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DISCUSSION PAPER

// LARA BARTELS, MARTIN KESTERNICH, AND ANDREAS LÖSCHEL

The Demand for Voluntary Carbon Sequestration – Experimental Evidence From a Reforestation Project in Germany

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Lara Bartels[a], Martin Kesternich[a,b], Andreas Löschel[a,c,d]

[a] ZEW – Leibniz Centre for European Economic Research, Mannheim
[b] University of Kassel
[c] Ruhr-University Bochum
[d] Alfried Krupp Institute for Advanced Study, Greifswald

Abstract: With the increasing recognition of the use of reforestation measures as a complement to conventional carbon emissions avoidance technologies it is important to understand the market valuation of local forest carbon sinks for climate change mitigation. We conducted a framed-field experiment among a Germany-wide sample to provide a revealed preference study on the individual willingness to pay (WTP) for carbon sequestration through forests. Our particular focus is on the role of local co-benefits of climate protection activities. In addition, we add geo-data to our experimental data to analyze the impact of spatial variation on the individual WTP. We find that the WTP for carbon removal exceeds the WTP for mitigation efforts found in previous studies. While spatial distances does affect the likelihood to contribute to a local carbon sink, it does not affect the average amount given. Additional survey data finds that trust in forest measures is higher compared to mitigation via an emissions trading scheme, which could explain the comparably high WTP.

Keywords: voluntary provision of environmental public goods, climate change mitigation, carbon sequestration, willingness to pay, co-benefits, revealed preferences, framed-field experiment

JEL: Q51, Q54, C93, Q23, H41

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Correspondence: Lara Bartels (lara.bartels@zew.de), P.O. Box 103443, 68034 Mannheim, Germany

1. Introduction

At the Paris Climate Convention, countries around the world agreed to limit global warming to 2°C - preferably 1.5°C - above pre-industrial levels. To fulfill this target, economies have committed to reach net zero greenhouse gas (GHG) emissions by the mid of the century. Net zero by 2050 is an ambitious yet important goal that requires a rethinking of traditional GHG avoidance approaches and calls attention to negative emission technologies (NETs) as a complementary method to lower the atmospheric CO_2 concentration levels. NETs are based on carbon sequestration and cover approaches that remove carbon dioxide from the atmosphere, and capture and transfer it back to geologic reservoirs and ecosystems (Herzog and Golomb, 2004). Following the discussion on the remaining carbon budget and the insufficiency of solely applying conventional GHG avoidance methods, NETs are already firmly anchored in 87% of IPCC scenarios that give a more than 50% chance of meeting the 2°C target (Fuss *et al.,* 2014). A range of natural and technological approaches (though still lacking the capability to serve at larger scales) exists for removing carbon dioxide from the atmosphere. Especially measures based on forest carbon sink have recently received a particular amount of attention from both politics and the public.

The Paris Agreement (PA) assigned a key role for combatting climate change through the protection and maintenance of forests (UNFCC, 2015: para. 5). Several transnational initiatives have recently stressed the need for increasing forest coverage. The European Commission has released the *EU Forest Strategy for 2030* that aims to increase the EU forest coverage, plant tree billion trees by 2030, and create payment schemes for forest owners for the provision of ecosystem services. At the One Planet Summit for Biodiversity, French President Macron announced additional funding of $14 billion for the Great Green Wall for the Sahel and Sahara Initiative (GGW) in January 2021. At COP 26 in November 2021, over 130 countries – accounting for more than 90% of the world's forests – have committed to the Glasgow Leaders' Declaration on Forests and Land Use to reverse forest loss and land degradation. Further popular programs are the Trillion Tree Campaign, launched in 2006 by the United Nations Environment Program (UNEP), the Eden Reforestation Project, the International Tree Foundation or Plant your Future.

The estimated potentials for carbon sequestration from forest measures such as reducing deforestation, forest management, and afforestation differ depending on chosen activity, region, time horizon and methods used (Nabuurs *et al.,* 2007; Neumann *et al.,* 2016; Obersteiner *et al.,* 2018; Bastin *et al.,* 2019). Nonetheless, research suggests that these activities inhibit a large potential to support the necessary ambition to meet climate stabilization targets (National Academies of Sciences, Engineering, and Medicine, 2019; Pires, 2019; Austin *et al.,* 2020). One reason being its comparable low marginal costs in particular in case of fast-growing tree species (Forster *et al.*, 2021). But even with growing scientific and policy recognition (Fuss *et al.,* 2014; Geden *et al.,* 2019; Hilaire *et al.,* 2019), far less is known about natural NETs as "unconventional" avoidance efforts and, in particular, in the interplay with traditional forms of carbon mitigation. However, a successful integration of forest carbon sinks into climate policies requires a profound understanding of the markets valuation of carbon sinks considering the socioecological context and potential trade-offs. This also includes a better understanding on the value of forests serving as a non-permanent GHG removal option but with a potential to contribute to lower peak emissions in the short- to mid-term.

From an economic point of view, analyzing consumers' willingness to pay (WTP) for reforestation projects for climate protection provides an interesting source of experimental variation to elicit the role of co-benefits for voluntary GHG reduction efforts. The IPCC (2014) classifies co-benefits (or ancillary benefits) as positive effects that a certain climate policy measure aiming at one particular objective (e.g. reducing GHG emissions) has on a further related objective. Co-benefits from reducing GHG emissions include both positive impacts on environmental concerns like air pollution or biodiversity but potentially also effect economic indicators such as innovation and technological spillovers. While the primary public good component (i.e. the benefits from reduced GHG emissions) is globally at scale, most of the co-benefits from reforestation projects (e.g., reduced air pollution and noise, clean water, a livelihood for local people and improvements in health and biodiversity) particularly accrue in a local context. This highlights the role of place attachment on the WTP for a local forest carbon sink.

We conducted a framed-field experiment among a Germany-wide sample. Therewith, we provide to the best of our knowledge the first revealed preference study on the individual WTP for the carbon sequestration services of forest. Our experimental variation is inspired by the idea that an active communication of co-benefits can encourage mitigation activities (Bain *et al.,* 2016). Especially in the context of afforestation, these local co-benefits are highly visible and perceptible. Highlighting co-benefits can help to mitigate free-riding incentives, which are frequently observed in previous experimental research on the WTP for GHG mitigation efforts through purchasing and withdrawing emissions allowances from existing emissions trading schemes (ETS) (e.g., Löschel *et al.,* 2013; Diederich and Goeschl, 2018; Löschel *et al.,* 2021). Survey evidence reveals that individuals rank carbon storage as the most important contribution of (tropical) forests, followed by biodiversity and support to local communities (Baranzini *et al.,* 2010). As co-benefits are expected to be positively correlated with spatial distance to the local carbon sink, we further add a distance measure and geo-data (i.e. forest coverage, rusticity, spatial distance) to our experimental data allowing an in-depth analysis on the impact of spatial variation on the individual WTP. As a follow-up, we run a survey among a group of individuals that has been uninvolved in the experiment to elicit predominant perceptions and existing knowledge on the function of forests. Insights from the survey enable us to explain our results.

Our empirical findings indicate substantial differences to the previous empirical literature investigating the WTP for individual GHG avoidance activities. In particular, we find that the public valuation of a local forest carbon sink exceeds that of conventional mitigation of emissions by far. We do not observe a strong empirical link between highlighting the co-benefit component and the individual WTP. Instead, we find evidence for a negative relationship between spatial distance and the willingness to contribute to a local carbon sink. Distance does play a role on the decision whether to contribute voluntarily to the local carbon sink or not. It does not influence the contribution levels.

