describes the rational calculus of individuals with respect to large public goods in reality, we can derive the following: An individual, who is not interested in improving the public good or understands that their own contribution is marginal, still exhibits a positive willingness to pay for the public good due to social incentives, even if their contribution need not actually impact the public good. Environmental activists hence contribute an optimal amount that e.g. silences their conscience. By being environmentally active they still try to increase the level of the environmental good. This is possible for instance, if the preference for social incentives β of all other individuals increased as well. So, one strategy could be to appeal to the conscience of all other individuals, which will be less feasible with larger public goods.

Our model explains multiple seemingly irrational decisions to pay for public goods. For instance, Desvousges et al. (1992) and Kahneman and Knetsch (1992) come to the conclusion that the willingness to pay for the rescue of birds seems to be independent of the number of birds actually rescued. This appears to be hypocritical at first glance. If people really care for the birds' welfare (public good), their willingness to pay should increase with the number of birds which can be rescued. But as the above model shows, it can be utility maximizing, and therefore rational, to just spend a specific amount of money on goods that supposedly improve the public good as the amount spent is not directly linked to the improvement of the public good but to any kind of social incentives.

The sum of all consumption choices of x_1 and x_2 influences the level of the public good. Knowing that one own's contribution does not influence the public good, this does not mean, that an environmental activist acts hypocritically, if she flies frequently. Therefore, flying frequently and being environmentally active is not a contradiction. On this individual level, the resulting change of the public good is only a non-intentional consequence of fulfilling social incentives, hence a positive externality. Furthermore, this does not imply that the public good cannot be influenced through other channels (e.g. via increasing all other individuals' β).

5.3.2 Quasi-Monarch Model

In our baseline model, an environmental activist can only marginally influence the level of the public good. However, the sum of all marginal contributions can add up to have a significant impact on the level of the public good, even if the impact of the single individual is negligibly small. The only way of influencing the contributions of all individuals – since we assume that reciprocity is not feasible – is to force a change in consumption patterns.

This is where the state can step in. By collecting taxes from its citizens, it can provide the public good, solve the coordination problem and force reciprocal behaviour. This shows how demanding the intervention of a public entity, while (apart from social incentives) individually defecting to raise the level of the public good remains the dominant strategy of an environmental activist.

To include this public enforcement mechanism into our framework, we add a direct per capita state consumption x_{1S} of good x_1 to our model. As it is financed through taxes, both the utility function and budget constraint need to be adjusted. Unlike individual consumption, the state consumption has a significant positive impact on the public good. In fact, its level is of the same order of magnitude as the total consumption of all individuals in our baseline model, as it is determined by the number of people in the state n and the desired level of per capita state consumption x_{1S}. We take the impact of one unit of x_{1S} on the public good to be identical to the impact of x_1 in the baseline model, which is θ_1. For simplicity, we assume that the state collects the same amount of taxes from all individuals. Therefore the more tax-paying individuals the higher the impact, or equivalently, the lower the per capita cost. Hence, the resulting level of the environmental good e equals

$$e = e_0 + \Delta e_n + n x_{1S} \theta_1 \tag{23}$$

and the utility function of an individual becomes

$$u(x_1, x_2) = (e_0 + \Delta e_n + n x_{1S} \theta_1)^{\alpha} x_1^{\beta} x_2^{\gamma}. \tag{24}$$

In comparison to the budget constraint of the baseline model, individuals have to in addition pay for the state consumption of x_{1S} in form of a lump-sum tax. Therefore,

$$m = p_1(x_1 + x_{1S}) + p_2 x_2 \tag{25}$$

In reality $p_1 x_{1S}$ is exogenous and should be thought of as decreasing an individual's budget m. To uncover the willingness to pay for the improvement of the public good, one could let an individual decide the level of state consumption, and hence tax contribution, for everyone including herself. As the effect of state consumption is substantial and everyone has to pay the chosen tax, nothing stops the individual from stating their true willingness to pay. We call this hypothetical construct the *Quasi-Monarch*.

Hence, we only need to solve the constrained optimization problem (given by equations 24 and 25) for an individual in order to derive the demand functions for x_1, x_2 and x_{1S}. A straightforward computation yields

$$D_{x_1}(p_1) = \frac{\beta(mn\theta_1 + p_1(e_0 + \Delta e_n))}{np_1\theta_1(\alpha+\beta+\gamma)} \tag{26}$$

$$D_{x_2}(p_2) = \frac{\gamma(mn\theta_1 + p_1(e_0 + \Delta e_n))}{np_1\theta_1(\alpha+\beta+\gamma)} \tag{27}$$

$$D_{x_{1S}}(p_1) = \frac{\alpha mn\theta_1 - p_1(e_0 + \Delta e_n)(\beta+\gamma)}{np_1\theta_1(\alpha+\beta+\gamma)} \tag{28}$$

The above demand functions are in line with our intuition and consistent with previous results. It is important to note that the willingness to pay for x_1 and x_2 decreases with larger n. Note, however, that per capita state consumption x_{1S} increases with n, as $\frac{\partial D_{x_{1S}}}{\partial n} > 0$. When optimizing, one unit x_{1S} has a higher total impact on the level of the public good – as it is multiplied by n.

Without state intervention, an individual can only increase her utility by consuming x_1 and x_2. Her own consumption (e.g. frequently flying) individually has a negligible effect on the public good. But the state can control the level of the public good by demanding everyone to contribute x_{1S}. Then the environmental activist would reduce her consumption of x_2, e.g. by flying less frequently, and reduce x_1 to maximize her utility. This shows that being an environmental activist and flying frequently is by no means contradictory or even hypocritical. An environmental activist demands a higher x_{1S} and will only start reducing her flights once a public entity intervenes and ensures her impact is not marginal anymore. Hence, the same individual makes different choices depending on the "rules of the game". The environmental activist aims to change these rules such that "choices within rules" improve the public good.

Without public intervention the level of the environmental good depends on the preference β for social incentives. If β is relatively high, a high level of the environmental good will be sustained, though not due to the utility derived from the enjoyment of the environmental good itself. Instead individuals consume x_1 based on their preference for social incentives, which in sum leads to a high level of the environmental good. Vice versa, for a low β the environmental good e remains on a relatively low level, even when the preference α for the environmental good e is high. If the state intervenes, the level of e compared to the situation with no public provision depends on the preferences α and β.

Splitting up the willingness to pay for a public good in two parts is crucial for making policy decisions. Naturally, public entities have to provide multiple public goods, but their resources are limited, as the state cannot or does not want to collect more than a certain amount of tax. Hence, the question arises in which public goods a policy maker should invest.[12] Private versus public provision leads to different levels of a public good, depending on the preferences of individuals, as we showed in our framework above. Public entities could base their resource allocation decisions on the differences between these levels. If individuals have a relatively high preference for social incentives, they, in

[12] There is a large literature on the optimal provision of public goods (see e.g. P. A. Samuelson 1954; Olson 1971; Varian 1993; Anomaly 2015).

sum, already provide a relatively high level of the public good, and less state intervention is needed.

