Investments in Impure Public Goods *

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Abstract

This paper experimentally investigates to what extend the type of risk inherent in social investments influences their attractiveness for investors. In particular, we analyze how risk in the provision of the public benefit and in the financial return to the investor each affect investment decisions separately and how, in addition, their correlation influences investments when both risks are simultaneously present. The results show that the reaction to risk in the private return to the investor and in the public benefit (that is paid to a charity) crucially depends on (1) the correlation of the co-existent risks and (2) the type of the investor. Identifying heterogeneous treatment effects shows a particularly strong reaction of pro-social and risk averse participants to co-existent risks when random draws are independent. It furthermore suggests that less inherently pro-social and less risk averse participants can be attracted to invest in risky impure public goods. The findings not only inform social investments such as crowdinvestments and microlending but also theories of giving under risk: the data rather support models that assume donors (also) care about the impact of their donation on the public good.

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1 Introduction

We create an experimental design that models investments in bundled investment goods, that may generate a private return to the investor as well as a public benefit. To illustrate, consider an investment in a green technology that will yield the investor a monetary return and with which she also contributes to the reduction of CO_2 emissions and to the mitigation of climate change. In sectors where such bundled goods, or ”impure public goods”, are being produced, for example the energy and the environmental sector, so-called ”crowdinvestments”, meaning small-scale investments by small businesses, private investors or regular citizens have recently been gaining importance as a financing alternative for social ventures and environmental projects (Lehner, 2013). According to the annual market report of crowdinvestments in Germany, the overall volume of crowdinvestments in Germany in 2015 was 48.9 million € and the market grew by 169% compared to 2014. As a comparison, in 2011, the total market for crowdinvestments only reached a volume of 1.8 million € . Crowdinvestments in green energy projects are one very popular branch attracting investment of about 6.9 million € in 2015 (thereby growing by 167% compared to 2014). The biggest share was financing of energy efficiency projects, followed by solar and wind energy (Harms, 2016).

These investments are often characterized by the simultaneous presence of risk in the financial investment of the investor and in the provision of the public good that the investment is supposed to generate. In the experiment, we investigate participants' responses to co-existent private and public risk in an investment situation. We focus on two aspects: first, we separate the two domains and introduce risk in the public and in the private domain one-by-one. Second, we vary the relationship between the risks in the two components of the bundled investment. By identifying crowdinvestors' willingness to invest dependent on the type of risk inherent in the investment, this study indicates under which conditions microlending or crowdinvesting might be able to best attract investors.

Recently, the riskiness of crowdinvestments has been debated in the context of new laws that have been proposed to regulate this new industry and to protect private investors from taking too high risks.[1] However, these regulations focus on the private part of the investment only, without taking into account that the investment decision in s bundled good might be determined by both payoffs it generates and that the perceived riskiness of the overall investment might depend on the relationship between the co-existent risks.

[1] In Germany, the federal government implemented the ”Kleinanlegerschutzgesetz” in 2015, which was proceeded by many controversies between the industry and the regulation authorities. One element of this laws is, for example, that an investor who invests more than 1000€ has to prove that he can afford to do so by issuing a self-disclosure (http://www.bundesfinanzministerium.de/Content/DE/Monatsberichte/2015/08/Inhalte/Kapitel-3-Analysen/3-3-kleinanlegerschutzgesetz.html, November 2017).

By exogenously manipulating the riskiness of the private or the public component of the investment, we establish a causal effect of different allocations of risk on average investments as well as identify heterogeneous treatment effects. The controlled decision environment in the laboratory allows to track the choices of different types of investors that differ in their concern for the public good as well as in their attitude towards risk.

We create a series of modified investment games where an investment is linked to giving to a charity. In individual decisions, subjects can allocate tokens from a safe account to one with risky payouts. Between treatments, we vary whether the risky account only generates a return from investment to the investor or whether it additionally generates a public dividend that is paid to a charity outside the lab. The variable of interest is the allocation of risk across these two returns, the private and the public one: the design varies whether one or both returns are risky and whether and how the risks are correlated. We measure how subjects change their investment behavior in response to those risks. In order to understand heterogeneity in treatment differences, we elicit subjects risk and social preferences and conduct a type-based analysis. In an additional part, we elicit participants' *social* risk preferences by identifying their preferences over risky prospects for themselves and for a charity.

The results show no differences in average investments when risk is exogeneously introduced in one component of the bundled investment good compared to a situation with no risk. When risk in the public component is introduced in addition to risk in the private return from a bundled investment good, mean investments significantly decrease if the risks are independent—but not if they are positively or negatively correlated. This decline in average investments is mainly driven by the subgroup of risk averse and pro-social participants. Furthermore, the data suggests that the not inherently pro-social and not risk averse participants can be attracted to invest in risky impure public good.

The implications of risk either in purely private or in purely altruistic decisions has been investigated by several studies on risk preferences and on giving under risk. The treatments in this experiment are based on the so-called investment game as proposed by Gneezy and Potters (1997) which has since been used in many experimental studies as a simple task to elicit risk attitudes of participants (Charness and Viceisza, 2012, Charness and Gneezy, 2012). This game is combined with a dictator game with donations as first experimentally examined by Eckel and Grossman (1996). Dictator games with student recipients have been used to investigate how risk for another person affects giving decisions by Krawczyk and LeLec (2010), Brock et al. (2013) and Freundt and Lange (2017). The authors find that prosociality generally decreases when risk for the receiver is being introduced or does not change significantly. Similar findings have been obtained in public good game experiments

(Gangadharan and Nemes, 2009). In an auction experiment by Güth et al. (2008) where participants state their willingness to accept to forego the payoffs of a prospect that pays money to the decision-maker and another passive participant, participants are other-regarding under certainty but not as much when risk is involved.

Many studies of pro-social behavior under risk are conducted in games where a small number of people interact. In these situations, changes in pro-social behavior compared to environments with certain payoffs can be driven by different preferences as for example fairness preferences over outcomes and over procedures or social comparisons that will not play a role in individual decisions. As I am interested in the interrelation of altruistic concerns and risk attitudes I choose an individual decision framework with giving to a charity – which can be regarded as an approximation of investment decisions in a market setting with many actors where individuals are price takers (an argument also mentioned in the discussion of Falk and Szech (2013) in (Kirchler et al., 2015, 9)).

Exley (2014) investigates risk in donations and finds that the deterring effect of risk is much stronger when giving involves a cost for the decision maker. When making decisions over lotteries for a charity that do not involve own payoff consequences the risk attitudes do not change significantly between charity risk and own risk. Exley (2014) concludes that the reaction to risk in giving is stronger when the risk can serve as an excuse not to give.

In a field experiment among US households, Landry et al. (2006) find that using lotteries significantly increases contributions for a charitable cause compared to simply voluntary contributions which is mainly explained by an increase in participation rates rather than in the magnitude of contributions. However, in their theoretical framework higher contributions with lotteries can be explained by externalities rather than based on (risk) preferences, which is outside the scope of this article. The theoretical model and experimental evidence in Lange et al. (2007) demonstrate the importance of having information about contributors' risk preferences –and heterogeneity of those preferences in the population– for choosing an optimal charity fundraising mechanism.

The question whether people have some concern for the actual impact of their donation on the public good rather than caring about the cost they have to incur when donating relates to the discussions in the literature on charitable giving about rebates and matches and about overhead costs. Charitable giving has been shown to be significantly influenced by the price of giving as shown by the introduction of matches and rebates in experimental studies. For example Eckel and Grossman (2006), Karlan and List (2006), and Scharf and Smith (2010) show that donors increase their giving when rebates are introduced and they increase it even more with matches. The argument that people might care about the impact of their donation (instead of simply deriving utility from the act of donating) relates to a discussion on so-called 'overhead aversion' that donors seem to exhibit in charitable giving. Gneezy et al. (2014) show that large overhead costs lead to lower donations but only if the donors pay for the overhead costs themselves. This can be seen as an example of donors caring about the actual impact of the donation.

The present study relates to this field by informing about whether the cost of donating or the impact of a donation motivate pro-social behavior. Furthermore, it extends the environments being studied in the context of charitable giving to bundled goods and to risk. How charitable giving responds to risks is essential to understand in order for charities to decide whether disclosing to donors how their donation will be used. A donor who cares about the *impact* of their own donation on the public good might want to know whether her donation has been used to cover overhead costs or not and, in case it is used directly for the public benefit, whether it has really been provided as expected. A charity might furthermore want to know how the demand for charitable contributions changes when bundled with private goods and in which circumstances this is beneficial for her.

An impure public good denotes a bundled good that yields a private and a public payoff and consumers derive utility from both its private and its public component. My research project extends existing models (Cornes and Sandler 1994, Kotchen 2005, Chan and Kotchen 2014) and experimental studies on demand for impure public goods. to risky environments by drawing on evidence from the literature on rebates and matches in giving decisions and on giving under risk. In lab and in field experiments, previous studies have found a willingness to pay a price premium for a public benefit bundled with a private consumption good, like organic cotton (Casadesus-Masanell et al., 2009), certified toilet paper (Bjørner et al., 2004), charity-linked products (lab: (Frackenpohl and Pønitzsch, 2013), field: Elfenbein and McManus (2010)) or electricity from renewable energies (Kotchen and Moore, 2007). In the latter study, the authors show moreover that altruistic attitudes influence the demand for such goods. Lange et al. (2017) empirically assess the question whether impure public goods might be a substitute for direct donations in the context of climate change mitigation. The survey data does not confirm this hypothesis but rather suggests an overall complementary relationship. Lai et al. (2017) provide a theoretical model analyzing in which situations it is financially profitable for firms and for charities to bundle private with public goods. The concept of bundled goods allows to jointly examine individuals' reactions to risk in the private and the public good, thereby informing about how to model social preferences under risk.