2. Research Design

2.1 Framed-Field Experiment

We embedded our framed-field experiment in a survey conducted jointly by the University of Münster and an online comparison platform for electricity tariffs that operates all over Germany from 16 to 25 March 2020. The customers of the comparison platform took thus part in our experiment. The survey was thematically unrelated to our experiment and investigated consumer behavior in the electricity retail market. The survey software *Qualtrics* was used to implement the online questionnaire and generate personalized survey links. The links were distributed via email using *MailChimp*. In the invitation email, participants were informed about the general purpose and expected duration of the survey as well as their fixed payment of 20 € for complete participation. They could receive further payments between 6 € and 40 €, depending on their answers within the survey on electricity tariffs. The final sum of payments was distributed as a voucher that could be redeemed at over 500 shops. The survey consisted of four parts. Personal traits of participants such as risk preferences, time preferences, trust, need for recognition, paternalism and keeping control of decisions were investigated[1]. All answers were collected using a strategy method.

After completing the online survey, participants were, for the first time, confronted with the opportunity to donate their fixed payment (20 €) to a carbon sink project located in Mannheim, Germany. For this, we collaborated with the city of Mannheim that hosts the *Bundesgartenschau*[2] (German National Garden Show) in the year 2023. For the event, sealed areas and brownfields are transformed into a green area creating new recreational spaces, a species conservation area and an additional local carbon sink by permanently planting about 1.000 trees, and at the same time improving the city`s air quality and climate.

For the donation decision participants could determine if and how much they want to give with the help of an adjustable slider. Unknown to the potential contributors, subjects were divided randomly into two treatment groups that vary the information given on the carbon sinks project: the *sink* (S) and the *co-benefit sink (CBS)* treatment (see Table 1).

Table 1: Treatment Overview

	Treatment contains information on…				
	Climate protection	NETs & carbon sinks	Av. CO2 absorption capacity of trees	Reforestation project	Local co-benefits
S	yes	yes	yes	yes	no
CBS	yes	yes	yes	yes	yes

In both treatments, participants received relevant information on the need for global climate protection and the role of NETs based on the PA and the IPCC reports. In particular, we explained the role of carbon sinks as a form of NET within this process. In addition, participants received information on the average CO_2 absorption capacities of trees based on an example of a beech, which on average absorbs 100kg of CO_2 in eight years (Klein, 2009). In order to make this information more readily accessible to participants, we provided the information that 100kg of CO_2 approximately equal the emissions value of a 550km car trip. Finally, we gave participants information on the reforestation project in Mannheim and that their donation would be used to plant additional trees. In the CBS-treatment, we additionally included information on the local co-benefits. We highlighted the recreational value, local air quality improvements, an increased

[1] The questions on risk preferences, time preferences und trust were closely related to the GPS (Falk *et al.,* 2016; Falk *et al.,* 2018). The question on the need for cognition were closely related to the NFC-K (Beißert *et al.,* 2014).
[2] The German National Garden Show is an exhibition on horticulture hat enjoys great popularity. It takes place every two years in varying German cities and lasts 189 days. In 2019, the show took place in Heilbronn and attracted 2.3 million visitors.

balance of temperature, and improved biodiversity. After participants received these information, we asked them on a next screen if and how much they would like to donate for the removal of 100kg CO_2 from the atmosphere through the reforestation project. The likelihood to give (i.e. the extensive margin effect) and the amount given (i.e. the intensive margin effects) are our main outcome variables for the WTP analysis. As the survey platform records the geographical position of each participating subject, we are able to link these positions with further geo-coded data.[3] For an overview and explanations of the sample characteristics, see Appendix Table A1.1 – A1.3. Appendix 3 includes the translated treatment texts used in the questionnaire.

2.2 Observational Data on Geographical Indicators

The attitude towards planting trees may not only affected by the physical distance to the forest carbon sink but also by the characteristics of the spatial surrounding of the participants' location such as e.g. forest coverage, agriculture or rurality. Participants living in areas with a high degree of forest coverage and enjoying the value of trees may see the value added of additional trees even in more distant areas. Contrary, these individuals may not see the need to spend money to afforest additional areas. Czajkowski *et al.* (2017) found that geographical particularities may influence the respondents' WTP in a way that the respondents' WTP was higher the closer they lived by a forest and the scarcer forests were in the area they lived in. To control for these potential effects, we match our experimental data with geo-data from the INKAR-Database (BBSR Bonn, 2020) from the German Federal Office for Building and Regional Planning. The database covers over 700 indicators ranging from labor market, education, social services, demographics, income, housing, public finances, transport and the environment. Most of these indicators are continuously collected since 1995 and are clustered along the different German constitutionally distinct and legally independent political levels. The lower the level the less area they cover allowing a more precise analysis of the indicators impact. The lowest level available for the indicators used in our analysis are districts. For an overview and explanations of the variables, see Appendix Table A1.4-A1.6.

2.3 Survey Data

Our expected experimental results may also depend upon the beliefs of participants concerning the different effects of a reforestation project. Assessing prior or post beliefs can be instructive

[3] We acknowledge that the participants' whereabouts during survey participation do not necessarily have to be their actual place of residence. However, the survey took place during the beginnings of the German COVID lockdown. Kindergartens and schools were closed, home office encouraged and public life brought down. These factors increase the chance that people answered from home.

for interpreting the results (Haaland *et al.,* 2020). Especially in the *CBS* treatment, where we stress the local co-benefits, the response to the information depends on the participant's prior beliefs and knowledge and to which extent this information updates existing beliefs. When participants are already fully aware of the role of co-benefits of forests, stressing them may not have the intended effect. Even in the *S* treatment participants may account for the benefits of the local program. While the field-experiment itself did not permit to measure the participant's beliefs, we instead conducted an extensive survey among students of the University of Münster to assess the knowledge about forests and general attitudes towards environmental donations such as voluntary giving in form of purchasing certificates or tree donations. We used the *Online Recruitment System for Economic Experiments* of the University of Münster to recruit participants; 567 students participated. The survey covered questions on knowledge on ETSs and reforestation measures. We elicited whether people prefer to buy credits from emissions-saving projects, plant trees within a reforestation project, or neither. Further questions on the participant's faith on certificates or reforestation programs were included as well as knowledge on forest co-benefits. The summary table of survey variables are in Appendix Table A1.7. The complete and translated survey is in Appendix 4.

2.4 Statistical Power Analysis

We base the optimal sample size calculations for our experiment on results from the experimental study by Löschel *et al.* (2021) as it is closest to our design. The authors use a local sample in China and report an extensive margin effect of -31% when turning from the local (Beijing, 66% of the subjects contribute) to the global setting (Shenzen, 44% of the subjects contribute). To be able to detect a similar effect size, a power analysis with an underlying two-sample proportions (Pearson's $\chi 2$) test (with α=0.05, p_1=0.66, p_2=0.44) indicates that at least 150 experimental observations are needed to achieve a statistical power of 0.7. We were able to recruit 160 subjects for our experiment. Therefore, we expect our experimental setup to be "well-powered" for being principally able to detect similar treatment effects compared to those reported by Löschel *et al.* (2021).