5.3.3 Extensions

We have so far made many simplifying assumptions, as is often the case in economic modeling.[13] For example, one can include a negative effect of x_2 on social incentives. This decreases the willingness to pay for x_2, while increasing it for x_1 (and x_{1S} in the Quasi-Monarch model). Many other extensions are feasible without changing the qualitative results presented in this paper so far. There exist some exceptions though.

Social incentives and the level of the public good

One could argue that social incentives depend on the level of the public good. For instance, an increasing level of the environmental good e may reduce the social reward an individual earns for consuming x_1, which in turn shifts consumption towards x_2 and x_{1S}. Assume we extend the baseline to capture such an effect. Would the level of e at optimum be larger or lower than for the Quasi-Monarch model described in Section 5.3.2? At first one might expect the level of e to be larger as the consumption of x_{1S} increases. However, since all individuals lower their consumption of x_1, the change Δe_n is substantial, and in fact larger than the preceding increase in e. Therefore, the environmental level e is actually lower than for the Quasi-Monarch model due to the stronger crowding-out effect.

Impact of state consumption on social incentives

We have assumed, that only private consumption has an impact on the utility based on the preference for social incentives β. However, we can easily imagine the case that higher state consumption x_{1S} is positively linked to internal motivations – e.g. soothes an individual's conscience as well. The optimal consumption of x_1 and x_2 would then decrease, while x_{1S} increases. With an increasing marginal utility of x_{1S}, the level of the public good e increases as well.

[13]The mathematical proofs of the following results can be made available on request.

Overestimation of own impact

We argued that individual consumption choices, when considering large public goods, have a negligibly small impact on the level of the public good. Therefore, we assumed it to be zero. However, this is not true for smaller public goods or if people overestimate their individual impact on the public good. This can be caused by information asymmetries or the hope of reciprocity. The own consumption of x_1 could influence other individuals, so that they increase their consumption of x_1 as well. As a result, the willingness to pay for x_1 increases as its marginal utility increases. Therefore, x_{1S} decreases as it will be (partly) substituted by x_1. Finally, e increases in the model without state intervention, whereas it remains constant in the Quasi-Monarch model, if we assume homogeneous individuals. However, due to the overestimation of the own impact, the utility of an individual decreases in both cases, as the impact of the individual consumption on e isn't as large as expected.

5.4 Conclusion

In this paper we argued that frequent flying environmental activists do not suffer from hypocrisy, if they only demand the state to intervene but don't change their consumption choices on an individual level in the same manner. Despite a high preference for a public environmental good, it is optimal to free-ride, as individual consumption choices do not influence its level and hence their impact is marginal. Only the sum of all individuals' behaviour can alter the level of the good, but due to the lack of reciprocity this does not factor into decision-making. Nevertheless some level of the environmental good is sustained, but only due to social incentives linked to the public good rather than the public good itself.

Environmental activists, however, will demand the state to intervene, as they understand that collective action is needed. To squash free-riding the state can force every individual to contribute towards the public good by for instance levying a tax. We suggested the following method to determine the individual willingness to pay for the tax:

Treat one individual as Quasi-Monarch, who can set a level of state consumption for everyone including themselves, which resolves the free-riding incentive.

By considering the environmental activist as an example, we argued that the total willingness to pay for a public good is based on the utility derived from the public good itself and the associated social incentives. This split is important for making policy decisions. Politicians need to understand both the social incentives and the preference for the public good of their electorate in order to determine the optimal level of state provision of the public good. Studying interactions between preferences is important to prevent over or under supplying the public good due to crowding-out or -in effects. How to empirically measure these two types of willingness to pay needs to be subject of further research.

6 How to (not) Measure the Willingness to Pay for Public Goods

In the following paper, the author and his colleague Felix Schlieszus further explore the suitability of stated willingness to pay approaches to measure the individual and the Quasi-Monarch willingness to pay introduced above.

6.1 Introduction

From a theoretical point of view, autonomous and independent purchase decisions of individuals lead to the maximisation of their utilities when private goods are concerned. However, this is not the case for public goods, where individual purchase decisions only have a marginal impact on the level of the public good which potentially leads to free-riding behaviour. The larger the public good, the higher the incentive to not participate in providing it. Therefore, intervention of some (public) entity is necessary. This (public) entity needs to be aware of how important a certain public good is for the individuals, in order to provide the optimal level of the public good. For this, it regularly relies on opinion studies and surveys of polling institutes.

One of these public goods in question which is publicly discussed frequently is for instance animal welfare. Typical questions like "How important is animal welfare to you?" are misleading though, as they don't take any form of opportunity cost into account. Instead, polling institutes should rather focus on the willingness to pay. The willingness to pay for a good shows exactly, how much an individual is willing (and able) to pay for a certain good, which simultaneously implies a reduction in budget, hence, giving up the consumption of other goods.

However, measuring the willingness to pay is not straightforward for public goods. In Chapter 5, we have argued in a theoretical model that "the" willingness to pay for a public good must be divided into two parts. One part is caused by social incentives, which are not part of the preference for the public good itself, but occur by measuring the willingness to pay on an individual level. The other part is the "true" willingness to pay for the public good and can only be measured, if the individual has an impact on its provision.

In this paper, we aim to measure exactly these two willingness to pay for the public good using the example of animal welfare. Animal welfare is receiving more and more attention in German politics and German society in general. For instance, the German government is going to prohibit the killing of male chicks in laying hen breeding from 2022 onwards (Bundesministerium für Ernährung und Landwirtschaft 2021). Instead, the gender of the chick has to be determined inside the egg or male chicks must be raised as well. We will use eggs and especially the killing of male chicks as an instrument for measuring the willingness to pay for animal welfare. As this property is not related to other criteria which potentially could have an influence on the willingness to pay for eggs, like taste (Bray and Ankeny 2017; Güney and Giraldo 2020) or health (Pettersson et al. 2016; Bray and Ankeny 2017), this instrument is appropriate.

Animal welfare also seems to be a good example to explain the difference of the two kinds of willingness to pay. In Germany for instance, even though organic food is increasing in popularity, its market share is still relatively low. In 2020, organic fresh eggs had the highest organic share of food products in the basket of goods of German households with "only" 15,4% according to Bund Ökologische Lebensmittelwirtschaft (2021). For all other products, the organic share was even smaller. On the other hand, some studies suggest, that the majority of Germans would support increasing animal welfare levels, if they were enforced on a public level (Bundesministerium für Ernährung und Landwirtschaft 2019; Sorg et al. 2021). This gap seems to be exactly what can be explained by the two types of willingness to pay we distinguish in our model.

In the survey presented in this chapter, we aim to determine these respective levels of and the difference between these willingness to pay by using the example of eggs. Knowing these willingness to pay and their interdependencies should give a sophisticated foundation for policy implications regarding governmental intervention.