The paper is organized as follows. Section 2 outlines the experimental design together with the behavioral predictions. In section 3 we present the summary statistics and the regression analyzes on the aggregate and the individual level and the main results. Section **??**

concludes.

2 The Experiment

The experiment consists of three parts. The main part consists of a series of investment games linked to donations. The remaining two parts are meant to obtain more detailed information on individual preferences. Specifically, part 2 aims at decomposing the bundle such that subjects can freely allocate risks and returns. The design and the results from part 3 are provided in appendix B.

2.1 The bundled investment game

An impure public good is represented in the lab in the following way: Participants get an endowment of 100 units of the experimental currency (ECU) in each treatment. They can choose to transfer an amount $0 \leq x_i \leq 100$ from a private *Account A* to an *Account B*. The nature of the payout from *Account B* differs between treatments. The basic structure builds up on the investment game as originally proposed in Gneezy and Potters (1997). Here, the invested amount x_i is either multiplied by a constant return r^H (high return) or it is lost, $r^L = 0$ (low return). Both outcomes can happen with a probability of 50% (see also Charness and Gneezy, 2010). To create an impure public good in the lab, an investment game is combined with a donation game as originally used in Eckel and Grossman (1996). We modify the investment game such that the return generated in *Account B* is split between the investor and a charity at a fixed proportion. In other words, in the 'impure public good'-treatments, the investment of an individual i may generate a private payoff to herself as well as a public payoff to a charity in case the investment is "successful" (probability 1/2).

Across treatments, the state-dependent private payoff of an individual i is:

$$\pi_s(s_s) = m - x_i + r_s(s_s)x_i \tag{1}$$

Accordingly, the public payoff to the charity is:

$$\pi_{ch}(s_{ch}) = r_{ch}(s_{ch})x_i \tag{2}$$

where m denotes the endowment and x_i the amount invested by i, r_s and r_{ch} are the state-dependent returns (to self and to charity):

$$r(s_s) = \begin{cases} r^H \ if \ s_s = 1 \\ r^L \ if \ s_s = 0 \end{cases}$$

$$h(s_{ch}) = \begin{cases} h^H \ if \ s_{ch} = 1 \\ h^L \ if \ s_{ch} = 0 \end{cases}$$

In the experiment, we denote the state-dependent returns from investments to the investor and to the charity by r_s^H, r_{ch}^H for high return and r_s^L, r_{ch}^L for low return, which is always equal to zero.

2.2 Treatments

The experiment uses a within-subject design with one-shot decisions. The treatments are played in random order so that we can control for order effects in the regression analysis.One decision is randomly chosen for payment after the experiment has been completed. Feedback about the outcomes of the random draws is not given until the end of the experiment. Treatment *DG* is a standard dictator game in which participants can donate a desired amount to a charity instead of to a randomly selected other participant, see Eckel and Grossman (2006). *DG_RCharity* modifies this donation game by making the donation risky: with a likelihood of 50% the amount donated is multiplied by r^H, otherwise the transfer to the charity is zero. In the experiment, the realized low return is $r^L = 0$, the high return is $r^H = 2.6$ and $p = 1/2$. The parameters are chosen such that the returns in the treatments without risk satisfy $\bar{r} = pr^H + (1-p)r^L$. In *DG*, the donation is multiplied by 1.3 so that the expected value of *Account B* is kept constant.[2] Treatment *IG* is a standard investment game as described in subsection 2.1 (Gneezy and Potters, 1997, parameters based on Charness and Gneezy, 2010). We first replicate standard settings to ensure that preferences in this sample do not differ significantly from previous experiments so that the results of this study can be related to previous findings in the literature. Importantly, these games elicit participants' risk preferences and social preferences which will serve for classifying subjects' types in the statistical analysis of the 'impure public good'—treatments.

These basic games are extended to investigate the impact of (co-existent) risk in bundled goods. The payoffs of all treatments are summarized in Table 1. In all impure public good treatments the high return r^H is split between the investor and the charity at a *fixed*

[2]This reduced price of giving corresponds to a match by the experimenter as analyzed and described in detail for example in Eckel and Grossman (2003, 2006, 2008).

	Account B		
Treatment	r_s	r_{ch}	EV
DG	-	1.3	1.3
DG_RCharity	-	2.6-0	1.3
IG	2.6-0	-	1.3
IPG_NoRisk	0.65	0.65	1.3
IPG_RCharity	0.65	1.3-0	1.3
IPG_RSelf	1.3-0	0.65	1.3
IPG_RBoth	1.3-0	1.3-0	1.3

Table 1: Returns from Account B in all treatments of Part 1, EV=expected value

proportion. For simplicity (and to make the donation non-negligible) we chose an equal split in all treatments. In *IPG_NoRisk*, *Account B* generates a bundled return without risk. Thereby, it resembles treatment *DG* with the difference that the return of 1.3 is split equally between the investor and the charity, $\bar{r} = \bar{r}_s + \bar{r}_{ch} = 1.3$ and $\bar{r}_s = \bar{r}_{ch} = 0.65$. This setup can be interpreted as introducing a rebate in the donation game. At the same time, this treatment serves as the benchmark for the remaining *IPG*—treatments with risky returns. *IPG_RBoth* divides the high return of the investment game *IG* equally between the investor and the charity. Thus, the investment x_i may generate a bundled return $r^H = r^H_s + r^H_{ch} = 2.6$, $r^H_s = r^H_{ch} = 1.3$, with $p = 1/2$, zero otherwise ($r^L_s = r^L_{ch} = 0$). With this, it holds that $\mathbb{E}[r(s_r)] < 1$, $\mathbb{E}[r(s_r)] + \mathbb{E}[h(s_r)] > 1$, meaning that it is only worthwhile to invest for people who care about the public component. In order to assess the impact of introducing risk in each dimension separately, we add treatments *IPG_RCharity* and *IPG_RSelf*. In the former, only the return from *Account B* to the charity is risky and the investor receives a risk-free payoff of $\bar{r}_s * x_i$, $\bar{r}_s = 0.65$. As in *IPG_RBoth*, the risky payoff to the charity is $p_{ch} * r^H_{ch} * x_i$. Correspondingly, in *IPG_RSelf* the charity receives a safe payoff and the payoff to the investor from *Account B* is risky. Importantly, the parameters are chosen such that the risk-less returns satisfy $\bar{r}_s = p_s r^H_s + (1-p_s) r^L_s$ and $\bar{r}_{ch} = p_{ch} r^H_{ch} + (1-p_{ch}) r^L_{ch}$ and expected returns therefore stay the same across treatments, see Table 1.

In the case of risk in both components of the bundled return from investment, the two risks can be either independent random draws or positively correlated or negatively correlated. We integrate all three cases because the interrelation of the two risks determines the overall riskiness of the bundled investment good and is therefore expected to impact individuals' investment decisions. We distinguish *IPG_RBoth_Ind* with independent private and public risk, *IPG_RBoth_Neg* with (perfectly) negatively correlated private and public risk and *IPG_RBoth_Pos* with (perfectly) positively correlated private and public risk. To illustrate, the bundled investment good in *IPG_RBoth_Neg* generates a high return for the investor when the provision of the public good fails and the other way round. *IPG_RBoth_Pos* generates either a high return for the investor and a public benefit or neither, meaning that in case of a financial failure the public good is also not provided. In *IPG_RBoth_Ind*, the successful provision of the public good and the high return for the investor are independent of each other. Taking up the example of investments in a CO_2-reducing technology, *IPG_RBoth_Pos* represents a case in which the project can completely fail such that the private return from investment and the reduction in CO_2 emissions would equal zero. However, one could imagine that the project can be financially successful but fail to provide the public good, or the other way round (*IPG_RBoth_Ind*). This is the case if the two components are driven by different underlying processes. The financial success might be influenced by the financial skills of the manager or the economic situation whereas the environmental success might be determined by biological or technological factors.

2.3 Decomposing the Bundle

When investing in or buying bundled goods, their composition, the share of the public component and the riskiness of the bundle, is determined beforehand due to the nature of the product or according to the objectives of the producer. Therefore, it is modeled as being exogenously fixed in part 1 of the experiment. In part 2, however, we elicit the features of an individual's preferred bundle to see how it compares to the fixed bundle in two dimensions, the allocation of risks and the allocation of the return. We will use the information about how the fixed bundle relates to the subjects' *preferred* bundle for analyzing the demand for the bundles offered to subjects in part 1. Participants make three choices in part 2: one on the distribution of the high return, r^H, from investment and two choices on the distribution of risks within a bundle. The additional information about individuals' preferences will be used in the statistical analysis of part 1.

	Outcome A	**Outcome B**
Investor	65+$Transfer_s$	65-$Transfer_s$
Charity	65+$Transfer_{ch}$	65-$Transfer_{ch}$

Table 2: Distribution of Risks in *T_Distr_Risk* and *T_Distr_Risk_Ind* (Part 2)

In treatment *T_Distr_Return* ("‘distribution of return"’) the whole endowment of 100 ECU of a subject is allocated to one account that pays a high return of $r^H = 2.6$ and a low return of $r^L = 0$, both with a probability of $p = 1/2$ (as in *DG_RCharity* and in *IG*). However, now participants decide *ex-ante* how to split the high return r^H between themselves and the charity in case they win the lottery. Thus, the expected payoff of the investor is $p * (r^H -$

$r^H_{Transfer})100 + (1-p)0$ and the expected payoff to the charity is $p*(r^H_{Transfer})100 + (1-p)0$, where $r^H_{Transfer}$ denotes the share of the high return the subject allocates to the charity. This game is a version of a dictator game under risk, tailored to the decision environment of the investment games in part 1. Because the giving choice in this game is state dependent, i.e. the person gives *conditional on winning the lottery*, we expect decisions to not deviate from giving in *DG*.[3] Importantly, the division of the return creates a direct measure of an individual's distance of the fixed bundle to her preferred split of the return.

