The Influence of Transparency on Investments in Climate Protecting – An Economic Experiment

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July, 2014

ABSTRACT: Climate change is one of the biggest problems humankind is currently facing. Therefore, there have recently been a rising number of studies which analyze the economic components of climate change. Especially experimental economics offer a promising way to circumvent the missing data problem and the lack of control in the field. The present study experimentally analyzes the influence of transparency on investments in climate protection using a collective-risk social dilemma framework. The results are as follows: There is a positive influence of transparency on investments in climate change, but it turns out to be not significant. However, the results of the present study taken together with the results of former studies using the same framework indicate that information saliency regarding climate change and climate protection have a huge promoting influence on investments in climate protection and therefore could be a part of the solution of the climate change problem.

JEL Classification: Q54, H41, D03

Keywords: *Climate Change, Emission Reduction, Public Goods Game, Transparency, Economic Experiment*

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1 INTRODUCTION

Climate change is one of the biggest, if not the biggest, problem humankind is currently facing. Increasing numbers of extreme weather events of different kinds from all around the world are proof of the climate change, and so there is a broad consensus between scientists specializing in topics regarding climate change that humans are responsible for these changes and thus the consequences. The Intergovernmental Panel on Climate Change (IPCC (2013, p.17)) states in their current Assessment Report:

> *"Human influence has been detected in warming of the atmosphere and the ocean, in changes in the global water cycle, in reductions of snow and ice, in global mean sea level rise, and in changes in some climate extremes […]. This evidence for human influence has grown since AR4 [the last Assessment Report in 2008]. It is extremely likely that human influence has been the dominant cause of the observed warming since the mid-20th century."*

To attenuate the negative consequences of climate change or to prevent them in the long run, international agreements – like the Kyoto Protocol – have been written up to reduce the emissions worldwide that cause the climate change. However, besides the necessity of emission reduction, there is empirical evidence that it is economically efficient to reduce emissions for individuals as well as for companies. Hart and Ahuja (1996), for example, show for a sample of American manufacturing, mining and production companies that emission reduction efforts begin to pay off after one to two years, where the time lag is due to the fact that, on the one hand, up-front investments are often necessary to reduce emissions and, on the other hand, the resulting cost savings take time to be realized. Konar and Cohen (2001) show that a good environmental performance is valued by the market. In their sample of publicly traded firms, a "10% reduction in emissions of toxic chemicals results in a $34 million increase in market value." Corresponding effects have been found for private households, for example in the fields of power and gas usage as shown by Fischer (2008) or Ayres, Raseman and Shih (2013). When the individual actor does not benefit directly as it is the case with cost savings in the case of reduced power and gas usage, the problems of a public good occur, or in the present case a public bad.[1] Because each individual benefits

[1] While in the normal case, a public good is provided if investments reach a certain threshold, in the present case a public bad is prevented if the threshold is reached. For the effects that stem from these different angles, see e. g. Sonnemans, Schram and Offerman (1998). For the different institutional settings

not only from its own investments in climate protection but equally from everybody else's, there is a huge incentive to free-ride for the single individual. This incentive gets stronger, the bigger the group which is affected. This effect is pointed out by Milinski, Semmann, Krambeck and Marotzke (2006, p. 3994) who describe the task to prevent climate change as "[…] probably the greatest 'public goods game' played by humans. However, with > 6 billion 'players' taking part, the game seems to rule out individual altruistic behavior." Therefore, it is crucial to find out how these problems in preventing climate change can be solved. These few examples already indicate that there is an economic component in climate change and climate protection. Additionally, it is quite obvious that any negative consequences of a changing climate – be it floods, droughts, the rising sea level or other extreme weather and climate events – result in negative economic consequences.

The present study investigates how the level of transparency of investments in climate protection influences the investment behavior of a group of investors and how the level of transparency influences the distribution of investments in climate protection over time in such a group. To analyze these questions, an economic experiment is conducted because of three reasons. First, the required empirical data are not available, second, the crucial parameters are hard or impossible to influence in the field and third, it would therefore not be possible to identify any causality of effects. So, experimental economics offer a unique opportunity to investigate the proposed questions.

The reminder of the paper is organized as follows. Section 2 discusses the state of the art of (economic) experimental research in the context of climate change with focus on the topic of emission reduction. The importance of transparency for emission reduction is discussed in section 3. The experimental design and experimental procedure are presented in section 4, where the hypotheses are also derived from the literature regarding the influence of transparency in related contexts. While in section 5 the data are analyzed and results are discussed, some concluding remarks are provided in section 6.

that have been used to study public good provision and public bad prevention, Ostrom, Gardner and Walker (2006) offer an overview.

2 EXPERIMENTAL ECONOMIC ANALYSIS ON CLIMATE CHANGE

In the field of economic analysis of climate change using experimental methods, there are different bodies of literature, especially concerning the allocation and trading of pollution permits and emission reduction. There are many studies for pollution permits which experimentally analyze how efficient different kinds of auctions or other distribution mechanisms, such as grandfathering, are (e.g. Franciosi, Isaac, Pingry and Reynolds (1993) and Ledyard and Szakaly-Moore (1994)).[2] Other studies focus on the consequences of the banking of permits (e. g. Godby, Mestelman, Muller and Welland (1997), Cason and Gangadharan (2006) or Stranlund, Murphy and Spraggon (2011)) or how compliance with permit allocation is effected by different types of polluters (Murphy and Stranlund (2007)). For a more detailed overview of experiments on pollution permits, see for instance Noussair and van Soest (2014).

In the field of emission reduction, Milinski, Semmann, Krambeck and Marotzke (2006) were the first to conduct a public good experiment in a climate change framework. They were interested in how altruistic personal investments in protecting the climate can be increased. They analyzed two factors that could influence investment behavior: the players' state of knowledge and social reputation. They designed their climate public goods game, so that six subjects had to simultaneously decide in each round whether they would invest € 0, € 1 or € 2 into a climate account. At the end, the total sum in the account would be doubled by the experimenters and used to publish an advertisement in a German newspaper that would inform the readers about climate change in general, besides giving recommendations on how people can contribute to climate protection in their daily life. The size of this advertisement was determined by the total amount in the climate account. The rounds of the climate public goods game took turns with rounds of an indirect reciprocity game[3], where each group member was assigned to another group

[2] Further studies in this area are e.g. Cason (1995), Cason and Plott (1996), Cason and Gangadharan (1998), Ben-David, Brookshire, Burness, McKee and Schmidt (1999), Muller, Mestelman, Spraggon and Godby (2002), Porter, Rassenti, Shobe, Smith and Winn (2009) or Goeree, Palmer, Holt, Shobe and Burtraw (2010).

[3] Indirect reciprocity means that when an individual A behaves cooperatively toward individual B it can build a positive reputation for doing so in the eyes of individual C, which observes the cooperative behavior. Because of this reputation, individual C will act cooperatively towards individual A and therefore reciprocate indirectly. (Direct reciprocity would mean a cooperative act of B towards A.) See for example

member in each round, to whom he could donate € 1.5 to, which would again be doubled by the experimenters. To analyze the effects of social reputation, at the end of each round of the indirect reciprocity game and of every second round of the climate public goods game, the decisions of all the group members were shown to all group members on the computer screen.[4] Additionally, the treatment group received written information from an expert in the field of climate and climate change on this topic. The authors analyzed the data of 156 subjects (13 groups of 6 subjects for the treatment and the control group respectively). They found that subjects were willing to contribute more often to the climate account in non-anonymous rounds than in anonymous ones. Regarding social reputation, they show that subjects who did not contribute to the climate account in non-anonymous rounds of the climate game were significantly less often supported in the following indirect reciprocity game than subjects who contributed nothing in an anonymous round. Regarding the information level, well informed subjects did not only contribute significantly more often but also did contribute significantly higher amounts than their uninformed counterparts.