6.2 Methodology

6.2.1 Stated Willingness to Pay Approaches

In Chapter 5, we proposed, that the total willingness to pay for a public good – in this paper animal welfare – must be divided into two components as introduced above. The total willingness to pay in the case of private provision will only be based on individual preferences like social incentives or taste, if reciprocity does not play a role. In the case of public provision, the willingness to pay will additionally be based on the willingness to pay for increasing animal welfare. In our model, we introduced an approach with which this willingness to pay for increasing animal welfare can potentially be measured: The Quasi-Monarch. As a Quasi-Monarch, an individual can determine the level of contribution of every individual including herself. Therefore, this individual has no incentive to not state her "real" willingness to pay, because her impact is not marginal anymore. Following this model, we would have to determine the difference in total willingness to pay of these two scenarios: One, where every individual contributes on her own and one, where she has the possibility of forcing everyone to participate in improving the level of the public good.

For measuring these willingness to pay, there are multiple methods available depending on whether the willingness to pay for the respective public good can be measured directly and whether there is real data of market transactions available. To be able to use this real data to determine the willingness to pay for animal welfare, one would need to fluctuate market prices on an extensive level and in a controlled environment, which is often not feasible. Therefore, economic literature uses stated willingness to pay approaches to determine the individual willingness to pay indirectly. One of them is the previously discussed contingent valuation, where participants have to either state their willingness to pay directly (open-ended question) or have to confirm binarily, whether they would be willing to pay a specific amount for a given product. Contingent valuation suffers from multiple biases though. The settings are for instance hypothetical in nature (hypothetical bias), focus on one specific aspect, that participants might not have thought of beforehand (prominence bias) or suffer from biased strategic answers, if participants see through the survey design. A more complete list of potential biases can be found in Perman et al. (2011) and Freeman et al. (2014).

Another possibility would be to use choice experiments which are broadly based on Lancaster (1966). Choice experiments are said to have multiple advantages over CV studies making them popular in economic literature (Adamowicz et al. 1998; Hanley et al. 1998; Freeman et al. 2014). It is for instance easier to include multiple different attributes into choice sets, which is why they have been highly used in market research (Louviere and Woodworth 1983; Adamowicz et al. 1998; Hanley et al. 1998). By using a choice experiment, we would be able to include preferences for, in our example, the amount of eggs, the farming method or whether the killing of male chicks is permitted in only one study. This hypothetical multi-attribute setting is typically also better suited to model real scenarios, which leads to a smaller influence of biases.

But there are also disadvantages of choice experiments compared to CV studies. Choice experiments are typically harder to process cognitively (Adamowicz et al. 1998; Perman et al. 2011). Respondents might only focus on some aspects of the question without considering all options or they might focus on certain labels to make the choice easier. And while some biases might be weakened in choice experiments, multiple other biases – most importantly the hypothetical bias – still have to be taken into account.

Keeping these limitations in mind, we tried to measure the two willingness to pay separately. For each of them, we aimed to choose a hypothetical scenario that is similar to the one that individuals would face in reality. The individual willingness to pay will be revealed in a purchase scenario in a supermarket. The most similar indirect stated preference method would be a choice experiment. The Quasi-Monarch setting on the other hand will typically be presented in the form of a referendum, where individuals can choose whether they agree with a proposition or not. This is why we opted for a CV approach in the second step. We will go through both approaches separately.

6.2.2 Individual Willingness to Pay

The most widespread choice experiment in market research for modelling individual purchase situations is the choice-based conjoint analysis (CBC) (Ku et al. 2017; Voleti et al. 2017). In a CBC, respondents typically choose the preferred alternative out of fixed or random choice sets, which are lists of a manageable amount of alternative products. They may also choose the "None" option, if no product is to their liking. Based on these choices, researchers determine utilities of different attributes of these products to ultimately estimate the willingness to pay for these respective attributes (Andrews et al. 2002; Evgeniou et al. 2007; Sonnier et al. 2007; Otter 2019). This offers the advantage of being able to focus on the willingness to pay for each attribute considered, while setting an indirect scenario that is closer to a real purchase process.

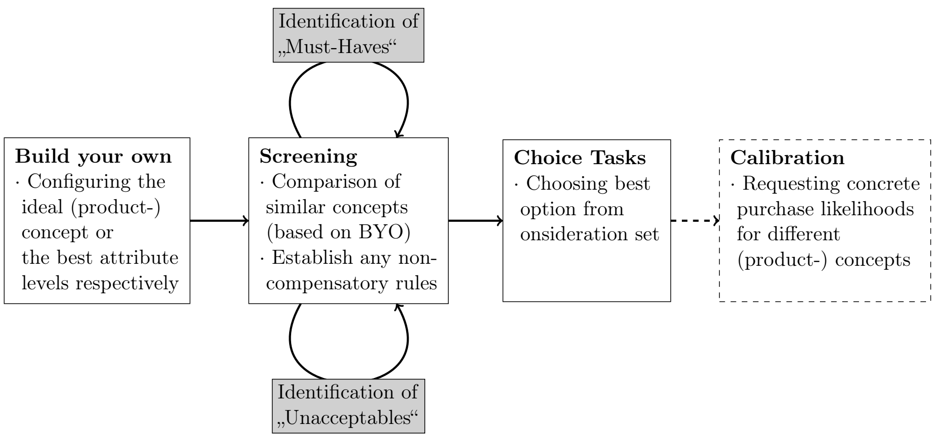
But basic CBCs suffer from multiple disadvantages as well (Brand and Baier 2020). Firstly, it is only possible to include a certain amount of attributes without overstraining participants (Meyerding and Merz 2018; Scherer et al. 2018; Brand and Rausch 2021). Some CBC studies are considered to be boring and monotonous, because respondents answer the same question (type) multiple times (Lines and Denstadli 2004; Bauer et al. 2015). This can partly be explained by respondents facing products, that might not be relevant to them, which are nevertheless fixed in the choice sets (Garver et al. 2012). The monotony might therefore lead to a simplification of the choice process, leading to rash decisions, where some attributes of the products might not be considered appropriately (Gilbride and Allenby 2004; Yee et al. 2007; Ryan et al. 2009; Scholz et al. 2010). In multiple studies respondents also suffer from extreme response behaviour, where they either do not select the "None" option enough (Sonnier et al. 2007; Natter et al. 2008; Parker and Schrift 2011) or choose it very extensively (Gilbride et al. 2008; Steiner and Meißner 2018). One problem with choosing the "None" option is, that it does not offer any information of whether the price of the presented products was just too high or whether the products were completely unacceptable for the respondents (Kamakura et al. 2001; Gunasti and Ross 2009; Gensler et al. 2012).