In treatment *T_Distr_Risk_Ind* (distribution of risk), a subject is presented two lotteries, one for herself and one for the charity. Each lottery has two outcomes of 65 ECU each, outcome A and outcome B, that can be obtained with a probability of 1/2 at the beginning of the task. Each participant decides whether to transfer an amount $0 \leq Transfer^{IND}_s \leq 65$ to the own lottery that will be added to outcome A and at the same time subtracted from outcome B. This means that a higher transfer increases the variance of the lottery while the expected value stays the same. In the same way, the decision-maker can decide to transfer $0 \leq Transfer^{IND}_{ch} \leq 65$ to the lottery of the charity. Comparing the two independent transfer decisions allows to directly elicit a subject's risk attitudes in both domains. Note that subjects play two versions of this task (in random order), as displayed in Table 2. In the modified version *T_Distr_Risk* (see T6 in Brock et al., 2013) subjects make the same decision over the own lottery as described above but with one additional constraint: The sum of the transfers has to equal exactly 65 ($Transfer_s + Transfer_{ch} = 65$). Thereby, the amount a subject does not transfer to her own lottery is automatically put on the lottery for the charity. In other words, reducing the variance of a subject's private lottery automatically increases the variance of the lottery for the charity and the other way round. Assuming that an individual has the same risk preferences over both domains (which we test in the experiment), this constraint introduces a tradeoff between allocating the 65 tokens to one of the two lotteries. Securing a safe payoff for herself ($Transfer_s = 0$) implies a risky lottery with outcomes 130 and 0 for the charity (and the other way round).[4]

The difference in transfers $Transfer^{IND}_s - Transfer_s$ with and without this constraint additionally elicits a subject's *social risk preference*, defined as the amount of risk a risk-averse subject is willing to incur to reduce the variance of the charity's lottery, or, as the amount of risk a risk-loving subject is willing to forgo in favor of the lottery for the charity.

[3] To make the decisions directly comparable, we could rewrite an individual's donation decision in *DG* in terms of the fraction of the endowment donated.

[4] We implement negatively correlated random draws for the two lotteries (and subjects are informed about this) such that the decision-maker cannot bring the final outcomes closer to each other by "'giving risk"' as the differences in outcomes between her and the charity stay the same. For example, with $Transfer_s = 0$, the difference in final outcomes is 65; with $Transfer_s = 65$, the difference in final outcomes is 65; with $Transfer_s = 30$, the difference in final outcomes is $100 - 35 = 95 - 30 = 65$.

The task relates to experiments on risk sharing in group decisions (e.g. Bone et al., 2004). They find that teams fail to allocate prospects in an ex-ante efficient way, taking into account individual risk preferences, i.e. their potentially different individual certainty equivalents for a given prospect. In our simple task, the allocation of risks according to one's risk attitudes over own and the charity's payoff is stripped off the allocation choice and thus simple and in the focus of the decision-maker.[5] Furthermore, due to the constant expected values and the negative correlation of the random draws any concerns about fairness and comparison of *payoffs* should be excluded. Thus, we are confident to obtain a measure of a subject's isolated *social risk preference*, i.e. a measure of her willingness to take on the cost of increased (decreased) risk in order to benefit the charity if she is risk-averse (risk-seeking).[6] One drawback is obviously that this measure can only be used after having established that an individual has the same risk preferences in both domains.

Intuitively, risk preferences can be an important determinant of investment in impure public goods and the treatments in part 2 are designed to shed light on *how* exactly they impact investment decisions. This includes measuring to what extend risk preferences in the private and public domain differ in order to then establish which risk preference dominates the investments and treatment differences in willingness to invest. In addition, the social risk preference provides a measure of pro-sociality with respect to the allocation of risks (instead of (expected) payoff allocations as measured in dictator games). Previous experiments suggested that risk-aversion and generosity might be correlated characteristics in individuals and risk-aversion tends to dominate the latter in giving decisions where the own payoff is risky (Freundt and Lange, 2017). As a consequence, for risk-averse subjects giving under certainty might not predict giving under (private) risk very well and the measure of social risk preference might better capture pro-social motives in the cases where transferring tokens to *Account B* makes own payoff risky.

2.4 Predictions

We will begin by assuming an additively separable individual utility function that allows for individuals being heterogeneous with respect to their degree of pro-social concern and with respect to their risk preference. It also allows for heterogeneity in the difference between risk

[5]The results in Bone et al. (2004) suggest that team members are diverted from the agreement over the choice of prospects and thus fail to pay attention to ex-ante efficiency in the allocation of the chosen prospect. This explains choices in their experiment better than a desire to split prospects equally.

[6]The term has been used in a different way by Güth et al. (2008) to denote a participants' choice over risky prospects similar to *DG* versus *DG_RCharity* and *IPG_NoRisk* versus *IPG_RCharity*. Subjects in their experiment can give expected payoffs to another participant but do not face trade-offs between the *allocations of risk*–with expected payoffs remaining constant under each allocation choice.

preferences over the two components of subjects' utility, the private and the public payout. Such a utility framework is presented in equation 3. The concavity of u_i and v_i describes individual i's risk aversion over each component. α_i describes i's concern for the public benefit generated by her donation to the charity.

$$U_i(\pi_s, \pi_{ch}) = u_i(\pi_s) + \alpha_i v_i(\pi_{ch}), 0 \leq \alpha_i \leq 1 \tag{3}$$

π_s and π_{ch} are as defined in equations 1 and 2. We will consider a decision-maker who exhibits some degree of pro-social concern, i.e. who has positive utility from donating, $\alpha_i > 0$. As noted in section 2.1, the parameters are chosen such that a participant who only cares about her own payoff should not invest in the impure public goods. Among the pro-social participants, we expect investments to be influenced by their risk preference and the difference between their risk attitudes over private and public lotteries. Note however, that risk aversion is not sufficient to make comparative statics predictions over the sizes of investments across treatments for the average individual in our sample. A risk-averse player's expected utility from a risky gamble is always lower than her utility from the expected value. However, her optimal investment depends on the marginal utility function and it's shape is determined by the third derivative, her prudence. From a measure of risk aversion alone we cannot determine whether the third derivative is positive or not and thus we can not make predictions on subjects' investments without assuming a specific functional form on participants' preferences. It remains an empirical question how average investments change as a response to the introduction of risks in each treatment, which we will address in this study.

However, for the parameters used in the experiment, $p_s = p_c = p = 0.5$, we can show that an expected utility function with additively separable utility does not predict differences in the investor's utility between the correlation treatments *IPG_Both_Ind*, *Neg* and *Pos*. To see that the expected utility representations for independent risk, perfect positive correlation and perfect negative correlation are equivalent, compare the general case in the first row of equation 4 with the rewritten equation for perfect positive (second row) and for perfect negative correlation (third row) for $p_s = p_c = p = 0.5$.

$$\begin{aligned} & p_s u_i(\pi_s^H) + (1-p_s) u_i(\pi_s^L) + p_c \alpha_i v_i(\pi_c^H) + (1-p_c)\alpha_i v_i(\pi_c^L) \\ &= p\left[u_i(\pi_s^H) + \alpha_i v_i(\pi_c^H)\right] + (1-p)\left[u_i(\pi_s^L) + \alpha_i v_i(\pi_c^L)\right] \\ &= p\left[u_i(\pi_s^H) + \alpha_i v_i(\pi_c^L)\right] + (1-p)\left[u_i(\pi_s^L) + \alpha_i v_i(\pi_c^H)\right] \end{aligned} \tag{4}$$

It clearly shows that, for the parameters we use in the experiment, the correlation of the random draws of the co-existent risks does not influence an individual's expected utility and we cannot predict differences in investments between the three treatments *IPG_RBoth*. Thus we expect to observe *IPG_RBoth_Ind=IPG_RBoth_Pos=IPG_RBoth_Neg*.

A different reasoning directly builds up on previous findings on the nature of charitable giving showing that donors might derive utility from the act of giving (i.e. warm-glow preferences, Andreoni, 1989) as well as from the level of the public good that is provided by the donations (i.e. altruism, Andreoni, 1989). Andreoni (1989) provides a general formulation of so-called "'impure altruism"' that allows for both motivations to play a role in donation decisions. However, the introduction of a lottery over the payoffs for the charity drives a wedge between the individual donation and the *impact* on the public good. Therefore, we can expect a donor who is motivated by altruism, to exhibit an adverse reaction to the introduction of risk to the charity's payoff, while warm-glow types of donors should not show a reaction because their utility depends on the act of giving. Thus, an agent with warm-glow type of preferences is expected to behave *as if* risk-neutral over the charity's payoff. Only a donor or investor who cares about her impact can be affected by risk in giving.

2.5 Implementation

The experiment has been conducted at the experimental laboratory of the School of Economics and Social Sciences, University of Hamburg in 2015. Participants are students from all departments of the University of Hamburg. The experiment is programmed in ztree (Fischbacher, 2007) and recruitment was administered via hroot (Bock et al., 2014). In total, we conducted 6 sessions with 151 participants in total. The payoffs consist of a 5€ show-up fee plus the payoff from one randomly chosen treatment. The average payoff of a participant was 12.21€ and the average donation was 2.24€ . As part 1 is the part of primary interest in this study, it was always the first part of the experiment, while the order of part 2 and part 3 (Appendix B) was randomized at the sessions level. Experimental instructions can be found in section 4. Donations were made via online transfers to a project from the donation platform BetterPlace.org. Before beginning with the experiment, each participant could choose her preferred project out of a list of three projects on Betterplace.org to which her donations will be transferred if applicable. The list contained one local project for children in Hamburg, one animal protection project and one environmental project in a developing country so that participants could chose their preferred cause to donate for. Choosing the one or other project is assumed to not influence the treatment differences of interest. In order to make it credible that we indeed donate the amounts indicated and to foster trust, three precautionary measures were taken: First, we handed out a leaflet with information about the charity and a link to the webpage betterplace.org that participants were allowed to take home in order to be able to verify the information. Second, a webpage with a documentation of all donations was provided via e-mail to all participants upon the completion of the whole experiment to prove that the transfers have been made (this was announced during the experiment). Third, the experimenter made the individual online transfers together with the cash payments at the end of the experiments such that participants could watch her transferring the donation.