Milinski, Sommerfeld, Krambeck, Reed and Marotzke (2008) conducted a threshold public good game[5] in a climate change framing. There is one main difference to other applications of this game in the case of climate change. Usually, a gain is realized if the threshold is reached. When analyzing climate change it is a public bad situation; a loss can be avoided if the threshold is reached. In Milinski, Sommerfeld, Krambeck, Reed and Marotzke (2008), this loss is a dangerous climate change which occurs with a certain probability and translates into the loss of the remaining endowment for the subjects, if it occurs. Subjects were randomly assigned to groups of six and could decide in each of ten consecutive rounds whether to invest € 0, € 2 or € 4 of their € 40 endowment into a climate account. Investment in the climate account was anonymous and the threshold was at € 120. At the end of round ten, the subjects kept whatever money of their initial endowment was left, yet if the threshold was not reached by the group, all group members lost their remaining money with a certain probability. The money in the

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Bolton, Katok and Ockenfels (2005) for theories of indirect reciprocity as well as the experimental implementation.

[4] To each participant a pseudonym was assigned to guarantee anonymity, which was constant throughout the experiment.

[5] For a review of threshold public goods games, see Croson and Marks (2000).

climate account was again used to place an advertisement, like in Milinski, Semmann, Krambeck and Marotzke (2006). Three different treatments with ten groups each were played, where the probability of the dangerous climate change was 10, 50 and 90 percent, respectively. The analysis shows that in the 90 percent treatment, 50 percent of the groups managed to reach the threshold. It is notable that some of the groups in the 90 percent treatment that missed the threshold, did so by small amounts which "represents the worst possible outcome: low individual savings and no collective benefit" (Milinski, Sommerfeld, Krambeck, Reed and Marotzke, 2008, p. 2293). In treatments with a lower disaster probability, groups generally failed to reach the necessary threshold.

Brick and Visser (2010) introduced heterogeneity of players in climate public good experiments. They analyzed how players with different marginal costs for emission mitigation distribute the responsibility of emission mitigation within the group. For their experiment, they chose a somewhat more standard public good setting. Groups consisted of four subjects, of which two represented firms and two households. Subjects had to decide in a one-shot-game how to distribute their endowment of ten tokens between an investment in their private account and an investment in the public climate account which represented investment in emission mitigation. Each token invested in the private account yielded six tokens for household-players and twelve tokens for firm-players, while each token invested in the public account multiplied by ten if invested by households and by twenty if invested by firms. The total amount in the public climate account was then equally divided between all players, whether they contributed to the public account or not. Four different treatments were analyzed, for all of which a target of 240 units for the public account was specified. In the baseline treatment, this target was nonbinding. In the communication treatment, the target was still nonbinding, but subjects could use a chat program to coordinate their investments. In the tax_{36} treatment, emissions should be reduced equally across the sectors, so each firm should invest at least 3 and each household at least 6 tokens in the public account. Finally, in the tax_{44} treatment, cost of emission reduction should be distributed equally across the sectors so each firm as well as each household should at least invest 4 tokens. In both of the tax treatments, there was a carbon tax of ten tokens to be paid by each player for each token he or she undercut the specified minimum investment. In total, 204 subjects participated in 51 groups. 17 groups played the baseline treatment for four consecutive times, while the remaining 34 groups played all four different treatments in two different orders. On average, Brick and Visser (2010) find that only 18 percent of the groups that only played the baseline met the mitigation target. In the groups who played all treatments the target was met by 35 percent in the baseline treatment and when communication was introduced the level increased to 50 percent. Target achievement was almost complete when taxation was introduced. Even so, taxation did crowd out contributions above the respective minimum investments: the target was met by 91 percent in the tax_{36} treatment and by 88 percent in the tax_{44} treatment.

The differences between the baseline and the communication treatment are discussed in greater depth in Brick, van der Hoven and Visser (2013). Here, the authors concentrated on different contribution strategies, namely equality of income, equality of emission reduction and equity. They observed that most subjects had a preference for equality of incomes and that this strategy was also most frequently agreed upon in the group chats. They also found that communication leads to extremer decisions, so participants were polarized between free riders and perfect cooperators, although subjects with higher marginal abatement costs (in this case subjects representing a household) were more likely to become free riders.

Hasson, Lofgren and Visser (2010) investigated the question how the vulnerability of countries regarding consequences of climate change influences the trade-off between investments in mitigation and adaption. They chose a prisoner's dilemma to analyze their question[6] and played it one-shot, because they claim that "[a]n important factor in analyzing climate change is that decision making is, to a large extent, characterized by irreversibility" (Hasson, Lofgren and Visser, 2010, p. 334). The game was played by 16 groups consisting of four subjects each. Subjects had to decide whether they would invest ten tokens of their 100 token endowments in either mitigation or adaption. A splitting of the ten tokens was not possible. Each investment in mitigation resulted in a reduction of the probability of a climate disaster. Therefore, all subjects profit from an investment in mitigation and it can be interpreted as an investment in a public good. In

[6] More insights on the prisoners' dilemma and related climate-change games are provided by Irwin (2009).

contrast, an investment in adaption lowers the magnitude of a climate disaster only for the subject who invested in adaption and is therefore characterized as private investment. Because climate change and its negative consequences are uncertain in this setting, the underlying model is called stochastic model. There were a low vulnerability and a high vulnerability treatment, where the only difference was that the payoffs in the first are higher than in the second. The results show that, on average, 26.5 percent of subjects opted to invest in mitigation. Regarding the vulnerability level, there was no significant difference in mitigation rates between the two treatments.

Leaving the vulnerability level out, Hasson, Lofgren and Visser (2012) again used their stochastic model, this time testing it against their so-called deterministic model. The set up for the deterministic model is mainly the same as for the stochastic model. The only differences are that negative consequences of climate change are now certain and both, investments in mitigation and in adaption, reduce the magnitude of the loss due to the disaster. As before, investments in mitigation are a public good and reduce the magnitude for every subject in the group, while investments in adaption are private and therefore only benefit the investing subject. 144 subjects participated in random groups of four. In the stochastic treatment, 25 percent of the subjects chose to mitigate which nearly equals the 26.5 percent from Hasson, Lofgren and Visser (2010). Although the mitigation rate in the deterministic case was slightly higher (31 percent), the difference between the treatments is again insignificant.

Another form of heterogeneity in the climate change context was introduced by Milinski, Röhl and Marotzke (2011). As a starting point they used the collective-risk social dilemma game from Milinski, Sommerfeld, Krambeck, Reed and Marotzke (2008), yet introduced heterogeneity in wealth (initial endowments and operating funds) as well as two time horizons instead of one. In doing so, they wanted to shed further light on climate negotiations, where poor and rich countries try to reach agreements. Further, intermediate climate targets as well as climate risks were present. Subjects could either be rich or poor. Rich subjects received an initial endowment of € 60 and an operating fund of € 40, while poor subjects were endowed with € 30 and an operating fund of € 20. Again, subjects had to choose in ten consecutive rounds whether to donate € 0, € 2 or € 4 of their operating fund and, again, if the target of € 120 was not reached, all subjects in the group lost their endowment (not the remains of the operating fund) with a probability of 90 percent. The money invested to prevent climate change was again used to place an advertisement. There were three treatments with only rich, only poor and an even mix of rich and poor subjects. There were also three similar treatments with the additional intermediate climate target. If the intermediate target of € 60 was not met after round five, subjects would lose ten percent of their operating funds and their endowment with a probability of 20 percent in each of the rounds six to ten. A total of 57 groups with six subjects each were analyzed. From the groups without an intermediate target, all of the only-rich groups, 60 percent of the mixed groups, but none of the only poor groups reached the target of € 120 at the end of the game. With an intermediate target, investment in the five first rounds increased. Therefore, all rich, nearly all mixed and 60 percent of the poor groups reached the intermediate target. While investment levels on average stayed high in the rich and mixed groups, this was not the case for the poor groups. This resulted in only 33.3 percent of the poor groups reaching the final target, while again all rich groups and 66.6 percent of the mixed groups did so. The results for the mixed groups also show that in cases with an intermediate target, rich players compensated lower contributions from the poor players.