To tackle these biases, the marketing literature sometimes uses different modified versions of CBC, one of which is called adaptive choice based conjoint (ACBC) (Boesch and Weber 2012; Jervis et al. 2012; Heinzle et al. 2013; Hinnen et al. 2017; Brand and Rausch 2021). An ACBC is (ideally) structured in four stages (Johnson and Orme 2007; Sawtooth Software 2014):

- In the first stage called Build-Your-Own (BYO), respondents build their ideal product while having all possible attributes available. For each considered product, respondents are always confronted with the corresponding summed market price.
- Then respondents have to answer whether they can imagine purchasing different products for given prices in the Screening Section. Respondents can binarily identify products as “A possibility” or “Not a possibility”.
- In the third stage, respondents have to choose their most preferred option out of a specific number of concepts (product and price combinations). In most studies, three or four concepts are presented (Sawtooth Software 2014). It is also important to note, that there exists no “None” option in ACBC studies as the program should only consider products that are not excluded in the Screening Section.
- Finally, respondents are confronted with single concepts and have to choose how likely they are to purchase the respective products for a given price (typically on a 5-point Likert scale). This final stage is called Calibration Section.

To better illustrate the setting the following Figure 5 gives an overview of the four stages:

Figure 5: ACBC Survey Flow



Source: Brand and Baier (2020)

Compared to the standard CBC approach, several advantages of using ACBC methods exist. For example, ACBC surveys adapt the response behaviour of participants. Respondents that systematically do not choose concepts with certain attributes will not be confronted with these attributes further. Therefore, it is possible to capture more information at the individual level while screening a wide variety of product concepts (Sawtooth Software 2014; Gamel et al. 2016; Salm et al. 2016). The screening section, where respondents binarily decide whether they would possibly buy a product, is in line with the strand of literature which argues that respondents utilize non-compensatory decision heuristics (Gilbride and Allenby 2004; Ryan et al. 2009). This means that respondents apply "cut-off rules" (minimum requirements, must-haves, unacceptables, etc.) when choosing possible concepts instead of compensating disliked attributes with liked attributes.

In ACBC settings, prices can fluctuate around a defined base price per concept instead of having to set fixed prices as in a CBC analysis. Respondents choosing a concept with a certain price will later on be confronted with the same concept but a higher price. This summed price approach is superior in handling extreme response behaviour as it applies price intervals (Schlereth and Skiera 2009; Wlömert and Eggers 2016; Schlereth and Skiera 2017). Additionally, while taking longer to answer, ACBC surveys are said to be more engaging and interesting to answer due to their varied design (Sawtooth Software 2014; Brand and Baier 2020). Therefore, ACBC surveys are considered to deliver more precise results (Johnson and Orme 2007; Chapman et al. 2009; Cunningham et al. 2010; Sawtooth Software 2014; Bauer et al. 2015; Wackershauser et al. 2018). With these theoretical advantages in mind, we conducted an ACBC study to determine the individual willingness to pay for different attributes of eggs.

In our survey, after answering some introductory questions, participants had to go through the stages: BYO, Screening, six choice tasks and six calibration questions. The number of choice tasks and calibration questions were based on the recommendations of Sawtooth Software (2021). In order to decide, which attributes to include, we based our decision on past research focusing on consumers' willingness to pay for eggs. A good overview can be found in Rondoni et al. (2020) who present the results of 34 studies in their meta-study. They conclude, that

- socio-cultural (e.g. income, attitude or education) (Andersen 2011; Norwood and Lusk 2011a, Yang 2018),
- extrinsic (e.g. origin, production or sustainability) product characteristics (Norwood and Lusk 2011b; Pettersson et al. 2016; Ochs et al. 2019),
- intrinsic (e.g. nutrient properties) product characteristics (Ahmad Hanis et al. 2013; Pettersson et al. 2016; Bray and Ankeny 2017)
- and psychological factors (lack of knowledge or health-related beliefs) (Ayim-Akonor and Akonor 2014; Pelletier 2017; Sass et al. 2018)

seem to be the most important attributes. According to Mesías et al. (2011), Ahmad Hanis et al. (2013) and Baba et al. (2017), a larger egg size is preferred in most countries for various reasons. Egg shell colour seems to be important in some countries as well (Chang et al. 2010; Heng et al. 2013; Pelletier 2017). To concentrate on the main attributes relevant for our research question, we avoided these attributes by showing closed cartons of eggs. Instead, we focused on:

- Size of the egg carton (6 or 10 eggs)
- Husbandry system (organic, free-range or barn)
- Male chick killing (Yes or No)

Choosing more attributes (e.g. regionality, egg shell colour or egg size) would have prolonged the survey significantly and has the caveat, that respondents typically only focus on a few attributes in surveys anyways, which they might not do in a real purchase situation. Regionality, which is also a very relevant attribute according to Lopez-Galan et al. (2013) and Gracia et al. (2014), is difficult to believably implement without too extensive explanations. This leaves too much scope for interpretation as the underlying preferences are hard to identify. Therefore, we omitted all other attributes for simplicity purposes or told the respondents that all eggs have certain attributes (in our case: Size L).

To keep the ACBC as close to a real purchase in a grocery store as possible, the input was represented as a picture of an egg carton, that could be found in any grocery store in Germany. Different examples can be found below:

Figure 6: Design of Egg Cartons

The design of the egg cartons was very similar, so it would not bias the respondents' answers. Additionally, respondents were presented with a price that fluctuated 50% around the regular price of these egg cartons in a German discounter. This fluctuation should lead to enough variance in order to predict the willingness to pay for eggs and animal welfare on an individual level.

6.2.3 The Quasi-Monarch

To compare these individual results to the Quasi-Monarch[14] willingness to pay for animal welfare, we implemented a referendum setting. As already stated, we mainly chose the example of eggs because of the possibility of using the killing of male chicks as an instrument. Generally, one would consider the husbandry system to be the most relevant attribute with respect to the preference for animal welfare. But husbandry systems might also be correlated with other preferences. It is for instance stated that organic eggs taste better (Bray and Ankeny 2017; Güney and Giraldo 2020) and are more healthy (Pettersson et al. 2016 and Bray and Ankeny 2017). Responses in our survey in which we controlled for this correlation supported this view strongly. However, the killing of male

[14] One person determines the amount of money, everyone has to pay to improve animal welfare.

chicks has no individual utility apart from social incentives and can therefore be directly used to measure the willingness to pay for animal welfare.

To implement our referendum setting, we designed a two stage approach, being inspired by the literature with respect to referendums (Mitchell and Carson 1989; Arrow et al. 1993; Hanemann 1994; Schläpfer et al. 2004; Schläpfer and Hanley 2006). Individuals were presented with one of four forms of a referendum. In all of these hypothetical scenarios, respondents were told that the state is thinking about introducing a minimum standard with respect to male chick killing or the husbandry system. Here, we would be interested in the minimum price for a carton of 10 eggs until which respondents would approve a referendum. As respondents had problems with directly answering an open-ended question on how high their maximum willingness to pay was in the pre-test, we introduced the question with a binary choice beforehand. We stated that there would be no eggs available for a smaller than the given price. Respondents only had to choose whether they would sign the referendum for this given price or not. We additionally randomized the given price to reduce the starting point bias inherent with these types of questions (Carson et al. 2003). To avoid social behaviour – for instance thoughts of how other individuals would be affected by the stated price – we told respondents to only focus on themselves. Afterwards, we posed the question which we are really interested in by asking respondents in an open-ended question until which price for a carton of 10 eggs they would be willing to support the referendum. This is the Quasi-Monarch willingness to pay. It was of course always possible to just disagree with the referendum entirely.