3 Experimental Results

We will begin with reviewing the main summary statistics of the impure public good treatments to then briefly discuss the observed choices over the decomposed bundles in part 2. A regression analysis in subsection 3.3 sheds light on the determinants of individual choices.

3.1 Summary Statistics of Investments in Impure Public Goods

To assess subjects' reaction to the introduction of risk in the payout to the charity, we first compare mean transfers in the two donation games, *DG* and *DG_RCharity*. Risk in the payoff to the charity significantly reduces average giving from 24.72 to 21.24 token (out of an endowment of 100 token, $p \leq 0.01$, Wilcoxon rank sum test of equality of distributions (WRS in the following)).[7] The decline in donations when giving is risky replicates previous findings in the literature, such as in a donation game by Exley (2014). In dictator games with a student receiver, Krawczyk and LeLec (2010) and Brock et al. (2013), among others, find significantly lower giving with risk for the receiver, whereas this effect is not significant in Freundt and Lange (2017).[8] Mean investments in *IG* are 44.85 token. 10.9% of the participants chose to invest 0 in the risky asset while 15.8% chose to invest 100. This is very close to previous findings in investment games, see for example Charness and Gneezy (2012). Overall, the distribution of risk preferences and social preferences in the experimental population does not seem to differ much from student samples in previous experiments.

[7] In dictator games with student receivers, average giving is close to this result with averages of 25% of the endowment reported in Camerer (2003, 57) and 28.4% of the endowment reported in a meta study by Engel (2011, 6). Grossman and Eckel (1996, 187) find average donations of 11% for a student receiver and 31% for a charity receiver in dictator games.

[8] Note that in dictator games with student receivers different behavioral aspects might play a role that are not relevant in a donation game (such as social comparisons and procedural fairness concerns) such that treatment differences observed in dictator games are not directly comparable to those in donation games with risk in giving.

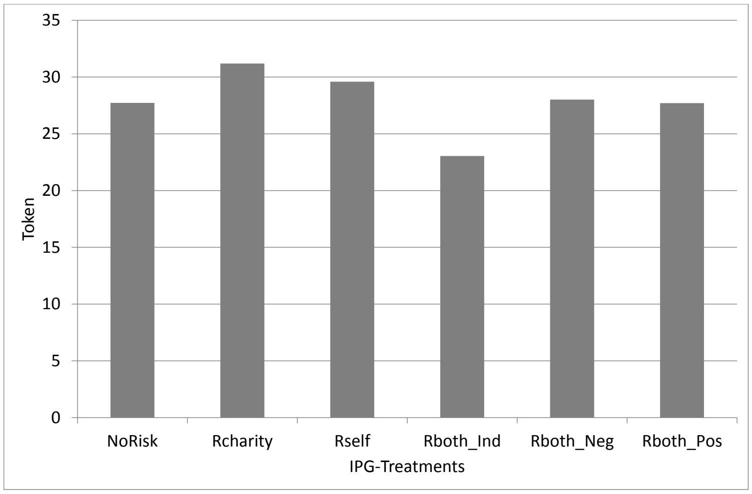


Figure 1: Mean transfers in token in each 'Impure Public Good'—treatment (N=151, Endowment=100 token)

Surprisingly, for investments in the bundled goods the decline in mean transfers as a reaction to the introduction of risk in the public return cannot be confirmed. Mean giving under *IPG_NoRisk* and *IPG_RCharity* does not differ significantly, mean transfers in *IPG_RCharity* are even slightly higher, see Figure 1. A closer look at the data suggests that this result might not be due to behavior in *IPG_RCharity* but rather due to an underinvestment in *IPG_NoRisk*: As the private payoff component in this treatment functions as a rebate, giving should be higher compared to the standard dictator game. More precisely, whereas a subject pays 1 token for a donation of 1.3 token in *DG*, she can donate the same amount in *IPG_NoRisk* for 0.7 token. The only slightly higher mean transfer compared to *DG* indicates that, on average, subjects do not appropriately account for this. This argument presupposes that subjects care about the *impact* of their donation rather than only about the amount they transfer (which would be in line with a model of warm glow, Andreoni, 1989). The difference in mean transfers to *IPG_RSelf*, where subjects have to transfer part of their endowment in a risky asset in order to donate, is also small and insignificant.

How do average investments react to introducing risk in the second component of each bundle? Whether or not the introduction of additional risk in the charity's payoff in the presence of own risky returns from the bundle reduces transfers depends on whether the risks are correlated: Mean investments significantly drop from 29.6 in *IPG_RSelf* to 23 in *IPG_RBoth_Ind* ($p \leq 0.001$, WRS), whereas no such decline can be observed for *IPG_RBoth_Neg* and *IPG_RBoth_Pos* (28 and 27.7 token, respectively). Also the differences between *IPG_RBoth_Ind* and the two treatments with correlated risks are statistically significant (p$\leq$0.1, WRS, for *IPG_RBoth_Neg* and p$\leq$0.05, WRS, compared to *IPG_RBoth_Pos*). The observation that mean investment with perfectly positively correlated risks are significantly higher than with independent risks and very close to the case with negatively correlated risks is very surprising and will be investigated in more detail in section 3.3.

Median decisions (that are less sensitive to outliers) across treatments mostly confirm the above behavioral pattern, however, some treatment differences appear more extreme: Giving declines from 17 token in *DG* to 10 token in *DG_RCharity*. Under-investments in *IPG_NoRisk* seem even stronger with a mean of 10 token, compared to 20 in *IPG_RCharity* and 25 in *IPG_RSelf*. The results for the treatments with co-existent private and public risk is reproduced: As with a comparison of means, independent private and public risks lead to lower median investments than in the two cases when risks are correlated (15 versus 20 token in *IPG_RBoth_Neg* and *IPG_RBoth_Pos*)—however, in all three cases median investments are lower than in the treatment with only risky private returns and a sure payoff to the charity (25 in *IPG_RSelf*).

Result 1 (Risk in one Component)**.** *We observe no differences in average investments when risk is exogenously introduced in one component of the bundled investment good compared to a situation with no risk.*

The finding that giving is reduced from *DG* to *DG_RCharity*, but not from *IPG_NoRisk* to *IPG_RCharity* is actually surprising. It implies that the finding that risk in giving reduces donations—that has been previously established by Exley (2014) and is in line with behavior in dictator games with student receivers—might not be replicated with bundled goods. As the payoff from a bundled good is divided between a private payoff to the investor and a public payoff to the charity, one might argue that payoff differences become too small to care about and especially the impact of risk becomes negligible. Thus, let us compare the impact of risk in *DG_RCharity* (where donations significantly declined compared to *DG*) and *IPG_RCharity* (where investments were more or less equal to *IPG_NoRisk*). In *DG*, donating 1.3 token imposes a cost of 1 token on the decision-maker. In the risky version *DG_RCharity*, the charity gets 2.6 or 0 token from this cost of 1 token to the investor. In *IPG_NoRisk* and *IPG_RCharity*, the cost of donating 0.65 token is 0.35 (due to the "'rebate"). Thus for a cost of 1.05 token the investor donates 1.95 token to the charity or, accordingly, in *IPG_RCharity* she would give a lottery with the outcomes 3.9 and 0. This demonstrates that the impact of risk in giving does not become negligible in *IPG_RCharity* compared to *DG_RCharity*.

To get a more detailed understanding of individual choices behind the averages reported in Figure 1, we report the whole distributions of the outcome variable in each treatment (Figure 2). In particular due to the high number of zero transfers, the distributions of transfers in

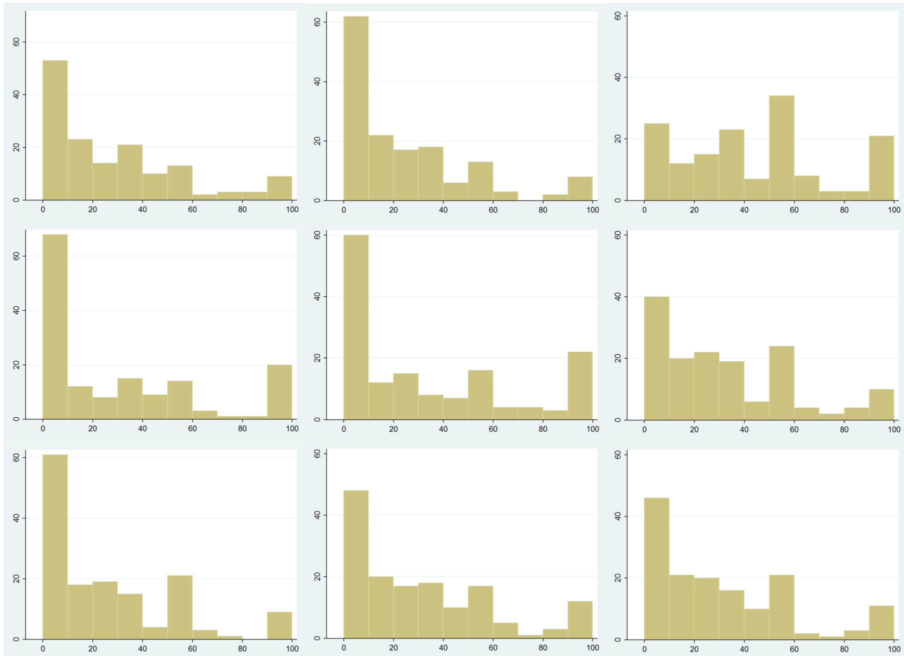


Figure 2: Frequency of choices in each treatment from top left to bottom right: *DG*, *DG_RCharity*, *IG*, *IPG_NoRisk*, *IPG_RCharity*, *IPG_RSelf*, *IPG_RBoth_Ind*, *IPG_RBoth_Neg*, *IPG_RBoth_Pos*, Number of choices on y-axis and transfer in token on x-axis in brackets of 0-19, 10-19,...,90-100