Tavoni, Dannenberg, Kallis and Loschel (2011) also investigated the influence of unequal endowment on meeting an emission target using the above described collective risk social dilemma game. In contrast to Milinski, Röhl and Marotzke (2011), here inequality should reflect that richer countries emitted more greenhouse gases than their poor counterparts. To implement this, the first three of the ten rounds were inactive, that is the computer decided about the investment in the climate account. In the unequal treatment the computer contributed € 4 each of the inactive rounds for three of the players (the poor players) and € 0 for the other three (the rich players), while in the base treatment the computer contributed € 2 for all 6 players. Hence, in both treatments all groups started deciding in round four, with already € 36 of the € 120 target in the climate account. If the target was not reached by the end of round ten, subjects lost the remainder of their € 40 endowment. The money on the climate account was used to purchase and retire CO_2 emission certificates from the EU if the target was met.

Otherwise, only half of the climate account was used in this manner, while the other half was kept by the experimenters. Additionally, subjects could make a nonbinding announcement after the third and the seventh round about the amount they wanted to invest in the game in two otherwise identical treatments. Each of the four treatments was played by ten groups. In total, Tavoni, Dannenberg, Kallis and Loschel (2011) found that inequality leads to lower rates of target achievement, while pledges make it much easier to reach the threshold although they are nonbinding. In the base treatment, 50 percent of the groups met the target, in contrast to only 20 percent of the groups in the unequal treatment. With the additional possibility to pledge, 70 percent of groups met the target when investments in the inactive rounds were equal and 60 percent when investments were unequal. When taking a closer look at the behavior of rich and poor players in the unequal treatments, the results show that the poor are not compensating for the inaction of the rich players in the first three rounds, but that in order to reach the target, rich players have to contribute more to remove this imbalance.

Burton-Chellew, May and West (2013) combined the factors wealth inequality and vulnerability in their study. They also adapted the collective-risk social dilemma by Milinski, Sommerfeld, Krambeck, Reed and Marotzke (2008). In the `egalitarian treatment´, all six subjects were endowed with 40 monetary units (mu), while in the `unequal-wealth treatment´ four poor players were endowed with 20 mu. The remaining two rich players received 80 mu. For both of these treatments, the risk of a climate disaster – and therefore losing their remaining mu if the target of 120 mu was not reached – was 70 percent for half of the groups; for the other half it was 80 percent. For the `rich suffer treatment´ and the `poor suffer treatment´, the distribution of initial endowments was equal to that in the unequal-wealth treatment. The catch here was that in the rich suffer treatment, the vulnerability, represented by the probability of disastrous climate change, was higher for the rich players (95 percent for one half of the groups in this treatment and 90 percent for the other half) than for the poor (65 percent for one half of the groups in this treatment and 50 percent for the other half). In the poor suffer treatment, it was exactly the other way around. In total, 36 groups were equally split between the four treatments. In the poor suffer treatment, climate change was only prevented in one of eight cases, whereas 75 percent of the groups in the other three treatments were successful in preventing climate change. The rates of target achievement were not significantly different between those three treatments; neither were the differences between the groups with different loss probabilities in all four treatments. One additional interesting finding was revealed when analyzing the post experimental questionnaire. Surprisingly, subjects who were more affirmative regarding climate change and the subsequent responsibilities invested significantly less in the climate account.

3 THE ROLE OF TRANSPARENCY

Transparency plays a crucial role in the challenge of preventing negative consequences of climate change. This becomes obvious when one realizes that with every human on the planet being a player, coordination is nearly impossible and the temptation to free ride becomes extremely high without or with a low level of transparency. On these grounds, the United Nations Framework Convention on Climate Change UNFCCC (2014) demands that every party of the Kyoto Protocol provides a National Inventory Submission (NIS) on a yearly basis that reports extensive information and estimations of the party's GHG emissions and removals.[7]

All studies mentioned above provide important insights on the factors which play an important role in either preventing or promoting climate change. However, it is striking that transparency has not been an issue in the experimental analysis so far. In all studies that used a design with repeated interaction, subjects were informed about who invested how much in climate protection after each round. An exception is the study by Milinski, Semmann, Krambeck and Marotzke (2006) where this strong assumption about the transparency of actions was attenuated in the anonymous treatment. In this treatment, subjects were still informed about the contributions of each player but they were provided in a random order and without screen names. Because in this experiment, reputation played an important role (as described above) it is not clear whether the significant differences in contributions between anonymous and non-anonymous contributions are due to the lower level of transparency or the inability to

[7] The NIS' are publicly available at the website of the UNFCCC at https://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/8108.php.

build reputation. Therefore, this finding can only be seen as a first hint that transparency is a promoting factor for emission reduction.

When turning from the lab to the real world, the assumption that CO_2 reductions – or more generally the investments in climate protection – of others are common knowledge is questionable. This assumption may hold for analyses of emission reduction on the country level. An example that supports this assumption is again the fact that the UNFCCC demands the annual National Inventory Submissions from every signee. Most of the actual emission reduction takes place on a much more individual level, be it firms or private households, while negotiations about the amount of emissions that each country should produce at maximum take place at the country level. Therefore, if we want to gain insights out of these experiments on the firm- or household-level, this assumption is no longer tenable and needs to be relaxed. This becomes quite obvious when one thinks of the aforementioned six billion players argument of Milinski, Semmann, Krambeck and Marotzke (2006, p. 3994) and that this should rule out altruistic behavior. And just this enormous amount of players illustrates that not every company can know how much their competitor, let alone any other company, pollutes or invests in emission reduction. Similarly, not every individual knows the size of its neighbors' carbon footprint; in fact many individuals will probably not know the size of their own.

Literature on the influence of transparency on emission reduction is scarce. There are some studies that show that households reduce their power consumption if the power company provides feedback regarding the own consumption behavior compared to that of the neighborhood. For example, Fischer (2008) gives an overview for studies between 1987 and 2007 where savings lie between 0 percent and 20 percent depending on the kind of feedback used in the respective studies. Ayres, Raseman and Shih (2013) analyze two more recent field experiments about electricity and nature gas usage and peer comparison feedback, where savings lie between 1.2 and 2.1 percent. So, in these cases transparency about the behavior of other individuals seems to promote an emission reducing behavior.

Besides this, there is somehow related work in the fields of public goods (e. g. Varian (1994), Fershtman and Nitzan (1991) and Admati and Perry (1991)), charitable giving (e. g. Marx and Matthews (2000) and Bag and Roy (2008)), and teams and employment relations (e. g. Bag and Pepito (2012), Mohnen, Pokorny and Sliwka (2008), Irlenbusch and Sliwka (2005) and Winter (2010)) which incorporates the aspect of transparency.

For public goods games, Varian (1994) shows that in a model with nonrecurring sequential contributions (so the action of the first mover is observable for the second mover) the amount provided of the public good is never larger than in the case of simultaneous contributions. In a related model, but with repeated contributions, Admati and Perry (1991) show that projects that are socially desirable are not realized if contributions are sunk the moment they are made. This inefficiency can be avoided, if the costs incur only if the project's costs are covered.