3. Hypotheses

Individual environmental conservation efforts are commonly described as donations to a pure public good, or, if linked to the consumption of a private good, as contributions to an impure public (green) good (Kotchen, 2006). As individual costs for conservation efforts usually are expected to outweigh by far the individual benefits from the increase in environmental quality, strong free-riding incentives are expected to prevent high contributions to global public goods like GHG mitigation. A series of revealed preferences studies that experimentally investigate the WTP for GHG emissions via purchasing and withdrawing emissions allowances from existing ETSs indeed report a positive but low average WTP for climate protection (Löschel *et al.,* 2013; Diederich and Goeschl, 2018; Löschel *et al.,* 2021). On the other hand, over the last years, offset issuances and retirements at the voluntary carbon market (VCM) have increased considerably. Over the past 20 years, VCMs have funneled more than $5 billion into emission reduction and removal activities, ranging from renewable energy to forest conservation (Forest Trends' Ecosystem Marketplace, 2020). In particular, forest projects among the most popular offsets and made up about 42% of all credits issued in last five years (World Bank, 2020). With the increasing recognition of the appliance of forest measures to complement low-carbon technologies as an additional path for future mitigation activities (and include them into emission trading systems), it is important to understand the markets valuation of carbon sinks in climate change mitigation. It however remains an open question whether the empirical insights on low levels for individual GHG mitigation carry over to a situation where subjects can actively contribute to CO_2 removal through contributions to a local forest carbon sink. Based on the theory on the voluntary provision of public goods and the available empirical evidence, our first statistical hypothesis on the WTP to contribute to CO_2 removal in the *S* treatment (WTP_S) reads as follows:

Hypothesis H1. H_0: $WTP_S = 0$ H_A: $WTP_S > 0$

The economic value of a forest consists of both use and non-use[4] values. Local co-benefits can be especially found in the use values, which are differentiated in direct and indirect use values. Direct use values can be experienced directly and cover recreation, education and tourism but also timber, fuelwood and edible plants. Indirect use values provide environmental services such as biodiversity, carbon storage, improved air quality, soil protection and hydrologic functions (Bateman and Lovett, 2000; Núñez *et al.,* 2006; van der Horst, 2006).

Co-benefits are expected to play an important role for voluntary GHG reduction efforts. There is empirical evidence that communicating co-benefits can encourage mitigation activities (MacKerron *et al.,* 2009; Ninan and Inoue, 2013; Bain *et al.,* 2016). The experimental literature on consumers' WTP for emission certificates however reports mixed results. Löschel *et al.* (2021) find a higher share of contributors to climate change mitigation and a higher median WTP when

[4] Non non-use values include the bequest value, altruist value and existence value.

local co-benefits are taken into account. Diederich and Goeschl (2018) and Baranzini *et al.* (2018) find no effect of highlighting local co-benefits.

Co-benefits of afforestation are highly visible and perceptible such that we expect them to mitigate free-riding incentives. Based on the literature and the forest context, we expect contributions to be higher when additional local benefits from CO_2 removal through reforestation are stressed compared to a setting when they are not stressed (i.e. $WTP_{CBS} > WTP_S$). However, the provision of these local public goods (e.g., improved local air quality, higher biodiversity) may provide further sources for additional (more local) free-riding behavior. It therefore remains an empirical question if and how subjects react to stressing the local co-benefits. We formulate our second hypotheses H2 as follows:

Hypothesis H2. H_0: $WTP_{CBS} = WTP_S$ H_A: $WTP_{CBS} > WTP_S$

Other than local benefits, also local favoritism may influence contribution behavior. Understanding the effect distance may have on voluntary contributions is an important factor for framing donation appeals. In the context of carbon offsetting, few studies on the WTP for emissions reductions have investigated the spatial dimension and present a rather heterogeneous picture. Diederich and Goeschl (2018) offer participants to buy either local EU-based or developing country offsets and find no locational preference. Anderson and Bernauer (2016) find that domestic offsetting is always preferred over international, only an efficiency argument increases the support for international abatements. Buntaine and Prather (2018) find in two behavioral experiments that American subjects have strong preferences for local activities. Using a choice experiment, Bakhtiari *et al.* (2018) show that individuals' marginal WTP for comparable biodiversity conservation measures vary with distance.

In the context of the reforestation project geographical influence may be of particular importance too, as already emphasized by forest valuation studies (Bollen *et al.,* 2009; West *et al.,* 2013; Hamilton *et al.,* 2017; Deng *et al.,* 2018). Participants living within a close distance to a forest project are more likely to benefit its local co-benefits. Torres *et al.* (2015) find a stronger support for local mitigation when local co-benefits are emphasized. Abildtrup *et al.* (2013) conclude that the spatial dimension is crucial for the recreational value of forest. With an increase in distance the likelihood to experience and profit from these co-benefits decreases, e.g. the use values would be decreasing in distance mainly due to travel costs. The relationship between non-use values and distance might be driven by a social-distance mechanism. By emphasizing the local co-benefits these beneficial but locally bounded components becomes more apparent to participants, such that we expect an interaction of distance and co-benefits.

If local favoritism holds in our setting and given the variety in places of residence of our subjects, we expect a difference between those who are located close to the reforestation project and those who are located further away. If this holds we would reject the Null-hypothesis (H_0: ρ(WTP,c)=0) in our hypothesis H3, which captures the correlation ρ between the spatial closeness *c* to the reforestation project and the willingness to pay as follows:

Hypothesis H3. H_0: ρ(WTP, c) = 0 H_A: ρ(WTP,*c*) > 0

4. Results

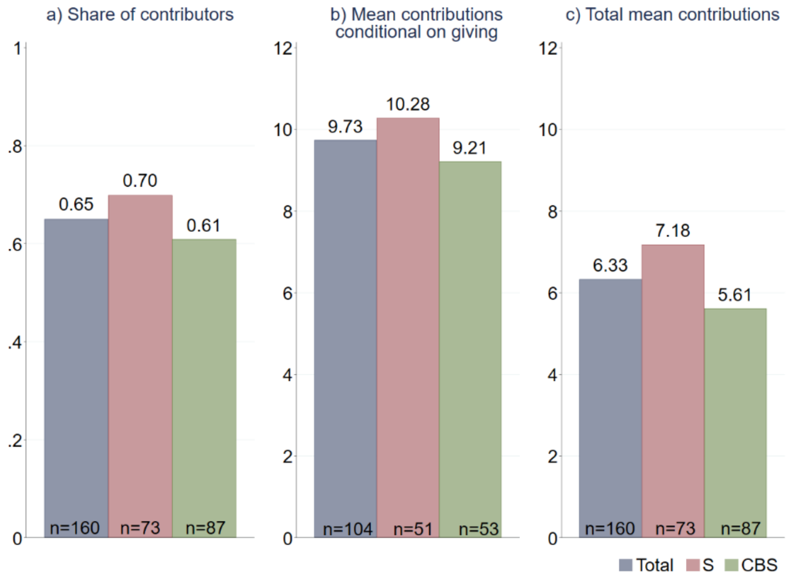
160 subjects participated in the experiment. The mean age is 44 and 30% of the participants are female. The *S* treatment has 73, the *CBS* treatment 87 observations. Balance tests were performed on age and gender and confirm a balanced sample. Appendix 1 provides a description of all experimental variables (Table A1 - A1.3), geographical indicators (Table A1.4 - A1.6), and the post-survey variables (Table A1.7). In total, participants in our experiment donated 1.797 EUR. With this money, four *Pterocarya fraxinifolia* of five to six meters height were planted in May 2021 on the area of the Mannheim National Garden Show.