the impure public goods look more similar to the distribution of choices in the dictator games than in the investment game (upper right panel). This result has been expected because the parameters haven been chosen such that a purely self-regarding individual should not be willing to invest in the impure public goods. When looking at the share of participants transferring $x_i = 0$ in each treatment, we observe similar treatment differences as in the above comparison of mean and median transfers, with a few interesting differences: First, while *IPG_NoRisk* and *IPG_RCharity* have similar participation rates of about 63% (defined as the share of participants transferring $x_i > 0$), it increases to 75% in *IPG_RSelf*, see Figure 2. This might indicate a "‘crowding-in"’ of players that are attracted by the gamble in *IPG_RSelf*–an interpretation resonating with the findings by Lange et al. (2007) where public good contributions increased when coupled with participation in a lottery. This interpretation would suggest that different types of participants react differently to the treatment variations. As the experiment is designed to elicit information about subjects' risk and social preferences and to follow individual changes in behavior across games we are able to explore such possible explanations in a type-based analysis of impure public good investments below.

3.2 Summary Statistics from Decomposing the Bundle

In *T_Distr_Return*, the average subject keeps 1.89 out of the overall return of 2.6, thus giving 27.31% to the charity conditional on winning the lottery. This share is remarkably close to average giving in the standard dictator game *DG* (24.72), thus confirming our hypothesis that giving between the two tasks should not differ.[9]

In the two independent choices in *T_Distr_Risk_Ind*, the average subject transfers $Transfer_s^{IND} = 22.54$ out of 65 token to the her own lottery, leading to an "average" gamble between an *Outcome A* of 87.54 and an *Outcome B* of 42.46 instead of the sure bet. With $Transfer_{ch}^{IND} = 27.13$ token, the average transfer to the lottery of the charity is only slightly higher, leading to a gamble between 92.13 and 37.87 (weakly significant with $p < 0.1$, WSR, median choices are 18 and 25). Participants' preferred risk allocations are thus not significantly different (in line with Exley, 2014), even though risk allocations on behalf of the charity exhibit slightly less risk aversion on average. When imposing the additional constraint of $Transfer_s + Transfer_{ch} = 65$ in *T_Distr_Risk*, mean transfers are $Transfer_s = 29.04$ and $Transfer_{ch} = 35.96$ ($p < 0.05$, WSR). Given that subjects on average prefer a smaller variance in their own lottery, they are on average willing to increase their own risk in order to not increase the variance in the gamble for the charity too much. Subjects did on average take significantly more risk upon themselves ($p < 0.01$, WSR of equality of distributions of $Transfer_s^{IND}$ and $Transfer_s$). This can be interpreted as the attempt of an on average moderately risk averse subject to 'share the burden". This interpretation is supported by the observation that in *T_Distr_Risk_Ind*, 34.44% of the participants chose a transfer of zero to the own lottery, whereas only 14.57%, i.e. about half as many, do so in the case of a trade-off with the charity's lottery. Furthermore, in the latter, about 1/3 (35.75%) of participants chose a transfer to the own lottery between 35 and 30 token, which corresponds to a (slightly biased) equal risk allocation.

Note however, that the above interpretation holds for risk averse subjects but that *T_Distr_Risk* imposes a different trade-off on people with different risk preferences. Thus, we look at subgroups of players in order to better understand individuals' motivations behind the aggregate choice pattern. Overall, we observe that the observations for the whole experimental population hold also for those classified as (moderately) risk-averse in this experiment. However, the subgroup of players that can be labeled "'risk-neutral or risk-seeking"' does not seem be affected by a possible trade-off between the lottery for the charity or their own

[9] Median choices are 2 for the own return and 0.6 for the charity and 30.46% of the subjects kept the whole return of 2.6 for themselves (which is exactly the same fraction of subjects as those who gave zero in the standard dictator game). The only difference in the distribution of choices compared to DG is that the equal split of 1.3 and 1.3 is chosen more often here, which might have been induced by anchoring from part 1.

lottery. Subjects who invest their whole endowment in the investment game in *IG* ($x_i = 100$, 21 / 151 participants) chose on average almost exactly the same transfers, whether this is independent of the charity's lottery or not (39.4 vs 40.8 token). Thus, they largely implement their preferred allocation regardless of the trade-off. Furthermore, the fraction of people transferring the maximum amount to their own lottery remains almost unchanged (17 and 18 subjects out of 151) across the two allocation tasks, suggesting that those participants who prefer the maximum risk in their own payoff do not alter their decision by a trade-off with a lottery for a charity.[10] [11]

The data thus indicate that the not risk averse subgroup of players does not exhibit significant social risk preferences. While there is no a-prioiri reason why risk attitudes and pro-social behavior should be correlated, we do find that risk-aversion and pro-social behavior are negatively correlated among the participants in this experimental study (according to both, choices in part 1, *DG* and *IG*, Pearson corr. coeff.= 0.27, p<0.01, and in part 2, distribution of risks and of returns, corr. coeff.=0.19, p<0.05). On the other hand, we can establish that the average (risk averse) subject exhibits pro-social concerns concerning the distribution of risks and is willing to take on some additional risk on herself in order to not make the charity's payoff less risky, thus exhibiting what we will label *social risk preferences*. The two observations together imply that there might be important differences between a person's social preferences and her *social risk preferences*.

Result 2 (Risk Preferences)**.** *Average choices over lotteries for oneself and on behalf of a charity recipient do not differ significantly. Additionally, participants exhibit significant social risk preferences by being willing to increase own risk to lower the riskiness in the payout to the charity if they are risk averse. In this sample, risk aversion is negatively correlated with pro-social concern.*

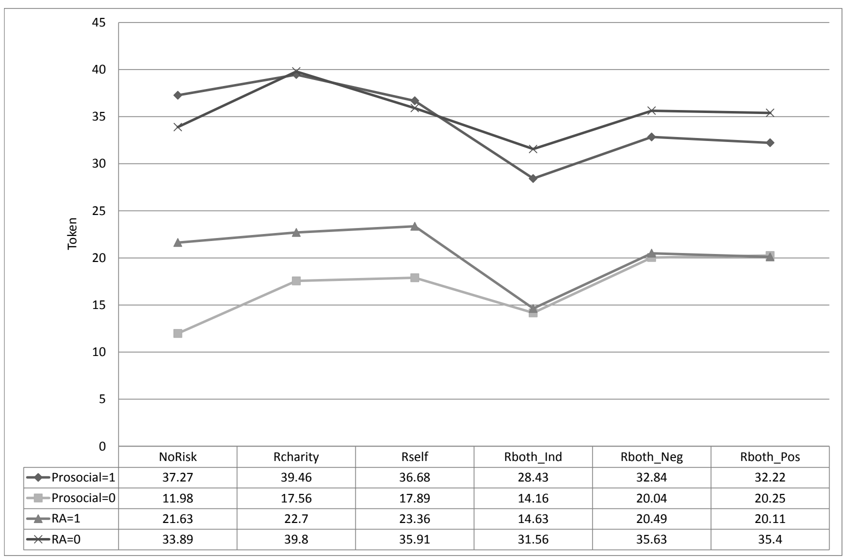
3.3 Individual Level Analysis of Investments

Based on the control treatments, we define different types of players in order to analyze investments in the bundled goods for the following individual types. Standard dictator games have been shown to be a reliable predictor also for giving under risk (Brock et al., 2013, Freundt and Lange, 2017), but as the *IPG*—treatments are composed from dictator and

[10] As a comparison, those who invested $x_i < 100$ in *IG* choose $Transfer_s = 27.1$ token to the own lottery when mutually exclusive and $Transfer_s^{IND} = 19.8$ when they are independent, thus adjusting the size of the transfer in order to reduce $Transfer_{ch}$.

[11] Note again, the behavior of subjects who hold opposite risk preferences over own payoff and payoff to the charity cannot be meaningfully interpreted in this task. However, we established that the hypothesis of same risk attitudes over payoffs for oneself and for the charity cannot be rejected for the experimental population in *T_Distr_Risk*.

investment games, we will not use the choices in those games as control variables for defining subgroups for the regression analysis. rather, we will draw on the choices in part 2. In particular, the preferred bundle in *T_Distr_Return* and the $Transfer_s$ in *T_Distr_Risk_Ind* will be used to classify relatively (not) pro-social and relatively (not) risk-averse subjects within this sample.[12] We define a binary variable $Prosocial \in 0, 1$ that is equal to 1 if a person assigned more than the median share of 0.6 (mean=0.71) of the high return of 2.6 to the charity, zero otherwise. In the same way, risk averse types are defined relative to the distribution of choices in the experimental sample by $RA \in 0, 1$, equal to 1 if the person transferred less than or equal the median amount of 18 token, zero otherwise. These measures provide us with similarly large subgroups for analyzing behavior in the impure public good treatments. 94 subjects are classified as $Prosocial = 1$, 57 as $Prosocial = 0$, 76 subjects are labeled as $RA = 1$, and 75 are of the type $RA = 0$.