Marx and Matthews (2000) model dynamic donations to public projects, where individuals can only observe the aggregated contributions after each round. Bag and Roy (2008) investigate how equilibria are affected by transparency of donations in such a case. They build a model for repeated donations to a charity and can show that under certain conditions the announcement of contributions leads to higher expected total contributions. Transparency about the contributions of others results in higher individual donations than in the case where contributions are not observable. They argue that this is the case because the announcement makes valuation and preferences of others transparent which are otherwise private information. Therefore, fundraisers for charities or other public goods should use announcements as an instrument.

Irlenbusch and Sliwka (2005) experimentally analyze how transparency influences the evolution of reciprocal behavior in a principal-agent framework. They find that, while transparency does significantly strengthen the reciprocal behavior, it does not increase the average efforts between their treatments. That is because agents' effort is much more homogeneous under transparency than when the chosen effort is non-transparent. Therefore, principals earn more, if efforts are transparent in their setting and agents earn more if they are not.

Mohnen, Pokorny and Sliwka (2008) show that peer pressure can be provoked by transparency of efforts which leads to a reduction of free riding and therefore to more efficient outcomes. However, transparency leads to different adjustments of behavior depending on the previously provided effort. Agents with higher effort levels than their partners drastically reduced their effort in the following periods while agents with a lower effort level increased theirs, but to a smaller extent. They come to the conclusion that "the total sum of efforts is greater in the transparent than in the nontransparent case."

Another interesting aspect is analyzed by Bag and Pepito (2012). They show that the effect of transparency about efforts in teams depend on whether the efforts are complements or substitutes in the production of the team outcome. In their model, transparency makes no difference if efforts are substitutes, but if efforts are complements collective and individual efforts are at least as high as or even higher than in the non-transparent case. Similar results were obtained by Winter (2010). His model also differentiates between complementary and substitutable efforts, but does not allow for repeated efforts as does the model of Bag and Pepito (2012).

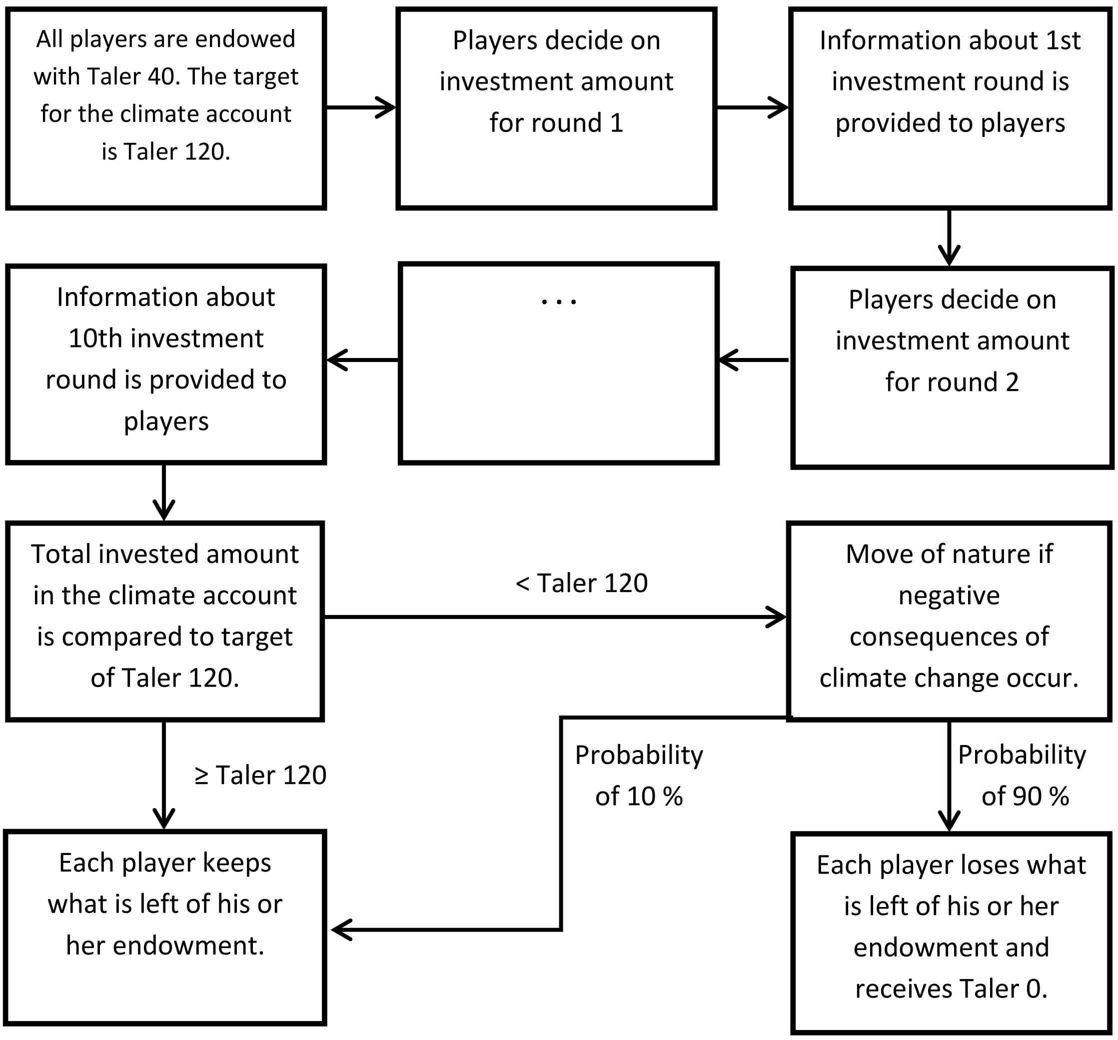
4 EXPERIMENTAL DESIGN AND PROCEDURE

Experimental Design

The prior experiments differ in terms of the experimental design and the framing with respect to the players acting as countries, companies or households/individuals. While Brick and Visser (2010) and Brick, van der Hoven and Visser (2013) explicitly model firms and households in their experiment, the experiments of Hasson, Lofgren and Visser (2010) and Hasson, Lofgren and Visser (2012) convey the feeling that players represent countries. Milinski, Semmann, Krambeck and Marotzke (2006), Milinski, Sommerfeld, Krambeck, Reed and Marotzke (2008), Milinski, Röhl and Marotzke (2011), Tavoni, Dannenberg, Kallis and Loschel (2011), and Burton-Chellew, May and West (2013) do not frame a certain role for the players, so that players can be interpreted as being either countries, firms or households/individuals, because the decisions and consequences modeled in their design work on each of these levels. Following their approach, there will be no explicit framing with respect to the players representing one of these groups in the present experiment.

Even so, Hasson, Lofgren and Visser (2010) and Hasson, Lofgren and Visser (2012) argue in favor of operationalizing emission reduction decisions in a climate change context as a one-shot prisoner's dilemma when it comes to the choice of the underling game; there are good reasons to refrain from doing so at all of the different levels mentioned above. It may even be that most countries, companies and households/individuals decide only once on a fundamental level whether to engage in climate protection or not, but the decisions that effectively reduce emissions of firms (which raw materials to purchase, which investments to make) and of individuals (taking the car or the bike, turning up central heating or wearing a sweatshirt at home, reusing/repairing something or buying something new) are made on a daily basis. And even the decisions of countries to engage in climate protection or not are not irreversible. In 2011, for example, Canada decided to leave the Kyoto Protocol prematurely (Kent (2011)).