All respondents were confronted with two types of referendums, hence, four questions in total. In the first stage, respondents were randomly assigned to the following referendums:

- The minimum husbandry system is set to free-range (25% of the respondents).
- The minimum husbandry system is set to organic (25% of the respondents).
- Male chick killing is prohibited, but no minimum husbandry system is set (50% of the respondents).

In the second stage, we only constructed two groups. Half of the respondents, who had to answer the male chick killing setting, and all of the respondents from the free-range setting were asked their maximum willingness to pay for a minimum standard of free-range combined with a prohibition of male chick killing. All other respondents were confronted with the same referendum but with organic as the minimum husbandry system combined with a prohibition of male chick killing. By introducing these differing settings, we controlled for varying preferences for referendums as respondents considered the same referendum to not be far-reaching enough or too extensive to agree with them in our pre-tests.

Having acquired these two different forms of willingness to pay, we aimed to compare the individual willingness to pay without any referendums to the willingness to pay in the referendum. For a higher willingness to pay in the referendum, the difference can be assumed to be the willingness to pay for the public good animal welfare. But as the title of this chapter already suggests, we came upon some problems when measuring the willingness to pay, which are mostly associated with the ACBC method.

6.3 Data, Results and Challenges

Our survey was conducted by inviting respondents from the SoSci-Panel to participate in our questionnaire, which we implemented via Lighthouse Studio by Sawtooth Software. This led to 988 (96 of them incomplete) original responses of which we filter out the ones with illogical response patterns. Respondents are for instance dropped, if they agree with a certain referendum in the first stage and then state a smaller willingness to pay as the already agreed upon minimum price in the first binary question. This leads to 661 remaining responses.

With this data we aim to analyze the willingness to pay for the collective good animal welfare and its components. In order to do so it is necessary:

- That the ACBC produces a reliable willingness to pay on average and for each individual.

- That participants understand animal welfare to be a public (and not a private) good. This would lead to a different willingness to pay caused by the preference of animal welfare in the individual compared to the referendum case.
- That respondents see a benefit of public compared to private provision. Only then would they differentiate their willingness to pay.

In the following we will argue that none of these conditions are fulfilled in our survey.

6.3.1 Estimating Individual Willingness to Pay with an ACBC

We estimated the individual willingness to pay, by applying a Hierarchical Bayes (HB) estimation on the data gathered by the ACBC questions in our survey. This leads to the most solid results according to Rossi and Allenby (1993), Arora and Huber (2001), Rossi et al. (2005) and Otter (2019) as it utilizes answers of other respondents in an iterative process in order to determine individual-level partworth utilities. This means that each level of an attribute gets assigned a certain utility, which is zero-centered (the sum of the utilities of all levels of one attribute equals zero). So, the different part-worth utilities represent the importance of the respective levels of the attributes. To calculate these utilities as precise as possible, we ran 100.000 iterations (50.000 burn-in iterations) and included Otter's task-specific scale factor analysis (Allenby et al. 2005; Otter 2007; Sawtooth Software 2014; Otter 2019) with which differing error levels can be taken into account. Increasing the burn-in iterations further had close to no impact on the resulting utilities.

The validity of ACBC studies is typically evaluated by different quality criteria. The root likelihood of our model, a parameter which can take values between 1 and 1 divided by the number of concepts per choice task (in our case 1/3), is estimated to be 0.742. This can be interpreted as a high internal consistency (Kalwani et al. 1994; Chrzan and Halversen 2020). Our pseudo R-Squared of 0.606 is said to speak for a high explanatory power as well (McFadden 1973; McFadden 1979).

We also included four different holdout tasks – standard conjoint questions with three concepts that are not used to evaluate the participants' utilities. With these, the validity of the estimates can be checked even further by analyzing whether the respondents' choice was also predicted by our model. Comparing the actual choices and the predicted choice of our HB estimation, we are able to determine around 82.6% of the respondents' choices correctly with our model (first choice hit-rate (FCHR)), which is said to speak for a relatively precise estimate (Huber et al. 1993; Moore et al. 1998; Scholl et al. 2005; Wlömert and Eggers 2016). The mean absolute error (MAE) is also often used for verifying the validity of the estimates. Here, the means of the absolute differences between the actual shares of the concepts in the holdout task are compared to the predicted shares of the model. Our MAE is at 5.25%, which is similar to the ones in the studies mentioned above. In other words: According to the literature cited, our model should be relatively well-fitting.

As we are interested in the individual willingness to pay of each single respondent to be able to compare it to the willingness to pay in the referendum case, we have to calculate the former first. There are several methods of how to estimate willingness to pay in ACBCs. Following Kohli and Mahajan (1991), Jedidi and Zhang (2002), Miller et al. (2011) and Papies et al. (2011), it is possible to compare the total utility of a product $u_{i|-p}$ of individual i without the price p plus the utility of a given price $v_i(p)$ to the utility of an estimated "None" variable u_i^*, which represents the utility of not buying a good. This estimation is necessary as there doesn't exist a real "None" response in ACBC settings. In mathematical terms:

$$u_{it|-p} + v_i(p) \geq u_i^* \tag{29}$$

The willingness to pay for this product is at the point, where:

$$v_i(p) \geq u_i^* - u_{i|-p} \tag{30}$$

To estimate the utilities of the different prices, we apply a piecewise linear approach including five breakpoints in our price range from [0.49;4.89]. The willingness to pay is exactly at the minimum $v_i(p)$, for which (30) still holds. Using the inverse of $v_i(p)$, the willingness to pay can be formulated as (Miller et al. 2011):

$$WTP = v_i^{-1}(u_i^* - u_{i|-p}) \tag{31}$$

There are two problems with this calculation. First it is very dependent on the utility of the "None" variable. This "None" variable u_i^* is estimated through the respondents' answers in the calibrations tasks, the fourth stage of an ACBC. In these calibration tasks, respondents are asked how likely it is that they would buy a single concept, with which they are confronted. In our case, they could communicate their decision on a 5-point Likert scale. u_i^* is then calculated by assuming which value on that 5-point Likert scale will actually lead to a purchase. Assuming a threshold value of 4 means that only answers between "likely" and "very likely" will be considered as a purchase decision.

The effect of different "None" thresholds on the resulting willingness to pay is quite significant. Or in other words: The resulting willingness to pay is very sensitive to small changes in the "None" variable. Let's consider "None" thresholds between 3 and 3.75 in our example. For an organic carton of 10 eggs without chick killing, the resulting different u_i^* lead to a willingness to pay of 4.12 Euro (threshold 3) and -5.2 Euro (threshold 3.75) when looking at the average. Participants only have a positive average willingness to pay up to a threshold of 3.4 for the respective egg carton. For the same thresholds, the willingness to pay for other products – especially the ones with lower utilities – is even more inconsistent due to the high difference in "None" values, even when for instance excluding the outliers.