4.1 Univariate Analysis of the Treatment Effects

We compare individual contributions to the local carbon sink across treatments. Figure 1 gives an overview of the share of contributors, and the mean contributions both conditional on giving and of the total sample. Starting with the extensive margin effects (i.e., the share of contributors), results clearly indicate that the share of subjects that contribute to CO_2 removal is larger than zero in both treatments (t-test, p=0.000). 65.0% of all subjects in our sample contribute a positive amount to the public good. In *S*, 70.0% of all subjects give a positive amount, this share decreases to 60.9% in *CBS*. This decrease is however not statistically significant at any conventional level (exact Fisher´s test, p=0.249). We can clearly reject the Null-hypothesis (H_0: WTP_S= 0) of our first hypothesis (H1).

Continuing with the intensive margin effects on the subjects' implicit WTP for CO_2 removal, we denote the amount of money that a subject contributes to the reforestation project as the minimum WTP (WTP_{min}). Conditional on giving (see Figure 1.b) the mean WTP_{min} (10.28 EUR in *S* vs. 9.21 EUR in *CBS*, t-test, p= 0.4200) do not differ significantly between *S* and *CBS* in our sample. Including all observations (see Figure 1.c), the mean WTP_{min} amounts to 6.33 EUR/100kg removal. In the S-treatment, the mean WTP_{min} amounts is 7.18 EUR/100kg removal. In the *CBS* it is 5.61 EUR/100kg removal. The difference between the mean WTP_{min} in *S* and *CBS* is not significantly different (t-test, p=0.1663). In relative terms, the average contributions amount to 35.9% (*S*) and 28.1% (*CBS*) of the initial enumeration.

Figure 1: Extensive and intensive margin effects



Note: Figure 1a on the left shows the share of contributors in percent. Figure 1b in the middle shows the mean contributions conditional on giving in EUR. Figure 1c on the right shows the total mean contributions in EUR. The blue bar contains the whole sample, the red bar the *S* sample, and the green bar the *CBS* sample.

These first insights already indicate that a change in the treatments from a pure CO_2 perspective to a scenario where local co-benefits from CO_2 removal are explicitly stressed do not lead to a higher WTP_{min} but – if anything – rather suggest some backfiring tendencies. When we compare our mean WTP_{min} with studies than inhibit a similar setting in the context of emission mitigation, the WTP_{min} on carbon removal appears to be substantially higher than the revealed WTP for mitigation activities in Germany. Löschel *et al. (*2013) found a mean WTP of 1.2 EUR/100kg CO_2 and Diederich and Goeschl (2014) a mean WTP of 0.6 EUR/100kg CO_2 in settings with greenhouse gas mitigation through purchasing and withdrawing emissions allowances. These observations point into the direction that the public valuation of forest carbon sinks might exceed that of emission mitigation significantly. We discuss potential reasons for this observation using our post-experimental survey data in Section 5.

4.2 Relationship between WTP_{min} and Distance

Based on the existing literature, we hypothesized to find a correlation of distance and our outcomes. The spatial differentiation of the participants' locations allows us to investigate whether the distance towards the forest carbon sink located in Mannheim matters at either the extensive or the intensive margin. Our main distance measure tis car travel distance in minutes and indicates the travel time between the participants' location and the location of the local sink. The mean distance of a participant's location to the sink is 3 hours and 44 minutes. In addition, we generated a dummy indicating whether someone lives within a 60-minutes-radius of the carbon sink, and categorized the car travel distance in minutes into four categories: living in an under 60-minutes-radius, living in a 61-120-minutesradius, 121-180-minutes-radius, and living above a 180-minutes-radius (see Appendix 2 for a detailed overview).

Starting again at the intensive margin, we find a significant and negative effect: Compared to participants living within the 60-minutes-radius of the sink, with increasing distance the share of contributors' decreases (see Table 2, model 4). This finding is robust when including variables that control for geographical characteristics (see Table 2, model 5). Other than distance, the regression analysis also reveals that at least one geographical characteristic has an impact on giving – that is rurality. The more rural a district is the less likely are participants to give. Forest coverage, natural spaces and recreational areas do in our sample not affect the share of contributors.

Table 2: Regression analysis share of contributors

	(1)	(2)	(3)	(4)	(5)
CBS	-0.23 (0.21)	-0.23 (0.21)	-0.25 (0.21)	-0.25 (0.21) [-0.09]	-0.24 (0.23) [-0.08]
Female	-0.19 (0.22)	-0.19 (0.22)	-0.21 (0.23)	-0.18 (0.23) [-0.06]	-0.23 (0.25) [-0.07]
Age	-0.00 (0.01)	-0.00 (0.01)	-0.00 (0.01)	-0.00 (0.01) [-0.00]	-0.00 (0.01) [-0.00]
Distance			-0.00 (0.00)		
Distance category					
61-120min				-1.14^{+} (0.60) [-0.31*]	-1.17^{+} (0.66) [-0.29*]
121-180min				-1.42* (0.59) [-0.42***]	-1.60* (0.65) [-0.45***]
>180min				-0.98^{+} (0.56) [-0.25**]	-1.08^{+} (0.61) [-0.27**]
Rurality					-0.06* (0.03) [-0.02*]
Natural spaces					-0.02 (0.07) [-0.01]
Recreation area					-0.01 (0.01) [-0.00]
Forest coverage					-0.00 (0.02) [-0.00]
Beneficiary					0.08 (0.06) [0.03]
Income hh					0.00 (0.00) [0.00]
Habitat density					-0.00 (0.00) [-0.00]
Free area					0.00^{+} (0.00) [0.00*]
Car density					-0.00 (0.00) [-0.00]
Wind energy					0.00 (0.00) [0.00]
Constant	0.63 (0.33)	0.63 (0.33)	0.78* (0.37)	1.70** (0.63)	0.34 (2.28)
Observations	160	160	160	160	152

Standard errors in parentheses, marginal effects in square brackets; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. *Distance is the car travel distance to the carbon sink measured in minutes. For the categorical variable 'Distance category' the base category is '<60 min'. See Appendix 1 for an overview and description of the independent variable and dependent variables.*

Checking the given amounts conditional on contributing (see Table 3), we find no effects of distance nor of the variables controlling for geographical characteristics. However, we find robust evidence that giving increases with increasing age. We conclude that we can only partially reject our third hypothesis (H3). Averaged over both treatments, we find a correlation between giving and distance at the extensive margin. However, we do not find that distance has an effect on the given amount.