Figure 1: Flow diagram of the experimental design



Therefore, following the other part of the experimental literature, in this study a public goods game is used instead of a prisoners' dilemma. Because some aspects of the "classic" public goods game do not fit the case of climate change – such as for instance gaining a surplus from the total amount invested in the public good instead of preventing a further loss in the case of climate change – the aforementioned "collective-risk social dilemma" is used. The applied design is closely related to the original collective risk social dilemma of Milinski, Sommerfeld, Krambeck, Reed and Marotzke (2008) and is depicted in Figure 1.

Groups of six subjects are matched for the experiment, with each subject receiving an initial endowment of Taler 40 (the experimental currency) on their respective private accounts at the beginning of the experiment. In each of the following ten investment rounds, each subject simultaneously decides whether he or she wants to invest 0, 2 or 4 Taler of his or her private account for climate protection. The invested amount of Taler of all six group members is then transferred to a climate account after each round. After round ten, the total amount in the climate account is compared to a predefined target of Taler 120. If the target is met or exceeded by the group, negative consequences of the climate change are successfully prevented and each group member keeps the remaining money on his or her private account. If the target is not reached, the subject's group is affected by the climate change with a probability of 90 percent and loses all remaining money on their private accounts. With a probability of 10 percent, the group is not affected by the climate change and the group members keep the remaining money on their private accounts, despite failing the target. Whether or not the target is achieved, the amount on the climate account is used to compensate real CO_2 Emissions via the service contractor atmosfair.

To analyze the effect of transparency on the emission reduction decision, two treatments are implemented. In the high transparency treatment (htt), subjects are informed after each of the ten investment rounds about the investments of each of the six group members in the last round as well as about the current total amount on the climate account. Subjects in the low transparency treatment (ltt) only receive information about the current total amount on the climate account after each round. Therefore, it is only possible for subjects in the htt (but not in the ltt) to observe individual strategies of all group members, similarly to the original design of Milinski, Sommerfeld, Krambeck, Reed and Marotzke (2008).

Besides the situation in which every player in every round does not invest anything in climate protection (full defection), there are multiple other Nash equilibria where the threshold is met. This is because any situation in which the cumulated investments of all six players in one group reach the threshold of Taler 120 is a Nash equilibrium, since no player can yield a higher output by changing his or her strategy (Nash (1950)). Regarding rules of fairness[8], there are obvious equilibria besides full defection, in which each player transfers a total of Taler 20 to the group's climate account. This equals an expected payoff per player of Taler 20; full defection as an alternative would only yield Taler 4 as expected payoff. Therefore, no player should invest more than Taler 36, if he or she is rational, risk-neutral and wealth-maximizing, because under these circumstances full defection is the better alternative.

Hypotheses

In all previous studies that used a kind of the collective risk social dilemma implemented in the current experiment, some groups reached or exceeded the climate change target. This is especially true in the case of high probability for negative consequences of climate change. Additionally, this also happened in groups which had anonymous rounds in Milinski, Semmann, Krambeck and Marotzke (2006), which is a first indicator that target achievement is possible with a lower level of transparency. Therefore, the first hypothesis states:

Hypothesis 1: There is a positive proportion of groups that reaches or exceeds the climate protection target in both treatments.

As the related literature for public goods, charitable giving and team incentives shows, there seems to be a positive influence of transparency about the actions of others on the cooperation within a group of people. Depending on the circumstances, this positive influence can be caused by different factors, e. g. monitoring, peer pressure, reputation

[8] Due to player homogeneity in the present experiment, it is not possible to disentangle different fairness norms like equal proportional cost, equal total cost and equal outcomes from one another. For findings on this topic in the domain of climate change, see Burton-Chellew, May and West (2013).

building or reciprocity. Additionally, the field experiments reported by Fischer (2008) and Ayres, Raseman and Shih (2013) about feedback on power and gas usage of others also indicate the positive influence of transparency on climate protecting behavior. In agreement with the heuristic model of environmentally relevant behavior of Matthies (2005), peer feedback can also work on different levels, be it personal environmental norms, social norms or other motives, such as minimizing one's cost of action. Accordingly, hypothesis two states:

Hypothesis 2: The proportion of groups that reach or exceed the climate protection target is higher in the high transparency treatment than in the low transparency treatment.

Finally, the higher level of transparency enables some kind of peer monitoring – like it is in the case of team incentives – so it is no longer possible for individuals to hide their non-contribution behind the group's cumulated contributions in one investment period. Therefore, transparency should influence the distribution of investments within the groups and the standard deviation should be lower in the htt. Thus, hypothesis 3 states:

Hypothesis 3: Transparency should lead to a smaller standard deviation in total contributions.

Experimental Procedure

The experiment was conducted in June 2014 at the Business and Economic Research Laboratory (BaER-Lab) at the University of Paderborn and was computerized using the software z-Tree (Fischbacher (2007)). The participants of the seven sessions were recruited using the online recruiting system ORSEE (Greiner (2004)) and were only allowed to attend one of the sessions. In total, 162 subjects participated of whom 42.7 percent study economics and management, 38.2 percent study to become teachers and 19.1 percent are students from other fields of study. 56.2 percent of the subjects are female, on average subjects are 23.7 years old and in their 5.4th semester at university. In all sessions, the subjects were randomly assigned to groups of six. The composition of groups stayed constant throughout the experiment. In three sessions, the high transparency treatment was played and in four sessions the low transparency treatment, so each subject had to make the investment decision for only one of the two treatments. All subjects were seated in separate cubicles with a computer workplace. They had pen and paper at their disposal throughout the experiment, received the same introductory talk and were told that communication was prohibited during the entire experiment. Next, the subjects received a fact sheet regarding climate change and CO_2-compensation and were given time to read them thoroughly to ensure all subjects had the same minimum knowledge about the context of the experiment. Afterwards, the subjects received the instructions and were again given time for thorough reading.[9] The fact sheet and the instructions are provided in the appendix. For the ten investment rounds, subjects were endowed with Taler 40. The earnings for each subject consisted of the amount not invested at the end of round ten, if the group reached or exceeded the pre-defined target for investments of Taler 120 at the end of round ten. If a group missed the target, each subject's earnings consisted of Taler 0 with a probability of 90 percent and of the amount not invested by the subject with a probability of 10 percent. The earnings were paid out at the end of the experiment at an exchange rate of € 1 per Taler 2.5, the amount on the climate account were exchanged at the same rate and used to compensate CO_2 emissions via atmosfair. In addition, all participants were paid a show-up fee of € 2.50. After the experiment, the subjects were asked to answer a questionnaire that contained questions regarding the subjects' socio-economic background, their course of study, their risk preferences, and their attitude towards climate change as well as questions regarding their decisions during the experiment. For the questions regarding climate change, the questions of Burton-Chellew, May and West (2013) were used, which are reported in the appendix. The questionnaire was not incentivized. Each session lasted for approximately fifty minutes and the subjects earned € 8.61 on average. In total, participants compensated 56,030 kg CO_2 during the seven sessions which equals an amount of € 1,289.

[9] Control questions were not used after the reading of the instructions to prevent any kind of anchoring effect within the limited decision set of the experiment. To nevertheless ensure that subjects understood the instructions two measures were taken. First, focus groups were used beforehand to rule out any incomprehensibility and inconsistency in the introductions; and second, the answers to questions in the questionnaire regarding the comprehensibility of the instructions and the task itself did not exhibit signs of misinterpretation or misunderstanding.

5 RESULTS

The sample consists of 27 independent observations, because the 162 subjects were divided in groups of six. Of these observations, 15 were generated in the low transparency treatment and the remaining twelve in the high transparency treatment. As a first step, the distribution of the achievement of the climate change target is analyzed, which is depicted in Table 1.