	NoRisk	Rcharity	Rself	Rboth_Ind	Rboth_Neg	Rboth_Pos
Prosocial=1	37.27	39.46	36.68	28.43	32.84	32.22
Prosocial=0	11.98	17.56	17.89	14.16	20.04	20.25
RA=1	21.63	22.7	23.36	14.63	20.49	20.11
RA=0	33.89	39.8	35.91	31.56	35.63	35.4

Figure 3: Mean Investments in each IPG-treatment by Type $Prosocial \in 0, 1$ and $RA \in 0, 1$

The differences in magnitudes of transfers by $Prosocial = 1$ types and by $Prosocial = 0$ types in all *IPG*—treatments imply that the investments in impure public goods are regarded as pro-social decisions by participants. The pattern across treatments furthermore suggests

[12]We are mainly interested in how behavior of those who are more risk averse or more pro-social compares to the behavior of the respective other participants rather than making claims about subjects characteristics. Thus, our only claim is that the measure we use to elicit subjects' types allows us to draw conclusions about how subjects rank on this characteristic *relative to the other participants* in the sample instead of claiming that it provides an absolute measure of a person's risk preference or her absolute degree of pro-social concern.

that *Prosocial* $= 0$ types seem to rather increase their transfers as a response to risk in the bundle, i.e. they transfer least in *NoRisk* and almost twice as much in the treatment with the highest risk in *Account B*, *RBoth_Pos*. This observation hints at the interpretation that not inherently altruistic people can be motivated to invest in bundled investment goods that provide a public good because they are attracted by the gamble.[13] Figure 3 also reveals that the drop in average investments in *IPG_RBoth_Ind*, observed in Figure 1, can be found -to some degree- for *every* type of participant. Also, the pattern of average investments across the three bundles in *IPG_RBoth* can be observed for *all* types defined in Figure 3. Note that with respect to the *IPG_RBoth*—treatments, participants do not react to the introduction of risk in a fashion compatible with *any* rational risk preferences. No matter if people are on average risk seeking or risk averse, average transfers in *IPG_RBoth_Ind* should lie in the middle between *IPG_RBoth_Neg* and *IPG_RBoth_Pos*. Only a small minority exhibits a behavioral pattern that can be rationalized by an individual's risk preference, i.e.: 10 subjects transferred *IPG_RBoth_Ind*>*IPG_RBoth_Pos*>*IPG_RBoth_Neg*, 7 subjects transferred *IPG_RBoth_Neg*>*IPG_RBoth_Pos*>*IPG_RBoth_Ind* and 8 subjects transferred *IPG_RBoth_Ind*=*IPG_RBoth_Neg*=*IPG_RBoth_Pos*. The robustness of the pattern between the treatments with co-existent risks is very surprising and calls for further investigation in future studies.

Comparing investments by $RA \in 0, 1$ types, we observe that the $RA = 0$ types invest much higher amounts in all *IPG*—treatments. This is in line with what we expected to observe for the risky bundles. However, it is surprising that the same difference can be observed in *NoRisk*.[14] This finding is in line with the negative correlation between risk aversion an pro-social behavior among the experimental sample that we discussed in section 3.2.

A parametric test of the treatment effects and the importance of individual characteristics is provided by a OLS regression of the differences between treatments in Table 3 and by a random effects regression of treatments on individuals' investment decisions, coded as binary variables equal to 1 if the treatment applies, zero otherwise. The estimation results in Table 3 indicate that risk preferences and pro-social attitudes (measured by the subject's preferred bundle) have very little power to explain *differences* in investment decisions across treatments. The random effect regressions are performed for each $Type = Prosocial \in 0, 1xRA \in 0, 1$ separately. In all estimations in Table 4, treatment *IPG_NoRisk* is the baseline. Confirming the observations from the summary statistics, most

[13] Looking only at the "'selfish"' participants who gave zero token in DG (46 out of 151 subjects), makes the above pattern indicated by the above subgroup comparison even more prominent.

[14] Taking only the subgroups of individuals into account who invested the full endowment of $x_i = 100$ token in *IG* (21 out of 151), we also do not observe a systematic increase in transfers to *IPGs* with increasing riskiness of the bundles.

	(1) Diff	(2) Diff	(3) Diff	(4) Diff	(5) Diff
Prosocial	6.681	4.201	5.285*	6.505*	7.374
	(4.926)	(5.220)	(3.187)	(3.771)	(4.955)
RA	1.230	5.432	5.121	3.504	3.781
	(4.722)	(4.992)	(3.434)	(3.541)	(4.693)
_cons	-6.646	-8.819	0.682	-4.230	-4.606
	(5.342)	(5.821)	(2.439)	(3.118)	(5.556)
N	151	151	151	151	151

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 3: OLS regressions of $Type = Prosocial \in 0,1 x RA \in 0,1$ on treatment differences between amounts invested: (1) IPG_NoRisk-IPG_RSelf, (2) IPG_NoRisk-IPG_RCharity, (3) IPG_RSelf-IPG_RBoth_Ind,(4) IPG_RSelf-IPG_RBoth_Neg, (5) IPG_RSelf-IPG_RBoth_Pos, robust standard errors were used after conducting Breusch-Pagan tests of homoskedasticity

	(1) Inv	(2) Inv	(3) Inv	(4) Inv
IPG_RCharity	1.214	0.882	2.981	12.52
	(3.790)	(3.932)	(4.445)	(8.541)
IPG_RSelf	1.810	1.618	-2.519	12.26
	(3.600)	(4.103)	(4.288)	(7.610)
IPG_RBoth_Ind	-9.381**	-4.059	-8.404	11.39
	(3.795)	(3.095)	(5.646)	(7.491)
IPG_RBoth_Neg	-4.500	3.000	-4.365	15.52*
	(4.191)	(4.798)	(4.871)	(8.111)
IPG_RBoth_Pos	-3.929	1.441	-5.942	18.35***
	(2.792)	(4.211)	(5.916)	(7.115)
_cons	30.93***	10.15***	42.38***	14.70**
	(4.796)	(3.159)	(5.547)	(6.302)
N	252	204	312	138

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 4: Random effects regressions of investments on treatments, coded as binary variables equal to 1 if the treatment applies, zero otherwise, on investments for different subgroups: (1) $Prosocial = 1\&RA = 1$, (2) $Prosocial = 0\&RA = 1$, (3) $Prosocial = 1\&RA = 0$,(4) $Prosocial = 0\&RA = 0$. Baseline is *IPG_NoRisk*.

treatment differences are insignificant compared to the baseline condition without risk for all subgroups. As before, the only significant decline in investments is observed under treatment *IPG_RBoth_Ind*, however, the estimations in Table 4 reveal that this effect mainly occurs among the subgroup of risk-averse *and* pro-social types, see column (1). Only among $Prosocial = 0 \& RA = 0$ players, the coefficient is even positive (but insignificant). Likewise, the treatment effect of *IPG_RBoth_Pos* and *IPG_RBoth_Neg* is statistically significant and positive among the $Prosocial = 0 \& RA = 0$ subgroup. For interpreting the treatment differences in the subgroups it is important to note that giving in the baseline differs notably between the $Prosocial = 1$ (columns(1, 3)and the $Prosocial = 0$ types (columns(2, 4)).[15] Comparing the magnitudes of the coefficients in columns (2) and (4), i.e. treatment effects for the RA=1 and RA=0 types, show that—among those not classified as being pro-social—the not risk-averse participants start investing much higher amounts when risk is being introduced, thus confirming our intuition from the summary statistics.

Note that by testing the effect of treatment on our dependent variable ($investment_i$) for different subgroups we test multiple hypotheses at the same time (see also List et al., 2016). The chance of observing at least one positive significance test due to chance (i.e. making a type I error) increases with the number of dependent tests made simultaneously and we will have to adjust the p-values to take this into account. Therefore, we additionally report the multiplicity-adjusted p-values calculated according to the "'step-down"' procedure suggested in Romano and Wolf (2005). When applying these corrections, we find that, while the strong significances of the negative treatment effects of *IPG_RBoth_Ind* among the pro-social and risk averse types (column (1)) and of *IPG_RBoth_Pos* in column (4) remain (albeit at a slightly lower significance level), the weak significance for the effect of treatment *IPG_RBoth_Neg* in column (4) vanishes, with the multiplicity adjusted p-value being slightly greater than 0.1.

Result 3 (Crowding-In)**.** *The data suggest that the not pro-social and not risk averse participants can be attracted to invest in risky impure public good.*

In Table 5 we repeat the estimations from Table 4, but here we take *IPG_RSelf* as the baseline (and exclude treatments *IPG_NoRisk* and *IPG_RCharity* from the sample) in order to estimate the effect of introducing risk in the public component of the bundle *in addition to* already existing private risk. Again, we observe that *IPG_RBoth_Ind* significantly and negatively affects individuals' investments for the $Prosocial = 1 \& RA = 1$ types, as does *IPG_RBoth_Pos*. Multiplicity-adjusted p-values do not change the above conclusion considerable, the only difference is that the negative treatment effect of *IPG_RBoth_Pos*

[15] Mean investment of each subgroup in IPG_NoRisk: (1):30.93, (2): 10.15, (3): 42.38, (4): 14.7 token.

	(1) Inv	(2) Inv	(3) Inv	(4) Inv
IPG_RBoth_Ind	-11.19***	-5.676	-5.885	-0.870
	(3.481)	(3.528)	(3.648)	(1.417)
IPG_RBoth_Neg	-6.310	1.382	-1.846	3.261
	(3.853)	(4.896)	(2.445)	(3.109)
IPG_RBoth_Pos	-5.738*	-0.176	-3.423	6.087
	(2.946)	(4.014)	(4.470)	(8.181)
_cons	32.74***	11.76***	39.87***	26.96***
	(3.673)	(3.593)	(4.262)	(6.399)
N	168	136	208	92

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 5: Random effects regressions of treatments, coded as binary variables equal to 1 if the treatment applies, zero otherwise, on investments for different subgroups: (1) $Prosocial = 1\&RA = 1$, (2) $Prosocial = 0\&RA = 1$, (3) $Prosocial = 1\&RA = 0$,(4) $Prosocial = 0\&RA = 0$. Baseline is *IPG_RSelf*, treatments *IPG_NoRisk* and *IPG_RCharity* are excluded from the sample.