Table 3: Regression analysis on giving conditional on being a contributor

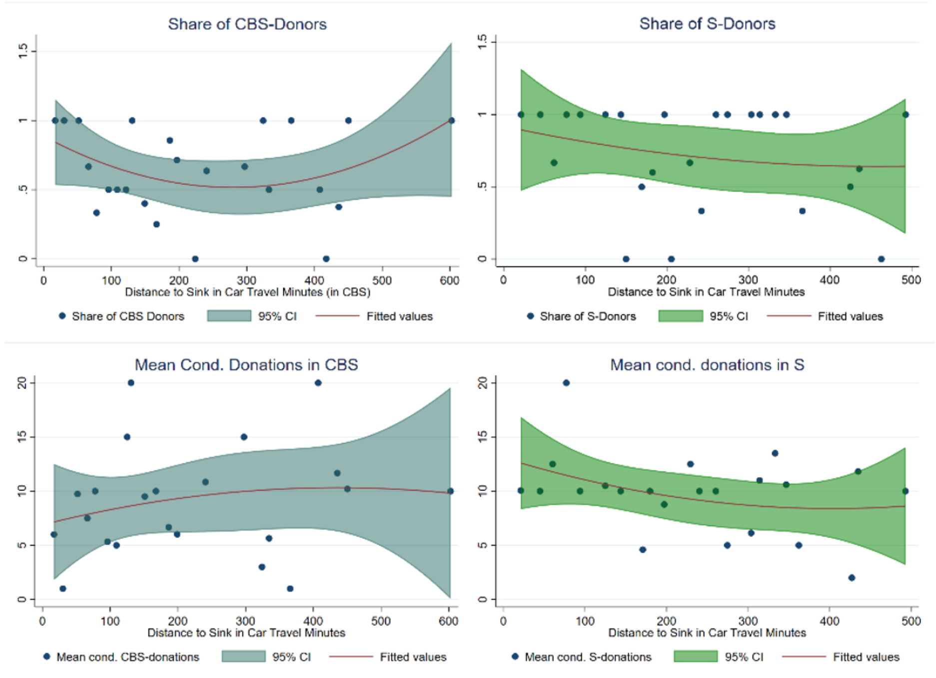
	(1)	(2)	(3)	(4)	(5)
CBS	-0.57 (1.29)	-0.57 (1.29)	-0.57 (1.30)	-0.55 (1.31)	-1.62 (1.40)
Female	-1.21 (1.51)	-1.21 (1.51)	-1.20 (1.52)	-1.54 (1.55)	-1.55 (1.74)
Age	0.09^{*} (0.04)	0.09^{*} (0.04)	0.09^{*} (0.04)	0.09^{*} (0.04)	0.07^{+} (0.04)
Distance			0.00 (0.01)		
Distance category					
61-120min				0.74 (2.70)	1.57 (2.93)
121-180min				2.37 (2.67)	3.17 (2.89)
>180min				0.19 (2.16)	0.92 (2.59)
Rurality					-0.03 (0.14)
Natural spaces					0.47 (0.41)
Recreation area					0.05 (0.05)
Forest coverage					0.07 (0.07)
Beneficiary					-0.21 (0.33)
Income hh					-0.00 (0.01)
Habitat density					0.00 (0.00)
Free area					-0.00 (0.00)
Car density					0.01 (0.02)
Wind energy					0.00 (0.00)
Constant	6.27^{**} (2.14)	6.27^{**} (2.14)	6.22^{**} (2.34)	5.72^{*} (2.75)	-2.44 (12.80)
Observations	104	104	104	104	97

Note: Standard errors are in parentheses, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$. Distance is the car travel distance to the carbon sink measured in minutes. For the categorical variable 'Distance category' the base category is '<60 min'. See Appendix 1 for an overview and description of the independent variable and dependent variables.

4.3 Correlation between Treatment and Distance

One explanation for the non-effect of the *CBS* treatment may be given through an interaction of the treatment with distance. We have seen that with increasing distance the share of contributors' decreases. Stressing the local co-benefits in *CBS* may interact through different channels with distance as conjectured in hypothesis 4. Figure 2 sums the mean given amount conditional on contributing and share of contributors gradually with increasing distance from the local sink differentiated by treatments. Indeed, we see that the graphs do develop differently. For S, both the graphs follows a rather linear and decreasing trend. For CBS, the share of contributors follows a clear U-shape. The mean given amount conditional on being a contributor follows a slightly increasing, rather linear trend. This suggests that there might be an interaction between treatments and distance. However, especially in closer distance we encounter only little observations not recommending a further regression analysis.

Figure 2: Distant-gradient graphs



Note: Upper row shows the share of donors in 15km distance bins to the local carbon sink in Mannheim measured in car travel minutes. The lower row shows the mean conditional donations in 15km distance bins to the local carbon sink in Mannheim measured in car travel minutes. The left pictures cover the whole sample, the middle pictures only the CBS-sample, and the right pictures the S-sample.

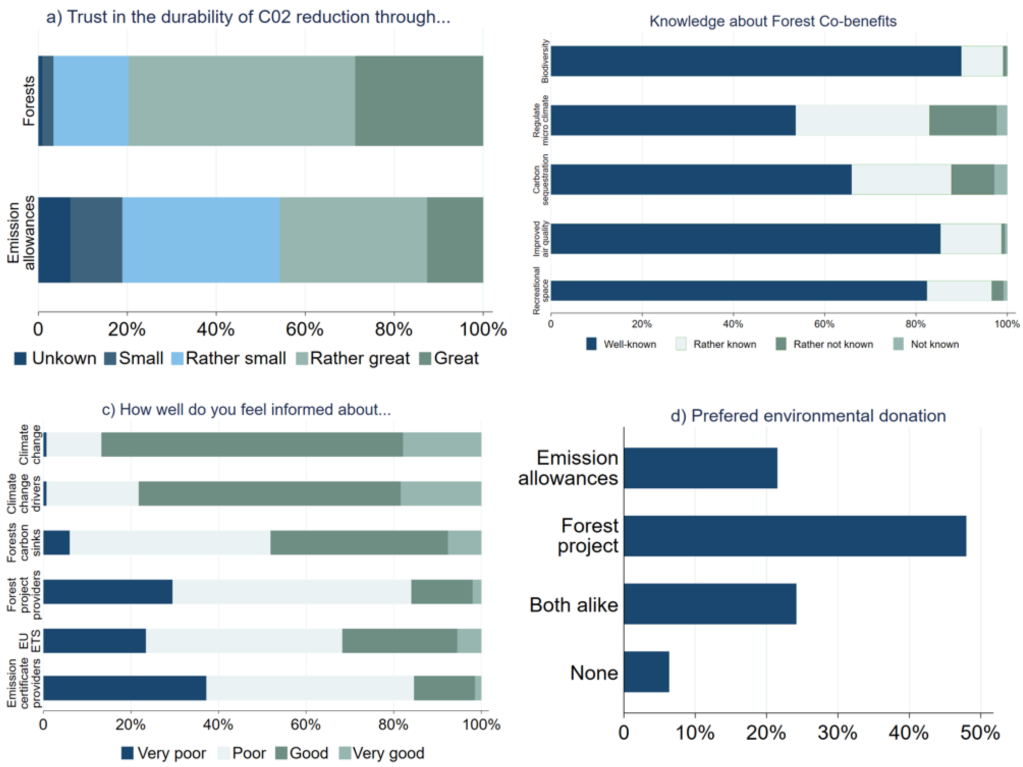
5. Understanding potential ex-ante priors

Existing knowledge and priors could drive the experimental results but especially the non-effect of *CBS*. When participants are already fully aware of the role of co-benefits of forests, stressing them may not have the intended effect. In Germany, tree-planting projects to prevent climate change are heavily courted by public campaigns. This high visibility and promotion of tree planting initiatives may have increased the awareness of forests as carbon sink and their co-benefits. While we did not include survey questions on priors and beliefs about local forest sink in our experiment to circumvent experimenter demand effects, we instead ran a survey among a group of students of the University of Münster. The survey results confirm our initial suspicions. Comparing knowledge on the ETS and forests, most participants feel rather uninformed about emissions trading schemes and the EU-ETS. Contrary, the idea to use forests as carbon sink to regulate the climate is comparatively well known (see Figure 3c). Asking participants about their knowledge on the co-benefits that were stressed in *CBS*, we find that at least student survey participants seem to be well informed about these co-benefits (see Figure 3b). This may well be attributed to the numerous initiatives in Germany that stress the role of trees to complement CO_2 mitigation.