Two things are remarkable when looking at Table 1. First, in total, 21 of the 27 groups – or 77.8 percent –reached or even exceeded the target of Taler 120 and therefore prevented negative climate change effects in the experiment. This is a much higher fraction than in comparable parameter constellations in previous studies. Second, the percentage of groups that did achieve the target is ten percent higher in the treatment with the highly transparent climate change investments than in the low transparency treatment. In both cases, binomial tests[10] show that the proportion of groups that reached or exceeded the climate protection target is statistically greater than zero on all conventional levels of significance. Consequently, hypothesis 1 cannot be rejected.

Table 1: Distribution of target achievement over treatments

	Target missed	Target achieved	Observations
Low transparency	4 (26.67 %)	11 (73.33 %)	15
High transparency	2 (16.67 %)	10 (83.33 %)	12
Total	6 (22.22 %)	21 (77.78 %)	27

Table 2 compares the rates of groups who did achieve the goal of previous studies which used the collective-risk social dilemma framework with the results of the present study. In the treatment with the 90 percent disaster probability of Milinski, Sommerfeld, Krambeck, Reed and Marotzke (2008) – which equals the present high transparency

[10] Because a binomial test against zero is mathematically not possible, both treatments were tested against 0.0001. As robustness checks for these results, t-tests – which are not applicable because of the small number of observations - and chi-square tests against virtual, same sized samples with target achievement rates of zero, yield congruent results.

treatment – about 50 percent of the groups reached the threshold. Therefore, the 83.3 percent of the htt (and even the 77.8 percent in total) are substantially higher.

Table 2: Comparison to results of previous studies

Paper	Design	Disaster prob.	No. of groups	Success rate (min., max. no. of treatments)	Use of climate account
Milinski et al. 2008	Disaster probabilities	10 % 50 % 90 %	10 10 10	0 % 10 % 50 %	Advertisement
Milinski et al. 2011	Rich/poor and intermediate target	90 %	57	60 % (0 %, 100 %, 6)	Advertisement
Tavoni et al. 2011	Inequality and communication	50 %	40	50 % (20 %, 70 %, 4)	Withdraw of CO_2 certificates
Burton-Chellew et al. 2013	Inequality in wealth and risk	70 % 80 % 65 %/95 % 50 %/90 %	8 8 8 8	75 % (50 %, 100 %, 2) 75 % (75 %, 75 %, 2) 25 % (0 %, 50 %, 2) 62.5 % (25 %, 100 %, 2)	Unclear
Janssen 2014	Transparency	90 %	27	77.8 % (73.3 %, 83.3 %, 2)	CO_2 compensation

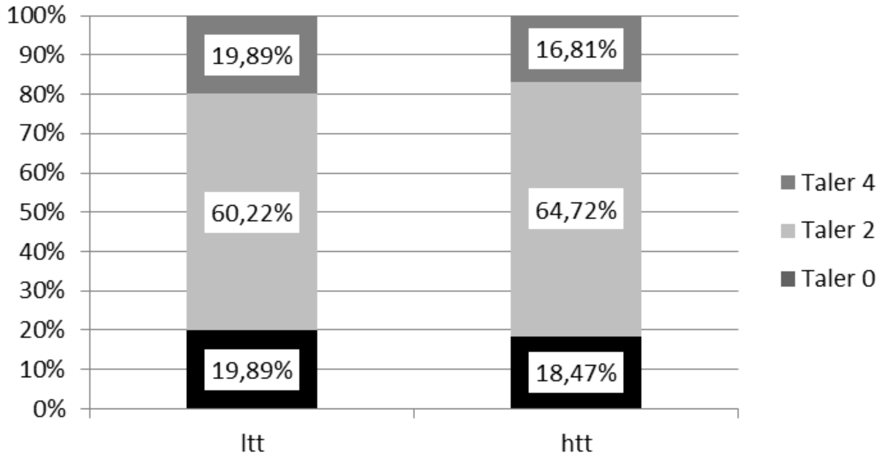
Note: **Design** indicates the research question that was analyzed in the respective paper. **Success rate** is the success rate for a corresponding disaster probability or the mean of success rates, if more than one treatment was conducted with the same disaster probability. Two values in the column **disaster prob.** indicate that different players in each group had these different disaster probabilities. See text for more information.

There are different explanations for this difference in the achievement level. On the one hand, the subjects in the present experiment were perhaps better informed about climate change because of the fact sheet. As shown for several contexts in the literature, higher levels of information do increase the probability to reach a goal. The fact that this also holds in the context of investments in climate change was already shown with the well-informed treatment of Milinski, Semmann, Krambeck and Marotzke (2006), as described above. Therefore, this higher information level is one factor that could explain this result. On the other hand, maybe the present subjects perceived the external validity or saliency of the investment in climate protection as higher than subjects in previous studies. In the present study, specific quantities of carbon dioxide were compensated via atmosfair.de. Previous studies either did not clearly state what happened to the money in the climate account (Burton-Chellew, May and West (2013)), or divided the money between the subjects like in a standard public goods game (Brick and Visser (2010), Brick, van der Hoven and Visser (2013)), or used the money to place an advertisement in a national newspaper that informed the readers about climate change and gave tips on how to reduce emissions (Milinski, Semmann, Krambeck and Marotzke (2006), Milinski, Sommerfeld, Krambeck, Reed and Marotzke (2008) and Milinski, Röhl and Marotzke (2011)) or CO_2 emission certificates were purchased and retired from the EU with the money in the climate account if the target was met[11] (Tavoni, Dannenberg, Kallis and Loschel (2011)). So, especially when comparing the advertisement of Milinski, Sommerfeld, Krambeck, Reed and Marotzke (2008) to the CO_2 compensation in the present experiment, the differences in (perceived) external validity could account for the differences in the results. According to Table 2, high disaster probabilities seem to have a positive impact on the achievement level, too. Besides the theoretical result that higher disaster probabilities lead to smaller expected values in the case of free-riding – which makes the alternative of the cooperating investment more appealing – the higher disaster probabilities can also be interpreted as having a higher external validity or saliency. Studies like the IPCC (2013) show that from today's point of view, probabilities of about 90 percent are much more realistic than probabilities of 10 or 50 percent. Additionally, their experiment was conducted in or before 2007, so that perhaps an increase in awareness of climate change problems during the last seven years could have led to a higher level of climate protecting investment. Abstracting from the different research questions of the studies in Table 2, there seems to be a tendency that achievement levels are higher in more recent studies than in earlier ones, when comparing treatments with similar disaster probability.

As formulated by hypothesis 2, the proportion of groups that did reach or exceed the target of Taler 120 on the climate account is higher under high transparency, where 83.3 percent of the groups achieved the target, than in the low transparency treatment, where only 73.3 percent did so. Yet, the one-sided Fisher's exact test shows with a p-value of 0.443 that this difference is not significant at any conventional level, which leads to the rejection of hypothesis 2. However, one has to bear in mind that the sample contains only 27 observations and that the present experiment only analyzes one parameter constellation, i.e. the 90 percent occurrence probability for negative climate change consequences.

[11] Else, only half of the climate account was used in this manner, while the other half was kept by the experimenters (Tavoni, Dannenberg, Kallis and Loschel, 2011).

Figure 2: Cumulated percentages of amounts invested by treatments



As a next step of the analysis, the distribution of the investments in climate protection is investigated. The cumulation of all investment decisions over all ten investment rounds yields a total of 1620 observations. Figure 2 depicts in how many percent of these cases the amount of Taler 0, 2 or 4 was invested in each of the treatments. In both treatments, over 60 percent of investments constitute Taler 2. The investments of Taler 0 and Taler 4 are with 18.5 and 16.8 percent respectively less frequent in the high transparency treatment than in the low transparency treatment with 19.9 percent in both cases. Still the differences are small. Accordingly, the chi-square test yields a value of χ^2=3.77 which is below the critical value of 4.61.[12] Therefore, the distribution of the investments is not significantly different between treatments.