We have to conclude, that estimating the willingness to pay of each single individual this way, is not feasible, as there does not exist a reference willingness to pay for eggs with which we could compare our data in order to specify the range of the threshold value. Even if we had reference points (for instance an average willingness to pay), it would be impossible to tell how this translates into the different individual willingness to pay. It can only follow, that the willingness to pay acquired by using formulas (29) to (31) is highly unreliable, if not just a random number, as the influence of the "None" variable is too severe while not being backed with any data. Still, lots of studies estimate willingness to pay in this manner with a comparable magnitude of utilities (see e.g. Jedidi and Zhang 2002; Miller et al. 2011; Papies et al. 2011; Wlömert and Eggers 2016). So, this is not an unique problem of our estimation. It may be that the average of our individual willingness to pay results in a realistic number for a few (but never all) concepts.

But there exist other methods with which it is possible to at least estimate the average willingness to pay. Orme (2001 and 2021) argues that the calculation introduced above estimates the willingness to pay as if there was no other alternative on the market. Therefore, the results must be imprecise. He proposes market simulations (offered by Sawtooth Software), where multiple competitors – in our case five – compete for market shares by varying prices and attributes. By doing this, it is possible to estimate at least the average willingness to pay for all attribute levels. In these market simulations, the raw data can additionally be transformed with the help of different exponents (below one). A lower exponent dampens the effect of outliers on the overall result.

As there was no real data available with which we could compare the resulting willingness to pay, we couldn't be sure which exponent to use in our simulations. Hence, we applied different exponents between 0.3 and 0.9 to evaluate the predictive quality of our model. This leads to highly differing results while the explanatory power remains relatively high.[15] For an organic carton of 10 eggs without chick killing they lie between 7.1 Euro (exponent 0.3) and 4.7 Euro (exponent 0.9). A very representative sample and extensive real market data as reference points would again be necessary to decide which of these willingness to pay and therefore settings are realistic. Unfortunately, none of the two above is available. Therefore, even our estimations of the average willingness to pay for the different levels of the attributes are highly unreliable.

ACBCs – and this should be transferable to conjoint analyses in general – may be useful for simulating market shares for existing products when real market data is already available, but it is highly questionable whether they can be used

- to acquire individual willingness to pay even if real market data was available as well, or

[15]The FCHR with an exponent of 0.3 is still at 81.9%.

- to acquire average willingness to pay, if no real market data was available and the sample was not highly representative.

As we cannot estimate the willingness to pay for eggs this way, it is impossible to estimate the willingness to pay for single attributes (in our case male chick killing). Therefore, any comparison to the results of the referendum is unfeasible.

6.3.2 The Assessment of Animal Welfare as a Public Good

In economics, a public good is defined as a non-rival and non-excludable good. Interpreting animal welfare as the overall (or average) welfare of animals, non-excludability and non-rivalry are clearly given. Nobody can be excluded from the utility of a higher overall animal welfare and the utility gained by one individual – for instance due to better husbandry systems – doesn't decrease the utility of another person. Following this argumentation, the property non-excludability establishes the incentive to free-ride and not participate in the provision of the public good as one's own influence on the overall level of animal welfare is marginal. Because of this property, we expect the individual willingness to pay to be lower in the individual case than in the referendum one.[16]

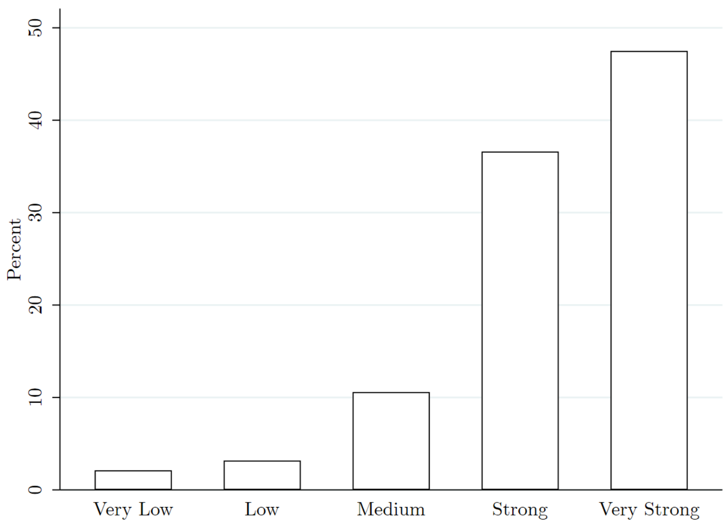
Apart from these two properties a third one is important: The size of the public good. Small sized public goods can be provided – even without governmental intervention – using different mechanisms. Olson (1971) already differentiated these mechanisms into selective incentives (for those who participate in providing the public good), social sanctions and a rich sponsor. All these mechanisms lead at least to a partial provision of the public good. The first and second argument are based on reciprocal behaviour. The third one is more applicable to small public goods as the investment of a sponsor would have to be very high otherwise. As there are around 45 million laying hens in Germany (Bundesanstalt für Landwirtschaft und Ernährung 2021), overall animal welfare can definitely be viewed as a large public good. For an individual, it is almost impossible to change the animal welfare via financial sponsoring or hoping for reciprocal behaviour. Comparing this result to the already cited market data underlines the view that the overall well-being

[16]It is important to note that there might exist a willingness to pay for social incentives that are linked to animal welfare in the individual case.

of hens is a public good. "Only" 15.4% of the fresh eggs that are purchased by German households are organically produced (Bund Ökologische Lebensmittelwirtschaft 2021). On the other hand, some studies suggest that the majority of Germans would support increasing animal welfare levels, if they were enforced on a public level, which speaks for an existing (high) preference for animal welfare (Bundesministerium für Ernährung und Landwirtschaft 2019; Sorg et al. 2021).

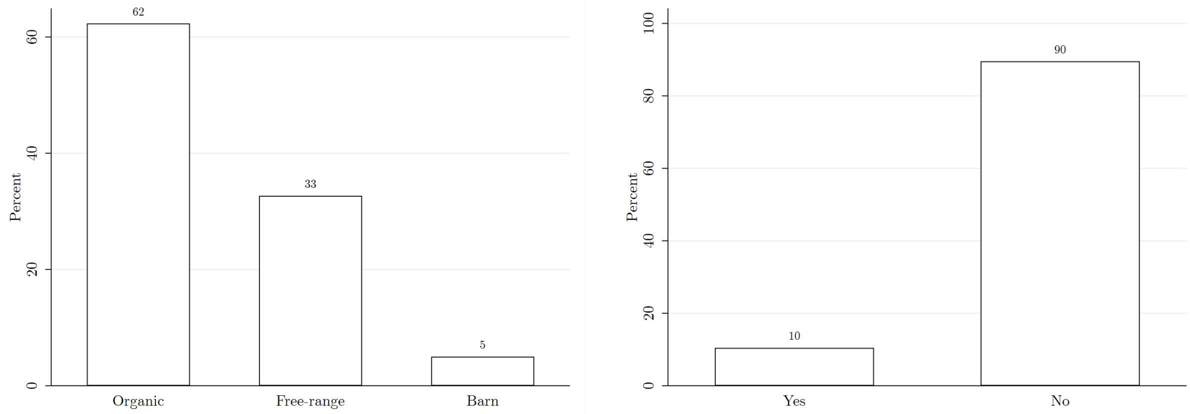
This is in line with our Quasi-Monarch model. But in order to actually have a different willingness to pay in the individual and referendum case, our respondents need to share the view, that animal welfare is a public good. To verify this, we asked them to what extent they share the following statement: "With my purchase of eggs I personally have an influence on the well-being of chicken."