(column (1)) is no longer significant. The adjustments in both cases clearly show that it is important to consider the dependency of the tests on the four subgroups and adjust the p-values accordingly in order to correctly identify the subgroup-specific effects of treatment. Taking all results together, we mainly observe an effect of introducing risk in the returns from the bundle in the case of co-existent private and public risks with *independent* random draws. This effects is driven by the relatively more risk-averse *and* pro-socially minded types.

Result 4 (Correlated Risks)**.** *When risk in the public component is introduced in addition to risk in the private return from a bundled investment good, mean investments significantly decrease if the risks are independent—but not if they are positively or negatively correlated. This decline in average investments is mainly driven by the subgroup of risk averse and pro-social participants.*

In dictator games, self-regarding players are predicted to give zero, leading to excess zeros in the data (which is also visible in the IPG investments, see Figure 2). Using a tobit model interprets these choices as being censored at zero, i.e. it assumes an underlying latent variable that can take negative numbers.[16] This would mean that some of the zero givers would actually *take* something from the charity if they were allowed to, while—from

[16] The latent variable can be seen as a subject's intended or preferred contribution that is a linear function of the covariates (plus a normally distributed error term). Due to the bound at zero, she can only implement her preferred contribution if it is positive, otherwise she has to give zero, leading to the data pattern that we observe in the experiment.

a behavioral point of view—one would prefer to view those types as "'selfish" types who act according to the prediction for rational agents. Hurdle models (e.g. Engel and Moffatt, 2014) allow for both interpretations and in addition they allow for analyzing how the probability to be a "'zero" type depends on individual characteristics. This models investment decisions as a two-step process. For example, one could imagine that selfish people who just never give cannot possibly be affected by treatments or by their risk aversion but those who are "'natural"' donors might well be affected by them in their decision *how much* to give.

We are interested to test to what extent treatment differences between the IPG—treatments with different risks are driven by risk aversion—and to what extent introducing risk in the two payoff components affects the decision how much to give. As before, we compare *IPG_RCharity* and *IPG_RSelf* both to the baseline treatment without risks, *IPG_NoRisk* (column (1) in Table 6), and we compare the three cases with co-existent risks (*IPG_RBoth_Ind, _Pos, _Neg*) to the case of only risk for the investor (column (2)) in order to observe how introducing additional risk in the provision of the public good affects investment decisions. Due to construction of the panel hurdle model, treatment variables can by definition not predict the likelihood to pass the first hurdle as it captures those participants who always transfer zero across all treatment. The first hurdle test if the participants who never invest can be predicted by their social or risk preferences as elicited in part 2 of the experiment.[17] Those players who might revise their giving decision as a response to the treatment modification are captured in the second part of the estimation.

Table 6 confirms the negative and significant treatment effect of *IPG_RBoth_Ind* on the magnitude of investments, conditional on investing a positive amount. Preferring a bundled investment that gives a higher share of the return to the charity in the case of a successful investment is significantly and positively correlated with the likelihood to invest in the impure public goods and with the magnitude of the investments. As observed already in Figure 3, risk loving participants invest higher amounts.

4 Conclusion

This paper investigated to what extend the risk inherent in social investments influences their attractiveness for investors. In particular, we analyzed how risk in the provision of the public benefit and in the financial return to the investor each affect investment decisions separately and how, in addition, their correlation influences investments when both risks are simultaneously present. We identified heterogeneous treatment effects for participants

[17] Note that we refrain from the binary classification in order to estimate the probit model of the first hurdle.

	(1) Inv	(2) Inv
hurdle		
Tr_Return_Ch	1.562***	25.43
	(0.567)	(267.139)
Tr_Risk_Self	0.00285	0.0148
	(0.008)	(0.011)
_cons	0.601**	0.0751
	(0.266)	(0.269)
above		
IPG_RCharity	4.220	
	(3.385)	
IPG_RSelf	4.825	
	(3.352)	
IPG_RBoth_Ind	-5.939*	-10.35***
	(3.409)	(2.725)
IPG_RBoth_Neg	1.926	-2.749
	(3.369)	(2.687)
IPG_RBoth_Pos	2.113	-2.674
	(3.362)	(2.681)
Tr_Return_Ch	9.921**	10.47**
	(4.589)	(4.267)
Tr_Risk_Self	0.404***	0.245**
	(0.138)	(0.104)
_cons	10.89*	15.76***
	(6.017)	(6.028)
sigma_u		
_cons	26.36***	24.78***
	(3.034)	(1.765)
sigma_e		
_cons	26.30***	21.20***
	(0.857)	(0.859)
transformed_rho		
_cons	-1.038**	0.215
	(0.528)	(0.527)
N	906	604

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 6: Panel double hurdle estimation (based on probit and tobit regressions) of investment decisions on treatments and types, treatments coded as binary variables equal to 1 if the treatment applies, zero otherwise. Baseline is *IPG_NoRisk* in column (1). In column (2), the baseline is *IPG_RSelf*, treatments *IPG_NoRisk* and *IPG_RCharity* are excluded from the sample.

who are more (less) risk-averse and who show greater (lower) pro-social concern compared to their peers in the experimental sample.

The results show no differences in average investments when risk is exogenously introduced in one component of the bundled investment good compared to a situation with no risk. When risk in the public component is introduced in addition to risk in the private return from a bundled investment good, mean investments significantly decrease if the risks are independent—but not if they are positively or negatively correlated. This decline in average investments is mainly driven by the subgroup of risk averse and pro-social participants. Furthermore, the data suggest that the not inherently pro-social and not risk averse participants can be attracted to invest in risky impure public good.

With respect to modeling preferences for giving, our results suggest that—in the context of impure public goods—models of individual giving decisions should take the *impact* of a participant's donation into account. The decisions on the allocation of risk within the decomposed bundles in part 2 as well as the importance of distinguishing between investors with different risk preferences and the strong decline in investments in *IPG_RBoth_Ind* all suggest that at least a fraction of subjects cares about the variance in the donation in addition to their own risk. Thus, models of giving that are based on a feeling of warm-glow from the act of giving (that can be interpreted for example as social-image or identity concerns) fall short of describing the overall observed investment pattern for impure public goods. The findings close an important gap in the experimental evidence on individual's pro-social behavior under risk when more than one risk co-exist, which can inform models of the demand for impure public goods under risk (Lai et al., 2017). By identifying determinants of crowdinvestors' willingness to invest in impure public goods and by outlining important heterogeneities in people's reaction to the risks in our treatments, this study helps to inform under which conditions microlending or crowdinvesting might be able to best attract investors. The observation that relatively less pro-social participants seem to be attracted to participate in risky investments in impure public goods if they are not risk averse seems interesting to further explore with respect to its consequences for charities and social entrepreneurship. In summary, the results show some interesting new aspects but also some puzzles that remain to be solved by further experimental investigations.

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Appendix

Appendix A: Additional Analysis

Treatment	**Mean**	**Median**	$\mathbf{x_i=0}$
DG	24.722 (27.644)	17	30.46
DG_RCharity	21.238 (26.39)	10	36.42
IG	41.192 (31.14)	40	12.58
IPG_NoRisk	27.722 (34.2)	10	38.41
IPG_RCharity	31.192 (35.26)	20	37.09
IPG_RSelf	29.589 (28.44)	25	25.83
IPG_RBoth_Ind	23.04 (27.27)	15	37.09
IPG_RBoth_Neg	28.007 (29.49)	20	29.80
IPG_RBoth_Pos	27.702 (28.72)	20	27.15

Table 7: Summary Statistics of transfers in part 1, mean with standard deviations in brackets (column 1), median (column 2), share of participants transferring zero token ($x_i = 0$) in percent (column 3), N=151

Appendix B: Experimental Instructions

Welcome to the experimental laboratory,

And thank you for participating in this experiment.

Please switch off your phones during the entire duration of the experiment. It is not allowed to communicate with other participants and not following this rule might lead to and exclusion from the experiment as well as from all payments. If you have a question during the course of the experiment, please raise your hand, we will come to your cabin.

Experimental Session

The experiment consists of three independent tasks. The instructions for the second and third part will be distributed and read loud after the previous part has been finished. The decisions you make during one part have no relevance for the decisions and payoffs from the respective other two parts. After the experiment is over, we will ask you to fill out a brief questionnaire.

Procedure

Part 1 consists of 9 decision-making situations, part 2 of 3 decision-making situations and part 3 of 2 decision-making situations. Out of these 14 situations, one single situation will be selected for payment by a random draw and each situation has the same likelihood to be drawn. The payoff from this one situation then determines your final payoff. You will be informed about the result of this random drawn at the end of the experiment.
All decisions will be made anonymously, i.e. neither another participant nor the experimenter can match them with personally identifiable characteristics.

Payouts

Your payout will be partly determined by your decisions, partly by chance. Because your decisions determine what payment you finally receive, it is important that you read the instructions carefully before making a decision. In case something is unclear to you, please do not hesitate to ask!
Your income in the experiment will be calculated in Taler. These will be converted into Euro at the end of the experiment with an exchange rate of

$$100 \text{ Taler}=8\text{Euro}.$$

In addition to the payoff from your decision in the experiment, you will receive a show-up fee of 5 Euro. The show up fee will not be used in the experiment. Payment will be made in cash after the experiment is over. The other participants will not be able to see how much money you earned. In some decision-making situations, your choice will affect not only your own payout but also a payout to the non-profit organization BetterPlace.