The results from our post-survey do too coincide with our experimental finding that the public valuation of forest carbon sinks appears to be higher than the WTP for individual mitigation activities in Germany implemented through purchasing and withdrawing emissions allowances. Asking participants for their preferred environmental donation, 48% of participants preferred donating to a forest project. Only 22% preferred mitigation via the purchase and withdrawal of emission allowances (see Figure 3d). Investigating potential reasons for such preferences, we asked participants on how much they trusted in the durability of CO_2 reduction through forest projects and the purchase of emission allowances. We find a surprisingly low trust in the durability of the emission reduction through emission trading (see Figure 3a). Only 45% have 'rather great' to 'great' trust in the durability of emission mitigation through emission allowances, while 80% inhibit 'rather great' to 'great' trust in forests. We additionally replicated the donation question of our experiment hypothetically. We asked participants to imagine they would participate in a survey lasting about 20 minutes for which they would get 20 EUR. Then, participants had to state how much of their remuneration they would be willing to give for the sequestration of 100kg of CO_2 within a reforestation project. This hypothetical setting produced almost identical values with a mean WTP_{hyp} of 6.7 EUR (vs. WTP_{min} 6.3 EUR) and a median WTP_{hyp} of 5 EUR (vs. WTP_{min} 4.6 EUR). We are therefore confident that insights from the survey are informative for a better understanding of the ex-ante beliefs in our experiment.

Potentially the high visibility and promotion of tree planting initiatives may have increased the overall acceptance of this measure compared to emission allowances, which may be perceived as rather abstract and diffuse. This is a surprising result as emissions reduction via e.g. the EU-ETS are considered as key climate policy element and reforestation/NETs only as complementary tool. From the political/scientific perspective this focus on avoided emissions is among others driven by uncertainties on the durability of the carbon stored, i.e. the permanence of the carbon sequestered. Permanence of forest carbon sequestration can be hampered by natural disturbances, but also intentional, e.g. by earlier harvesting (Gren and Aklilu, 2016). Although carbon sequestration in a non-permanent reservoir has also benefits, its value should be lower than that of avoided emissions (Herzog *et al.,* 2003). Thus, we observe a large discrepancy between participants' preferences and the political /scientific opinion.

Figure 3: Survey results



Note: Upper left graph (a) describes the trust in the durability of CO2 reduction through forests or the purchase of emission allowances; upper right graph (b) describes the participants knowledge on the following co-benefits: biodiversity, regulation of micro climate, carbon sequestration, improvements of air quality, and recreational spaces; lower left graph (c) describes how well survey participants feel informed about climate change and its drivers, as well as forest carbon sinks and the EU ETS and providers; lower right graph (d) shows the preferred environmental donation of survey participants.

6. Discussion

In the last years, an additional paths for future GHG avoidance activities has increasingly gained attention in science and politics but has not yet been investigated from an individuals' point of view – that is the large scale appliance of afforestation and reforestation measures as a natural negative emission technology. Combining experimental, geo- and survey data, our paper provides to the best of our knowledge the first revealed preference study on the willingness to pay for carbon sequestration services of local forest carbon sinks.

Most striking, our study reveals substantial differences to the prevalent literature investigating the WTP for avoiding greenhouse gas emissions through purchasing emissions allowances. For Germany, Löschel *et al.* (2013) report a mean WTP of 12 EUR/t CO_2, Diederich and Goeschl (2014) a mean WTP of 6 EUR/t CO_2 and both a (close to) zero median WTP. Assuming a linearity in the marginal WTP, we report a median WTP_{min} of 46 EUR/t CO_2 and a mean WTP_{min} of 63.30 EUR/t CO_2. This suggests that the public valuation of carbon sequestration via forest carbon sinks does exceed the one of emissions avoided. This impression was reinforced by the results from the post survey among students, which revealed that subjects feel better informed and have higher trust in forest measures to mitigate climate change. Knowledge on and trust in emission trading appears to be weak. This is surprising as especially emissions trading has not only been established in Europe more than a decade ago but there is also empirical evidence from 29 European countries that there is a positive relationship between trust and GHG emissions reductions (Carattini *et al.,* 2015). Natural carbon removal, on the other hand, has only recently entered the climate dialogue. Governments react with reserve and approaches to implement NET technologies are cautious (Fridahl and Lehtveer, 2018; Scott and Geden, 2018; Geden *et al.,* 2019). The reasons for the discrepancy between theoretically evaluated potentials and the so far missing practical implementation is that in the past forest projects had been considered as relatively risky investments. For example, forest measures are prone to the 'permanence problem' as carbon sequestration is reversible either through deforestation or natural disturbances such as droughts and fires. Other uncertainties include the amount and suitability of land to grow trees as well as land use conflicts. These complex ecological structures and an underlying development-versus-conservation conflict make it very difficult to integrate forests measures in official activities to mitigate climate change. But forest measures can also, when well-directed, provide numerous economic, environmental, and socio-cultural benefits (Canadell and Raupach, 2008). However, our analysis could not identify that highlighting these co-benefits lead to a further increase at the extensive or intensive margin. A likely explanation are non-observed ex-ante priors of the experiment-participants, which seems reasonable, as especially tree planting projects have become a popular measure. A similar effect is found by Baranzini *et al.* (2018). Their participants accounted largely for the local benefits such as local biodiversity, leading to a limited effectiveness of their local co-benefits treatment. What however matters in our study and has been reported in other studies is the effect of distance on giving. With increasing distance the likelihood to make a contribution decreases. This is an important insight for designing contribution appeals for such programs.

From a geopolitical perspective, future research requires to understand much better private giving behavior along the spatial dimension as tree-planting initiatives will occur all over the world with a focus on degraded areas to avoid land-use conflicts. For the case of Europe, the regulation on Land Use, Forestry and Agriculture has set an overall target for EU member states for carbon removals by natural sinks equivalent to 310 million tons of CO_2 by 2030. This includes a plan to plant three billion trees across Europe by 2030. Additionally, the no-debit obligation requires that emissions from land use, land use-changes and forest do not exceed removals from the same sector.

Understanding the WTP for carbon forest sinks also provides an incentive to foster the development of an institutional framework that explicitly targets the question to what extent forest offsets can be perceptively integrated into the EU-ETS, thereby both acknowledging the challenging question of permanence but also the valuable local co-benefits. Currently, the discussions are predominantly shifted to the EU's Effort Sharing Regulation dealing with GHG emissions from sectors such as transport, buildings, agriculture and waste that are not covered by the EU-ETS. The Effort Sharing Regulation already allows EU member states to buy and sell net accounted removals from land use and forestry from and to other Member States. This provides incentives to increase CO_2 removals beyond own commitments (European Commission, 2021). All these efforts require enabling conditions like reliable monitoring and verification systems and have to deal with the issue of permanence of the carbon stored via natural sinks. Only then, more comprehensive carbon markets can emerge. These markets might include a trading system for carbon removals and its potential inclusion in existing emissions trading systems, like the EU ETS.

We therefore hope that our study initiates additional research on environmental donations, in particular in the context of voluntary (land based) removal activities that addresses not only co-benefits, but also the associated risks. We consider insights from such demand-side reactions to be key for successfully designing these comprehensive carbon markets.

7. References

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Appendix 1: Summary Statistics

Table A1. 1: Explanation experimental data

Share of Contributors	Dummy variable indicating whether a participant made a contribution [1=made a contribution; 0=did not make a contribution].
Contributions cond. on giving	Variable indicating the amount given to the carbon sink project conditional on being a contributor.
Total contributions	Variable indicating the amount given to the carbon sink project by the whole sample.
CBS	Dummy variable indicating whether a participant is in the CBS-treatment group [1=CBS; 0=S].
Distance	Distance measure indicating the car travel distance in minutes between the participants' location and the location of the carbon sink project. The variable is created in Stata with the program *osrmtime*.
Distance cat.	Categorical variable that differentiates the distance in car travel minutes to the carbon sink into four categories [cat.1= within 60-min-radius; cat.2=61-120-min-radius; cat.3=121-180min-radius; cat.4=outside 180-min-radius]. For the analysis, category 1 is the base category.