Figure 7: Well-being of Chicken and Personal Choice



As Figure 7 shows, about 85% of the participants state, that with their purchase they have a strong or even very strong influence on the well-being of chicken. Respondents also state a high preference for organic eggs as the results of our build-your-own question indicate, where respondents have to build their "favourite" product for given market prices.

Figure 8: Aggregated Choices of "Build-your-own" Section of ACBC



(a) Choice husbandry system

(b) Choice male chicken killing

How can these responses be explained in comparison to the 15.4% market share of organic eggs in Germany?

- The survey participants of the SoSci-Panel are not a representative draw of the population. Therefore, a sample-selection bias might be present. This can be supported by the socio-demographic factors of the survey participants compared to the whole population. Especially the education of participants in our sample is greatly above the German average. However, there is only a slight negative correlation between the educational degree and the question regarding personal choice and the well-being of chicken.

- Another explanation is a strong hypothetical bias which is leading the participants to overestimate their individual willingness to pay in this survey. Even though our sample is not representative, the very high willingness to buy organic eggs might support this argument.

Apart from these potential biases between revealed and stated preferences, it is worth to explore at least the direction of the results. One possible explanation might be, that individuals do not understand animal welfare as a public good. As the aggregate of animal welfare consists of the welfare of single animals, consumers might focus on the well-being of these single animals which they support with their choice of the product.

For an individual it is more important to not be responsible for one or some badly treated animals instead of being really interested in an improvement of the average or overall well-being of animals. In this case, the good "animal welfare" is a private one (or at least a quasi-public good) as there exists excludability. The individual purchase decision leads to an increase or decrease of a single animal's welfare. The assessment of the individual impact on animal welfare (Figure 7) speaks for this argument. Then, the difference of the individual willingness to pay and the referendum answers cannot be interpreted as the willingness to pay for the public good animal welfare anymore.

If they knew that overall animal welfare was actually a public good, the answers would indicate that there is a high willingness to pay for social incentives related to animal welfare but not for animal welfare itself (see Chapter 5). This is supported by literature, that estimates the willingness to pay for social incentives, silencing one's conscience for instance, to be quite significant (Ostrom 1990; Blamey 1998; Yoeli et al. 2013).

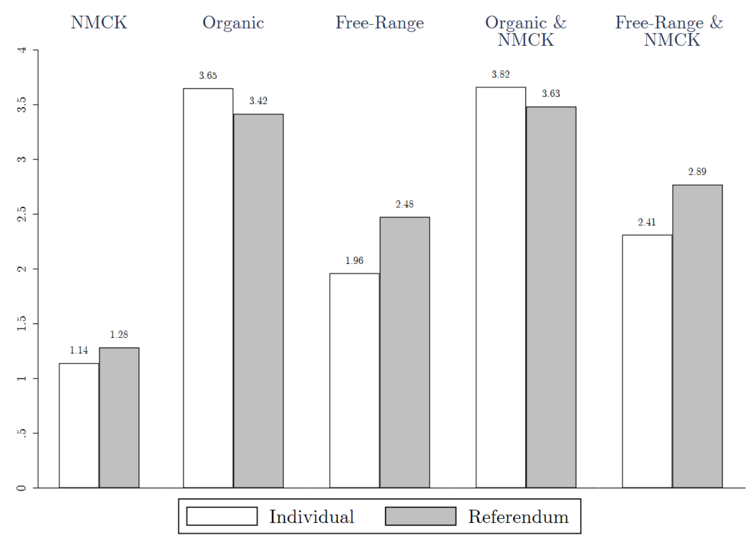
6.3.3 The Willingness to Pay for Public Intervention

Due to the lack of reliable estimations for the individual willingness to pay in our ACBC, we conducted a smaller second survey which was extended by directly asking for the individual willingness to pay after the ACBC section. The structure was identical to the referendum questions. 255 participants (68 incomplete) took part in the second survey. After removing illogical response patterns 114 answers remained.

We would hypothetically expect the willingness to pay for the referendum to be above the individual ones, if individuals had a preference for the public good. In a referendum, (the sum of all) individuals can impact the public good which is not the case on a private level. Figure 9 shows the different means of the willingness to pay (WTP) for certain criteria and products.[17]

[17] No male chick killing is abbreviated with NMCK.

Figure 9: Individual and Referendum Willingness to Pay



The resulting willingness to pay cannot be interpreted straightforward. For example, the willingness to pay for eggs without the killing of male chicks seems to be significantly larger in the referendum. However, around 50% of the respondents state identical individual willingness to pay (WTP_I) compared to the referendum response (WTP_R). This pattern can largely be observed in all of the settings.

	NMCK	Organic	Free-Range	Organic & NMCK	Free-Range & NMCK
$WTP_I > WTP_R$	24%	37%	21%	24%	14%
$WTP_I = WTP_R$	53%	43%	29%	54%	49%
$WTP_I < WTP_R$	24%	20%	50%	22%	37%

Table 9: Difference of Willingness to Pay in Individual Setting and Referendum

A large number of participants supposedly does not see a difference between paying individually or public intervention. This phenomenon might be explained by the following:

- There may exist a lack of knowledge, which is twofold. First, people do not understand animal welfare as a public good. Second, our respondents do not see the benefit of a publicly forced provision of the public good. However, the second argument is crucial for finding differences in the willingness to pay. If people do not understand the rules of the game, we can fairly expect them to plausibly distinguish between the two scenarios. This is supported by a strand of literature suggesting that individuals have to understand the rules of the game to maximize their utility. Then, repeated public goods games may start with cooperation in the first iterations. But this cooperation breaks down after the players understand the rules of the game (see e.g. Andreoni 1995; Gale et al. 1995; Roth and Erev 1995; Palfrey and Prisbrey 1997; Cooper and Stockman 2002; Guillen et al. 2007; Feige et al. 2014). This would mean that a large number of respondents may not have thought enough about animal welfare to understand it as a public good and the need of public provision through establishing collective rules.

- Our responses could also suffer from a "prominence bias". This occurs, when surveys focus on a topic which respondents normally do not focus upon in their decision making which leads to a higher attention compared to a real shopping situation. As respondents might guess that the survey is about animal welfare, they may overstate their willingness to pay.