Table 3: Distribution of groups' standard deviation of total investments by treatments

	Mean of standard deviations	Min. of standard deviations	Max. of standard deviations	Observations
Low transparency	5.501	2.338	13.624	15
High transparency	4.533	0.816	9.245	12
Total	5.071	0.816	13.624	27

This aspect changes when looking at the distribution of the groups' standard deviations of the total amount invested in Table 3. In the ltt, the mean of standard deviations is 5.501, which is about one Taler higher than the mean of standard deviation of 4.533 in

[12] A two-sided test was conducted with two degrees of freedom and significance level of ten percent.

the high transparency treatment. This difference is again in accordance with hypothesis 3; the conducted Mann-Whitney rank-sum test however yields a p-value of 0.29. Consequently, the difference is not significant and hypothesis 3 has to be rejected.

In the last step, further factors that could influence the subjects' investment in climate protection are analyzed. For that purpose, the treatment variable (*htt*) and information from the questionnaire are used in a regression analysis to explain the total amount invested by the subjects (*total investment*). Table 4 shows the results of OLS-regressions on the total investments. In all three specifications, the constant is very close to the mean of total investment of Taler 19.67. The dummy for the high transparency treatment turns out to be insignificant in regression (1), therefore confirming the results of the non-parametric test. This result does not change when control variables are added in the following two specifications.

Table 4: Results of OLS-regression on total investment

total investment	(1)	(2)	(3)
htt	-0.333 (0.680)	-0.457 (0.624)	-0.777 (0.663)
att_climchange		0.224*** (0.068)	0.204** (0.078)
risk		-0.675** (0.274)	-0.755*** (0.185)
age			-0.058 (0.126)
female			0.461 (0.882)
sem			-0.223* (0.125)
study_cat			yes
Constant	20.000*** (0.170)	17.753*** (2.163)	20.379*** (3.269)
Observations	162	162	157
Pseudo R^2	0.001	0.088	0.129

Note: Estimates of OLS-regressions. Robust standard errors in parentheses are clustered at the group level. See text for information on variables included in the regressions. Significance at the 10 percent, 5 percent, and 1 percent level is denoted by *, ** and ***, respectively.

Regression (2) in Table 4 controls for subjects attitude towards climate change (*att_climchange*) and the self-assessed risk attitude (*risk*). The attitude towards climate change is an equally weighted index of the five respective questions of the post-experimental questionnaire between one and seven, where higher values indicate a more supportive attitude towards climate protection. The attitude toward climate change has a positive impact of 0.22 which is significant at the 1 percent level. This means an increase of the attitude of one index point leads c. p. to a significant increase of total investment of Taler 0.22. This finding contradicts those of Burton-Chellew, May and West (2013) who – using the same questions – found that subjects, who were more affirmative regarding climate change and the subsequent responsibilities, invested significantly less in the climate account.

Risk is measured by the SOEP (2009) question for over-all risk attitude ("How do you see yourself: Are you generally a person who is fully prepared to take risks or do you avoid taking risks?") on a scale between one and ten, where higher values mean a more risk loving attitude. Here, the risk attitude has a negative effect of 0.68, which is significant at the 5 percent level, meaning that c. p. for each increase of one index point in the subjects' risk taking, the total investments decrease by Taler 0.68.[13] These two effects stay about the same size and remain significant in regression (3), where the *age* and sex (*female*) of the subjects are added, as well as dummies for their field of study (*study_cat*) and the number of semesters already studied (*sem*). Therefore, these effects seem to be robust and not driven by the surveyed socio-biographic factors. Additionally, Mann-Whitney rank-sum tests show that there is no significant difference between the two treatments with respect to the distribution of these variables.

6 CONCLUSION

Climate change and preventing its negative consequences is one of the biggest problems humankind is currently facing. This problem is not only an ecological one, it also has economic components. On the one hand, economic thinking plays a role when it comes to decisions of governments, companies or households and individuals that directly or indirectly cause climate change promoting or preventing behavior. On the other hand,

[13] The direction of this effect might seem counterintuitive at first, but it is not. The lower the investment in the climate account, the higher the chance that the target is not met and therefore the lottery is played which has a wining probability of just 10 percent. Hence, the more risk loving a subject is, the less he or she should invest.

the handling of natural disasters and related negative consequences of climate change is not least an economic problem.

When it comes to an empirical analysis of emission reduction behavior, experimental economics is the method of choice, because the necessary real world data is not available and the parameters of interest are hardly or even impossible to manipulate in the field. Over the past years, different kinds of economic experiments were conducted to identify factors that help or hinder emission reduction, starting with Milinski, Semmann, Krambeck and Marotzke (2006). Based on this prior work, the present study analyzes the influence of transparency on investments in climate protection - to be more precise: emission reduction. The results show that under high and low transparency, over 70 percent of the groups reached or exceeded a predefined investment target and in doing so prevented negative climate change consequences. The amount of groups that prevented these negative consequences is much higher than in previous experiments, which may be attributed to three aspects. First, all subjects were well-informed about the topic of climate change and its consequences by the fact sheet before they took part in the experiment. Second, the money invested in emission reduction in the experiment was used to compensate CO_2 in the real world and third, some years have passed, since the first experiments in this field were conducted, so that subjects today may perceive the problem of climate change as more urgent or real than some years ago. This is also indicated by the comparison of study results in Table 2, where it seems as though the mean rate of success increases over time, in the disaster probability and in a more direct use and predictable result of the money in the climate account.

When it comes to the influence of transparency, the amount of groups in the sample that achieve the target and therefore prevent negative consequences of climate change is ten percent higher in the high transparency treatment than in the low transparency treatment. However, this difference is not statistically significant at any conventional level. The same is true when it comes to the distribution of investments in the groups. The standard deviation of total investments is about one Taler smaller in the high transparency treatment, but the difference again is not statistically significant.

In contrast to the results of Burton-Chellew, May and West (2013), subjects, who are more affirmative regarding climate change and the subsequent responsibilities, invested significantly more in the present sample. In contrast, subjects with lower risk aversion invested significantly less.

Even though the influence of transparency turns out to be not significant in the present study, further research should investigate the topic of transparency in the field of emission reduction for two reasons. First, with a total of only 27 observations – twelve for the high transparency and 15 for the low transparency case – the sample in the present study is very small. So if there actually is a difference of about ten percent in target achievement in the population, as it turns out in the present sample, then the sample may just be too small to show the significance of the difference. Second, and even more important, the present study only used one probability for the negative consequences of climate change if the target was not reached, which was very high at 90 percent, but not unlikely to be close to real probability, according to the current reports of the IPCC (2013). Therefore, further research should vary this probability – within the range of likely real probabilities predicted e.g. by the IPCC – to investigate possible interdependencies between the influence of transparency and the entry probability of negative consequences of climate change. However, if transparency of investments does not have an impact on target achievement, this would be good news regarding climate change. As discussed above, this kind of transparency is not the usual case between individuals or companies and would probably be difficult to implement. Therefore, the lack of it would hinder the achievement of climate protection goals and the success rates in the previous studies would be too high.