Table A1. 2: Summary statistics of experimental data

	N	Mean	sd	Min	Max
Share of contributors	160	.65	.48	0	1
Contributions cond. on giving	104	9.7	6.7	0.9	20
Total contributions	160	6.3	7.1	0	20
Age	160	44.2	16.76	18	86
Female	160	.3	.5	0	1
Distance	160	226.6	128.5	3.017	602.55
Distance cat.	160	3.3	.9	1	4

Table A1. 3: Summary statistics of experimental data by treatment

	S-treatment					CBS-treatment					Balance test
	N	mean	sd	Min	Max	N	mean	sd	Min	Max	p-value
Share of contributors	73	.79	.5			87	.6	.5			0.25
Contributions cond. on giving	51	10.28	0.96	1	20	53	9.21	0.90	0.9	20	0.39
Total contributions	73	7.2	7.4	0	20	87	5.6	6.8	0	20	0.16
Age	73	45.1	16.7	18	86	87	43.3	16.9	18	83	0.44
Female	73	.3	.4			87	.3	.5			0.49
Distance	73	236.1	128.7	4.1	492.7.1	87	218.6	128.5	3.0	602.6	0.33
Distance cat.	73	3.4	.9			87	3.3	.9			0.56

Table A1. 4: Explanation of used independent and dependent geographical variables

Rurality	Indicates the proportion of inhabitants in municipalities with a population density < 150 E/km². The indicator points to rather rural dispersed settlement structures. The variable is measured proportional to the overall area of the administrative level 'Kreis'.
Natural spaces	Indicates the area of natural land proportional to the overall area of the administrative level 'Kreis'. Natural land comprises peatland, heathland and uncultivated land that cannot be used in an orderly manner (rocks, dunes).
Recreation areas	Indicates recreation area per inhabitant in m². Recreational areas are undeveloped areas that are primarily used for sports, and recreation. These include green spaces as parks, allotments as well as sports fields and campsites.
Forest coverage	Indicates the area covered with forests proportional to the overall area of the administrative level 'Kreis'. Forest areas include undeveloped land covered with trees and shrubs, but also forest patches, plant nurseries, grazing areas for big and small game.
Beneficiaries	Proportion of residents with a monthly claim to unemployment benefit I (SGB III).
Income hh	Average household income in € per inhabitant. Disposable income is to be understood as the amount available to private households for consumption purposes or for savings.
Habitat density	Indicates how many inhabitants live per km² of settlement and traffic area.
Free area	Indicates the open space per inhabitant in m². Open space includes all undeveloped areas, such as recreational, cemetery, agricultural, forest and water areas.
Car density	Indicates the number of passenger cars per 1,000 inhabitants.
Wind energy	Indicates the installed capacity of wind energy in watts per inhabitant. The indicator provides information on the installed capacity of all wind turbines in relation to the number of inhabitants. In this sense, the municipalities are compared with regard to their efforts to contribute to the energy transition and CO2 reduction through the generation of wind energy reduction.

**Note: Data are collected at the basis of NUTS-3 regions. Source: Indikatoren und Karten zur Raum- und Stadtentwicklung. INKAR. Ausgabe 2020. Hrsg.: Bundesinstitut für Bau-, Stadt- und Raumforschung (BBSR) im Bundesamt für Bauwesen und Raumordnung (BBR) - Bonn 2020. http://www.bbsr.bund.de*

Table A1. 5: Summary statistics of geographical Variables

	N	mean	sd	Min	Max
Rurality	152	10.8	20.6	0	100
Natural spaces	152	5.1	2.5	1.3	13.3
Recreation area	152	50.6	41.9	15.9	384.6
Forest coverage	152	22.9	12.7	1.7	59.5
Beneficiary	152	10.3	4.9	2	20.2
Income hh	152	1872.4	223.8	1486.6	2418.9
Habitat density	152	3345.7	1731.9	517.4	6287.1
Free area	152	2253.2	3525.1	83.3	25619.8
Car density	152	503.3	101.8	330.7	755.2
Wind energy	152	191.9	458.5	0	2849.8

Table A1. 6: Summary statistics of geographical variables by treatment

	S-treatment			**CBS-treatment**			**Balance test**
	N	mean	sd	N	mean	sd	p- value
Rurality	69	14.3	23.7	83	7.9	17.2	0.15
Natural spaces	69	5.2	2.6	83	5.1	2.5	0.90
Recreation area	69	57.4	53.4	83	44.	28.1	0.24
Forest coverage	69	23.8	12.1	83	22.1	13.2	0.39
Beneficiary	69	10.5	5.1	83	10.0	4.9	0.51
Income hh	69	1833.2	189.1	83	1905.0	245.3	0.09
Habitat density	69	3027.6	1642.1	83	3610.1	1769.6	0.04
Free area	69	2823.4	4225.1	83	1779.1	2752.9	0.06
Car density	69	511.0	97.3	83	496.9	105.6	0.42
Wind energy	69	290.5	613.9	83	109.9	244.3	0.48

Table A1. 7: Explanation of survey variables

Trust in durability of CO_2 removal… Scale: 1 = unkown, 2 = small, 3 = rather small, 4 = rather great, 5 = great	
... by forests	Indicates how much participant trusts that forests permanently remove CO_2 from the atmosphere
…through emission allowances	Indicates how much participant trusts that CO_2 allowances permanently remove CO_2 from the atmosphere
Informed on… Scale: 1 = very poor, 2 = poor, 3 = good, 4 = very good	
… climate change	Indicates how well participant feels informed about climate change in general
… climate change drivers	Indicates how well participant feels informed about the drivers of climate change
… forests as carbon sink	Indicates how well participant feels informed about climate regulation and carbon sequestration by forests
… forest project providers	Indicates how well participant feels informed about providers of compensation services from forest projects
… EU ETS	Indicates how well participant feels informed about the European emissions trading
… certificate providers	Indicates how well participant feels informed about providers of emission allowances or voluntary CO2 offsets
Informed on co-benefit … Scale: 1 = well-known, 2 = rather known, 3 = rather not known, 4 = not known	
… biodiversity	Indicates whether biodiversity is a forest function known to the participant
…regulation microclimate	Indicates whether the regulation of the microclimate is a forest function known to the participant
… carbon sequestration	Indicates whether sequestration of carbon is a forest function known to the participant
… air quality improvement	Indicates whether the improvement of air quality is a forest function known to the participant
…recreational value	Indicates whether the recreational value of a forest is known to the participant
Hypothetical environmental donation	The participant should for the question imagine that she gets 20 EUR for answering a questionnaire, which takes about 20 minutes. After answering the questionnaire, you she has the opportunity to donate the remuneration. The variable indicates how much the participant would hypothetically donate for the sequestration of 100kg of CO2 within a reforestation project.
Preferred environmental donation	Indicates whether the participant would prefer an environmental donation to set aside CO2 certificates (EU ETS), or to support a reforestation project in Germany, or none.