- Biases are in general very prominent in CV approaches, which might therefore not be feasible to measure the willingness to pay – at least according to Diamond and Hausman (1994) and Hausman (2012). Schläpfer and Hanley (2006) for instance argue that the real willingness to pay in referendums in Switzerland is actually considerably lower than the one measured via CV beforehand. So the stated individual and referendum willingness to pay in our second survey may both be biased. The problem is, that we cannot say in which direction and in which magnitude these biases influence the resulting stated willingness to pay. However, the ACBC hardly gives better results, as argued above.

Further, for some respondents the willingness to pay is higher on an individual basis than in the referendum case. One reason for this behaviour might be that participants feel restricted in their free choice if the state intervened. To maintain this freedom, they are willing to surrender some level of the public good. Especially for organic eggs (and combinations with this criterion), the mean willingness to pay on an individual level is significantly higher than the one of the referendum. Another explanation is that individuals link certain properties with the label “organic”. These properties are excludable, hence only have an influence on the consuming person. For instance, the data indicates clearly that participants of the survey connect a better husbandry system with increasing taste and own health. The consuming (and no other) person gains utility from the better taste and by improving her health – i.e. excludability is given. When focusing on these properties, there is no reason why a liberal person would require public intervention to force others to follow her example.

Only when looking at free-range eggs the stated behaviour is as expected in our starting hypothesis. Besides some contradicting effects, which also appear in this case, the referendum willingness to pay is significantly above the individual one in the mean as well as in total. This might indicate that there is a willingness to pay for the public good. However, as other willingness to pay are also involved (for instance individual reasons, information asymmetries and missing knowledge), the former willingness to pay for the public good will be somewhat superimposed.

6.4 Conclusion

Many public good problems that we face today cannot be solved individually. Instead, collective action is necessary as an individual’s influence often is marginal. But especially for large public goods, collective action is hard to implement reciprocally, as free-riding is omnipresent. This free-riding problem can only be solved sustainably by forcing individuals to cooperate with the help of a (public) entity. This (public) entity should not just provide any amount of the public good, but focus on providing the optimal level. For this, it needs information on the willingness to pay for the respective public good. Theoretically, this would be the amount of money an individual was willing to pay herself for the provision, if all others were forced to pay exactly the same amount as well, which we call the Quasi-Monarch.

In this paper, we explored one potential approach to measure this willingness to pay. Focusing on animal welfare and using the example of eggs, we aimed to estimate the individual willingness to pay for individual reasons and the Quasi-Monarch one by employing two stated preference methods. We introduced an ACBC setting to measure the individual and a CV approach for the collective willingness to pay. Choice experiments, of which the ACBC is one, are said to be more precise when estimating individual willingness to pay, as their multi-attribute setting better simulates a real purchase scenario. The CV approach comes closest to the real setting of a referendum, where individuals state their willingness to pay by agreeing or disagreeing in a vote.

Unfortunately, our results are extensively biased due to multiple potential reasons. First, we implement an HB estimation. While achieving a good model fit according to several indicators, the resulting willingness to pay is highly unreliable in the individual and in the average case due to many crucial assumptions and biases. This is not based on our data or our survey, but on the way in which the willingness to pay are estimated in ACBC analyses. ACBC surveys in general have these problems by design, if extensive real data is not available.

Second, in order for individuals to have a higher willingness to pay in the Quasi-Monarch case compared to the individual one, they need to assess animal welfare as a public good. Our results indicate that this is not the case and a large number of respondents focus on the welfare of one single animal instead of the overall animal welfare (when purchasing eggs). The effect of this assessment is unclear though, so we cannot determine in which direction both of the willingness to pay are influenced. Here, additional research is necessary.

Third, individuals also need to see a benefit in a (public) entity providing a public good in order to have a higher willingness to pay in that scenario. The apparent equivalence of individual and collective willingness to pay leads to the conclusion that this is not the case, at least in our study. This may be due to not understanding the underlying incentives in public good problems, which leads to overestimating the impact of one's own consumption decision or hoping on reciprocal behaviour.

From these findings it directly follows that there might be other – more obvious – public goods that are misinterpreted as private or quasi-public goods as well. There, individuals might also overestimate their impact leading to a sub-optimal provision of the respective public goods. This should be explored in further research.

7 Conclusion

After more than 70 years of research on the willingness to pay for collective goods, the underlying mechanisms are still highly debated. This is true for both theoretical and empirical research as introduced in the first part of the thesis.

The former debate is based on research claiming that the implications of theoretical collective goods models do not hold in many experiments. The literature on conditional cooperation for instance argues that cooperation is initially higher than free-riding would suggest and can be maintained if enough cooperators are present. On the other hand, there are those that see flaws in the experimental designs leading to the conditional cooperation hypothesis. According to them, cooperation might exist initially. But free-riding will be the stable equilibrium after the participants understand the underlying game.

Similar arguments are still ongoing when looking at empirically capturing the willingness to pay as well. Here, it is possible to either estimate the willingness to pay in stated or revealed approaches. While stated approaches acquire willingness to pay through hypothetical scenarios, revealed methods use market data in order to derive the willingness to pay for collective goods. Both of these models are biased in one way or the other. Stated approaches are hypothetical by design and suffer from multiple other biases potentially leading to overstated results. Revealed methods on the other hand fail to incorporate utility components (for instance non-use values) and will therefore potentially underestimate the willingness to pay.

In this thesis, we argued that most of these theoretical and empirical approaches only regard one of multiple willingness to pay for public goods. Instead, there exist at least two willingness to pay parallelly depending on the circumstances of the provision of public goods. This differentiation is crucial for determining the optimal level of public goods. If the public good is provided on an individual level, there exists only a willingness to pay, if reciprocity is feasible. In all other cases the willingness to pay for the public good will be zero in optimum even though the individual has a preference for the public good. This is due to the free-riding incentive and the marginal impact of each individual. This does not mean, that the level of the public good will be zero. Some level might be provided as a positive external effect due to other preferences as, for instance, for social incentives.

But the same individual will have another willingness to pay, if a (public) entity forces all individuals to cooperate as the sum of all individuals will have an impact on the public good. In this situation, it is then possible to evaluate how much money an individual would be willing to spend on the provision of a public good, if all others also had to pay the same amount. We call this hypothetical construct the Quasi-Monarch.

This Quasi-Monarch should always be taken into account when thinking about the willingness to pay for public goods. For this, the Quasi-Monarch willingness to pay has to be determined. Our first applications did not yield unbiased and reliable results. Two possible explanations are that individuals do not understand some public goods as such (in our case animal welfare). Additionally, individuals may not understand governmental intervention as beneficial. Therefore, further research has to be undertaken to explore these potential explanations. While the ACBC and the CV method are not useful in measuring the willingness to pay for animal welfare, the Quasi-Monarch model should always be kept in mind when considering willingness to pay for public goods.

We can only conclude that today's research does not allow generalizations or at least only with a very narrow perspective. The willingness to pay is too dependent on the type of the public good and the various circumstances of its provision, whose impacts are not conclusively explainable yet. One very promising approach is to further increase the number of participants in experimental designs, which hopefully sheds more light on how the willingness to pay is influenced by the number of parties involved.

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