In summary, the results of this study show, that there seem to be two other important factors: information and saliency. The results suggest that a high level of information about the topic of climate change and a high saliency, i.e. a realistic disaster probability and a direct and quantifiable result of the investment in climate protection lead to high levels of achievement of the climate protection target. This finding becomes obvious when taking the results of former studies into account. Therefore, further research should especially address the topics of information and saliency when searching for a way to prevent or attenuate the negative consequences of climate change. Current results of Lynham, Nitta, Saijo and Tarui (2014) indicate that the role of information is more prominent than that of saliency, when it comes to the reduction of energy consumption. If these findings would also be confirmed in other areas in the domain of climate protection, this could lead the way for policy makers to help solve the climate change problem via public information.

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APPENDIX

Facts sheet *(Originally, facts sheet was provided in German.)*

The subject of today's experiment is climate change. To bring all participants to the same level of knowledge, we provide some information on this subject in the following.

Greenhouse gas and climate change

Our atmosphere contains so-called greenhouse gases which surround the earth like a protective shield and prevent the heat of the earth from escaping into space. It would be bitter cold on earth without greenhouse gases. Due to the greenhouse gases, the average temperature on earth is constantly approx. 15 degrees Celsius.

Our current problem lies in the fact that the amount of greenhouses gases, particularly carbon dioxide (CO_2), has increased too quickly. Due to the industry, private households and traffic emitting CO_2, the amount has risen and continues to rise, thus leading to the atmosphere heating up unnaturally quickly. Especially the industrial countries are responsible for this additional, unnatural greenhouse effect. If the increasing warming is not stemmed in future, there will be global far-reaching consequences. It is estimated that the further emission of greenhouse gases will result in the average temperature increasing by up to 5.8°C and the sea level increasing by 10 - 90 cm until 2100. The consequences would be flooding of coastal regions and low-lying island states, the spread of deserts and the melting of glaciers. The climate change is already one of the main causes for natural disasters, such as floods and droughts. These catastrophes are accompanied by wide ranging economic consequences.

2°C goal

At the UN climate conference in Cancun in 2010, the global community of states formulated the goal to curb the average global warming to 2°C compared to the pre-industrial level till 2050 in order to keep the impact of the climate change in acceptable bounds (UNFCCC, United Nations Framework Convention on Climate Change).

Similar to the first commitment period of the Kyoto Protocol (2008 - 2011), CO_2-reduction targets for each state will be negotiated and resolved for the second commitment period in the next two years at the subsequent UN climate conferences.

In order to reach the 2°C goal, a global emission budget of approx. 750 billion t CO_2 remains until 2050 (WBGU, Wissenschaftlicher Beirat der Bundesregierung Globale Umweltveränderungen – German Advisory Council on Global Change). Assuming an average world population of 8.2 billion people from 2010 - 2050, this would mean that every person on earth would have a climate-friendly average share of approx. 2.3 t CO_2 per year. The average annual per capita emission in Germany is 11 t CO_2, according to the Umwelt Bundesamt (Federal Department of the Environment, UBA).

CO_2 compensation

The best solution to the climate problem is the avoidance of CO_2 emissions. Because this is not always possible, compensating CO_2 emissions offers a second best solution. The compensation does not alter the actual CO_2-source; the amount of emissions to be compensated is rather more saved elsewhere through a voluntary climate protection fee by various climate protection projects of a service provider, such as atmosfair. The emissions are often saved through the development of renewable energy in countries where this is not prevalent, so particularly in developing countries. The service provider saves CO_2 which would have been emitted through the use of fossil energy. At the same time, the local people benefit from the renewable energy, because this is often their first access to clean and constantly available energy – a must for education and equal opportunities (atmosfair).

Instructions *(Originally, instructions were provided in German.)*[14]

During the experiment all amounts will be given in the fictitious currency Taler.

The experiment consists of exactly **10 periods**.

At the beginning of the experiment you will be assigned to a group with 5 other participants; altogether there will be **6 participants in a group**. The composition of the group will stay the same during the whole experiment. You will be in in a group with the same participants during all 10 periods.

At the beginning of the experiment, your private account will be endowed with a deposit of 40 Taler. During the experiment, you are entitled to freely dispose over this sum. The remaining balance on your account will be translated in the exchange rates as stated below in Euro and paid off in cash with the Show-up fee.

For each period, you can decide whether or not to make an investment.

Your decisions are anonymous. To ensure this, the computer will assign each group member a name (Player 1, 2, 3, 4, 5 or 6). You can see your name in the lower left corner of the computer screen.

Climate Account

A climate account is assigned to your group. At the end of period 10 CO_2 emission will be compensated with the total amount on the climate account. For **1 Taler** there will be **17.20 kg CO_2** compensated through a service contractor.

Investment decision in each period

Over the course of the experiment you will play exactly 10 investment periods.

In each period you can make investments that support climate protection.

[14] Underlining indicates the text that was added in the instructions of the high transparency treatment.

In each period all six members of the group will be asked simultaneously:

„How much money do you want to invest in climate protection?"

Possible answers: 0 Taler, 2 Taler or 4 Taler.

After each player made the decision, all investments will be credited to the climate account.

Afterwards, all six decisions of the group members as well as the total amount on the climate account is (are) displayed.

End of the experiment

Achievement of the CO_2 goal

At the end of the experiment (after exactly 10 periods) the computer will compare the amount on the climate account with the predefined **target of 120 Taler**. This sum represents the amount that has to be achieved to prohibit the negative consequences of climate change in the experiment and corresponds to 2064 kg CO_2.

Consequences of climate change

If the target on the climate account is achieved or surpassed, there will be no negative consequences of the climate change and you will keep the remaining deposit on your private account.

If the target on the climate account is **not** achieved, the climate change will have considerable economic losses for the group with a probability of **90 % (i.e. in 9 out of 10 cases)**. **This means that you** and the other group member will lose **the entire remaining deposit from your personal accounts** with this probability.

With a **probability of 10 % (i.e. in 1 out of 10 cases)** your group will not be affected by the negative consequences of climate change and you and your group members will keep the remaining private deposit even though the CO_2 target was not achieved.

The computer will coincidentally decide on the entrance probability of the negative climate change consequences.

Payment

At the end of the experiment you will receive the remaining amount of your private account at the exchange rate of **1 € per 2.5 Taler** and the **show-up fee of 2.50 € in cash.**

The deposit on the climate account will be converted on the exchange rate of 1 € per 2.5 Taler as well and the corresponding amount of CO_2 will be compensated by atmosfair. The deposits of all climate accounts will be transferred as a total amount via bank transfer in EUR on the account of atmosfair (IBAN DE06430609674009153300). After the experiment one participant will be drawn to give a receipt for the total compensation amount. The transferred sum will be double checked from Prof. Dr. Fahr, the principal of the BaER-Lab. You will find the confirmation of the transfer and the confirmation of the control from Prof. Dr. Fahr on the homepage of the BaER-Lab one week after the experiment took place. Consequently, you will be guaranteed that with the help of the money, CO_2 was compensated by atmosfair.

At the payment you will receive a piece of paper with further information about atmosfair as well as the internet address of atmosfair and the BaER-Lab homepage.

Please note that:

No communication is allowed.

All mobile phones have to be switched off during the whole experiment.

All decisions you make during the experiment are anonymous, i.e. no other participant gets to know which decisions were made by you.

The payment also occurs anonymously, this means that no other participant will know how much the payment of the other participants is.

Please remain seated until the end of the experiment. You will be called up for your payment by the number assigned to your place.

Questions from Burton-Chellew, May and West (2013)

Subjects indicated their agreement/disagreement to the following five statements on a scale of 1 - completely disagree, to 7 - completely agree.

1: The climate is changing.

2: The climate is changing because of human actions.

3: Humans can prevent or limit climate change.

4: If climate change is preventable by a change in lifestyles then I am morally obliged to change my lifestyle.

5: If climate change has not been caused by human actions but is preventable by a change in lifestyles then I am morally obliged to change my lifestyle.