Appendix 2: Additional Analysis

Table A2.1: Distribution of participants and share of contributors within distance categories

	Share of Contributors	Total contributions			Contributions cond. on giving		
		Mean	Median	n	Mean	Median	n
within 60min	91%	8.1	5.1	12	8.9	5.2	11
60-120min	59%	5.2	5	22	9.7	10	13
121-180min	48%	5.4	0	27	11.3	10	13
>181min	65%	5.9	4.1	91	9.07	9	60

Table A2.2: Distribution of participants and share of contributors within distance categories by treatment

		Share of Contributors	Total contributions			Contributions cond. on giving		
			Mean	Median	n	Mean	Median	n
outside 60min	CBS	66%	2	5.2	77	9.1	10	44
	S	57%	6.6	5	63	63	0	42
within 60min	CBS	83%	5.4	2.3	6	2.5	6.5	5
	S	100%	10.9	2.9	6	10.9	7.6	6
60-120min	CBS	47%	3.1	0	15	6.6	5	7
	S	85%	11.4	10	7	15	13.3	6
121-180min	CBS	46%	6.1	0	13	13.1	12.5	6
	S	50%	4.9	0.5	14	9.7	10	7
>181min	CBS	63%	5.4	2	49	8.9	19	31
	S	69%	5	6.4	42	7	9.2	29

Appendix 3: Questionnaire and Treatment
(Translated from the German original)

The Questionnaire
The questionnaire is unrelated to the experiment. The questionnaire items can be supplied upon request.

The Treatment Text
[**S and CBS:** You now have the opportunity to use your remuneration to make a contribution to a climate protection project. You are completely free to decide whether and, if so, how much you wish to contribute. The following information is intended to provide you with essential background information on the selected climate protection project.

The Paris Climate Convention aims to limit global warming to 2 - preferably 1.5 - degrees Celsius above pre-industrial levels. According to the Intergovernmental Panel on Climate Change, this requires that "net emissions" of greenhouse gases such as CO2 are rapidly reduced to zero. More precisely, zero net emissions means that the amount of greenhouse gases emitted must be at least equal to the amount of greenhouse gases removed from the atmosphere.

Carbon sinks offer an opportunity to remove CO2 from the atmosphere and thus protect the climate globally. A well-known example of a carbon sink are forests: With reforestation the carbon sequestration capacities can be enhanced. In preparation for the Bundesgartenschau (Federal Horticultural Show) in 2023, the City of Mannheim intends to unseal urban areas over the next few months and to then create an additional local carbon sink by planting trees of predominantly native species. According to the current state of planning, the City of Mannheim guarantees permanent maintenance by the municipal park department.

You now have the opportunity to support this project of the city of Mannheim. With your contribution to the reforestation project additional trees can be planted. These trees actively remove CO2 from the atmosphere and bind it over their lifetime. How quickly or how much CO2 a tree binds depends on many factors, such as the tree species, its age, soil quality and water supply. For example, experts at the Forest Centre of the University of Münster calculate that a beech needs to grow for about 80 years to absorb one ton of CO2. On average, this means a beech absorbs 100kg of CO2 in eight years.]

[**Only CBS:** Your contribution will not only help to protect the global climate, but also creates additional habitats for animals and plants and supports local biodiversity. Besides, there are a range of other additional positive side-effects for society. Afforested areas serve as recreational and leisure areas. They improve local air quality by filtering harmful fine particles from the air, and improve the urban climate and the supply of fresh air. Especially in the summer months, reforestation can locally increase the balance of temperature and humidity extremes.]

[**S and CBS:** Please use the slider below to indicate the contribution you would like to make to the reforestation of the tree population in Mannheim.

I would like to support the removal of 100kg CO2 from the atmosphere as part of the reforestation project with:

[Slider]

Of course you can also decide to contribute nothing. The remaining amount of the participation fee will be sent to you in the form of a voucher as described above.

After evaluating the data of all participants, we will inform you about the results. No individual contributions will be mentioned.]

Appendix 4: Survey Questions

(Translated from the German original)

Page 1

In the past, participants of our studies have repeatedly asked us for the opportunity to donate part of their remuneration to projects protecting the climate and the environment. Please imagine you are a participating in such an incentivized study and answer the following questions against this background.

As you may know, there are different ways to make a contribution for the environment and climate protection. Consider the following two donation options:

- Retirement of CO_2 allowances under the European Emissions Trading Scheme. Once a CO_2 allowance is purchased it can no longer be used for entitlement to emit CO_2 on the market
- A reforestation project in Germany

In the context of such an environmental donation, would you generally prefer to have the opportunity to set aside CO_2 certificates as part of the European Emissions Trading Scheme, or would you prefer to support a reforestation project in Germany?

☐ Rather purchase CO_2 certificates
☐ Rather support reforestation project
☐ I would equally endorse both projects as a donation option
☐ I would not support either project as a donation option

Page 2

Please think again about the reforestation project. With which of the following functions of the forest are you familiar?

	Well-known	Rather known	Rather not known	Not known	No Answer
Biodiversity / Habitat for plants and animals					
Raw material supplier					
Regulation of the microclimate					
Carbon sequestration					
Water reservoir for flood protection					
Water filter for clean groundwater					
Protection against erosion					
Improvement of local air quality					
Noise protection					
Recreation					
Sports					

Page 3

Trees can absorb and bind CO_2 over the course of their lives as they grow. Please imagine again that have the opportunity to support a reforestation project.

- How many tons of CO_2 do you think an 80-year-old beech tree can sequester? [Slider]
- What is the corresponding emission value of a distance traveled by a car (in km) of this value? [Slider]
- Assume that participation in the study would be remunerated with 20 EUR, for which you would have to answer a questionnaire. Answering the questionnaire takes about 20 minutes. After answering the questionnaire, you have the opportunity to donate your remuneration in parts or fully. How much would you be willing to donate for the sequestration of 100kg of CO_2 within the reforestation project?

Page 4

How quickly or how much CO_2 a tree can sequester depends on numerous factors, such as the type and age of the tree, the soil quality and its water supply. Accordingly, data on the CO_2 sequestration potential of forests varies depending on the calculation base. Experts at the Forest Center of the University of Münster estimated that a beech must grow for about 80 years to absorb one ton of CO_2. On average, this means a beech can absorb100kg of CO_2 in eight years. This corresponds roughly to the emission value of a distance traveled by a car of about 550 km.

After having received this information, would you want to adjust your donation from the previous page?

- ☐ Yes, I would like to increase the donation amount (to_____€)
- ☐ Yes, I would like to decrease the donation amount (to____€)
- ☐ No, I would not change the donation amount

Page 5

	Great	Rather great	Rather small	Small	Never heard of this	No Answer
How much do you trust in the durability of CO2 reduction through forests?						
How much do you trust in the durability of CO2 reduction through the purchase of emission allowances?						

Page 6

In the following, we are in your basic assessment regarding various climate protection measures. How much do you agree with the following statements?

	Strongly agree	Agree	Disagree	Strongly disagree	No answer
Reforestation is a useful and sustainable climate protection measure					
Emissions trading can make a decisive contribution to climate protection					
Emissions trading alone is not enough to achieve emissions targets					
Especially natural approaches such as reforestation projects should be additionally used to reduce CO_2					

Page 7

Finally, we would now like to know how good you feel informed about...

	Very good	Good	Poor	Very Poor	No answer
climate change in general					
the drivers of climate change					
climate regulation and carbon sequestration by forests					
providers of compensation services from forest projects					
the European emissions trading system					
providers of emission allowance set-asides or voluntary CO2 offsets					

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ZEW – Leibniz-Zentrum für Europäische Wirtschaftsforschung GmbH Mannheim

ZEW – Leibniz Centre for European Economic Research

L 7,1 · 68161 Mannheim · Germany
Phone +49 621 1235-01
info@zew.de · zew.de