Description of the organization BetterPlace:
BetterPlace is a web-based donation platform and the largest online donation platform in Germany. Via their website, non-profit and non-governmental organization can collect money for charitable causes. 100% of the money collected is transferred to the respective project. At the beginning of the experiment, you will be able to choose between three projects that are supported by BetterPlace to which you want to transfer a possible payout. Your decision is binding for the whole experiment.

BP-Project 1: upbringing of orphaned elephants in Kenia
'Aktionsgemeinschaft Artenschutz e.V.' (Action Group Species Protection) looks after young elephants, whose parent often died due to poaching. The young animals get veterinary care, they are brought up and later released into the wild. Thereby, the project fosters the protection of elephants in Kenia, who are threatened by illegal poaching and ivory trade, and contribute to preserving biodiversity.

BP-Project 2: Mentorship for children in Hamburg
'Zeit für die Zukunft - Mentoren für Kinder e.V.' (Time for the Future - Mentorship for children) is a volunteer mentorship programme for the individual support of children and youth ages 6-16 years-old in Hamburg and surroundings. The children are accompanied by a chosen mentor for at least one year, who is available as a caregiver. Through this children from underpriviledged families and children in challenging life situations receive individual support and improved education opportunities.

BP-Project 3: Open-Source small hydropower plant
'Ingenieure Ohne Grenzen e.V.' (Engineers without borders) build 250W small hydropower plants for households in African developing countries. There the state owned electricity grids are poorly developed, so that especially households in rural areas do not have access to electricity. Engineers without borders has developed a micro water turbine, which enables an efficient and environmentally friendly power generation with low fix costs. This ensures an independent power supply for households. The construction manual is available in accordance with the open source principle, to promote on the ground local expertise in the field of environmentally friendly technology.

In case of a bank transfer to BetterPlace after the end of the experiment the money will be transferred for every participant to the chosen project. This will take place simultaneously with the cash payment in your presence via online bank transfer. On an extra sheet, which you'll be able to take home, you can find once more all information in regard to the projects. A few days after the experiment you will receive an E-Mail from the WiSo research lab with a link, with which you can review the original receipts of today's bank transfers to BetterPlace.

PART 1

During the first part of the experiment you will make nine independent decisions. Your decision in one situation does not have any impact on the decision or the payment of another situation. The participants do not run through the decision-making situations in the same order. It is therefore possible, that participants make different decisions at the same time, yet every participant overall runs through the same nine situations.

Decision-making situations

For every decision that you will take, you will receive 100 Taler to your private account, account A, to your disposal. Of these 100 Taler you can transfer an amount chosen by yourself to account B. The leftover Taler will remain in your private account A; these will be paid out to you. The payment from account B will be put together differently in every situation. It can include a private payment to you and/or a payment to the chosen BetterPlace project. In a few of these decision-making situations the level of the actual payment from account B is dependent on a lottery drawing. Should this be the case, the mechanism of the lottery will be described on your screen. The lottery drawing as described there will be carried out by the computer. Your final payment will be disclosed to you by the end of the experiment. Attention: As your decisions in every situation have different impacts on your payments, previous to every decision a detailed description of the respective decision-making situation will be displayed on your screen. It is important, that you read carefully through the changing descriptions on your screen, to know the consequences of your respective decision. If questions should arise, contact us, we will get in touch with you!

Do you have any questions regarding the instructions? If not, the experiment begins now. On the first screen a few questions will be posed to you to ensure, that you have understood the process of the experiment. As soon as you have answered these, you will get to the actual experiment.

PART 2

In part 2 of the experiment you will make three completely independent decisions. This means, every decision has no impact on the other decisions and the respective payments. The decision-making situation will be described here and show up in a random order on your screen.

Decision-making situations:

Situation A

In situation A 100 Taler are in your account B (and 0 Taler in your account A). Account B generates two payments, one to you and one to BetterPlace. Both payments are determined by a lottery: with a probability of 50% the payment will be 0 Taler and with a probability of 50% the 100 Taler are multiplied with a rate of return. The overall rate of return in account B is 2.6 and is the sum of Return1 to you and Return2 to BetterPlace. You can now decide the allocation of the overall rate of return by determining Return1 and Return2.

Your Payments	Payments to BetterPlace
Return1*100 or 0	Return2*100 or 0

Your payment with a probability of 50:50 will be Return1*100 Taler or 0 Taler. The payment to BetterPlace with a probability of 50:50 will be Return2*100 Taler or 0 Taler. As the overall rate of return is 2.6, the following must apply:

$$\text{Return2} = 2.6 \ \ \text{Return1}.$$

Lottery:

The payments to you and to BetterPlace are determined by one single lottery drawing. So either both you and BetterPlace receive the high rate of return or both of you receive 0 Taler with a probability of 50%.

Situation B

For the decision in situation B 65 Taler will be placed at your disposal. You can use these Taler, to alter the potential payment of two random lottery drawings, one for yourself and one for BetterPlace.

Both, a payment to yourself as well as a payment to BetterPlace are determined by a lottery, in which respectively two possible payments with a probability of 50% can occur. Both of these possible payments are named in the displayed tables 'left payment' and 'right payment'. In the starting situation you would receive 65 Taler if the left payment is drawn, and a payment of 65 Taler, if the right payment is drawn. BetterPlace would in the starting situation receive the same possible left and right payment.

Your possible payments:	
left	right
65+Transfer 1	65-Transfer 1

Possible payments to BetterPlace:	
left	right
65+Transfer 2	65-Transfer 2

By choosing a transfer, Transfer 1, you can change both of the possible payments in your lottery. The chosen value, Transfer 1, will be added to your left payment and consequently automatically deducted from your right payment. The same applies for the possible payments of the lottery for BetterPlace: The Transfer 2 chosen by you will be added to the left payment and consequently automatically deducted from the right payment. Both payments can occur with the same probability of 50%.
For the transfers you should use the above mentioned 65 Taler, which are available to you. Please note the following restriction in the choice of transfer 1 and 2: You have to divide up the full 65 Taler. This means:

$$\text{Transfer 1} + \text{Transfer 2} = 65 \text{ Taler.}$$

Lottery:
The actual payment to you and to BetterPlace are determined by one single lottery drawing. So either you or BetterPlace receive the left payment with a probability of 50%. Should you receive the left payment, BetterPlace will receive the right payment and vice versa.

Situation C
In situation C you will make two separate independent decisions, for which you will each be provided 65 Taler. In a decision you can use 65 Taler to change the possible payments in a lottery for yourself. In a second decision you can use the 65 Taler to change the possible payments in a lottery for BetterPlace.

Your possible payments:	
left	right
65+Transfer S	65-Transfer S

Your payment will be determined by a lottery drawing, in which two possible payments with a probability of 50% can occur. Both of these payments are named in the displayed table 'left payment' and 'right payment'. In the starting situation you would receive a payment of 65 Taler, if the left payment is drawn, and a payment of 65 Taler, if the right payment is drawn. You can now choose a transfer S, which will be added to your left payment and consequently automatically deducted from your right payment. The following applies: Transfer S≤65 Taler.

In a second decision you will make an analogue decision for both possible payments in a lottery drawing for BetterPlace. The chosen transfer B will be added to the left payment and consequently automatically deducted from the right payment. Here applies as well: Transfer B≤65 Taler.

Possible payments to BetterPlace:	
left	right
65+Transfer B	65-Transfer B

Your decision on transfer S has no impact on a payment to BetterPlace and your decision on transfer B has no impact on your payment.

Lottery:
The payment to you and the payment to BetterPlace are determined by one single lottery drawing. So either you or BetterPlace receive the left payment with a probability of 50%. Should you receive the left payment, BetterPlace will receive the right payment and vice versa.

The lottery will be carried out by the computer at the end of the experiment.
If you should not have any questions about the instructions in advance, the second part of the experiment will start now. Before the actual decisions you will receive a few brief questions to ensure, that you have understood the process.

PART 3

You will receive 100 Taler to be at your disposal, which you can transfer to a project 1 and to a project 2. You will divide the full 100 Taler here to both these projects, so both your transfers must add up to 100 Taler all together! There are nine decision-making situations, which will be displayed in a list on your screen. Every row in the list represents one new decision-making situation. In every situation 1 to 9 you will each receive 100 Taler, which you can divide up between project1 and project2 in a row. At the end there will be a lottery drawing one of the rows, while each row can be drawn with the same probability. The payments from project1 and project2 in that row will be added to your payment.

In the screenshot you can see such a list, as it will appear on your screen. In project 2 your transfer with a probability of 50% will be multiplied with a rate of return R2 of 2.6, which means you will receive a payment of 2.6 times the amount of Taler in project 2. With a probability of also 50% you will receive a payment of 0 Taler.
The transfer in project 1 generates two payments, one to you and one to BetterPlace. For your private payment from project 1 you will receive a transfer with a probability of 50% multiplied with a rate of return R1, which means you will receive R1 times the amount of Taler from project 1. With a probability of also 50% you will receive a payment of 0 Taler. The rate of return R1 changes from row to row. The lowest payment, which can be drawn with a probability of 50%, is always 0 Taler.
There will be 2 different lists, which will appear after one another on your screen. The payment to BetterPlace from project 1 is in these two lists composed differently.
In both lists you will divide up 100 Taler between a project 1 and a project 2. As previously described in the chapter 'procedure', one of these two lists or a situation from part 1 or 2 can be relevant for your final payment.

Do you have any questions in regard to the instructions? If not, the third part of the experiment will start now. In advance to the actual decisions you will again receive a few brief questions to ensure, that you have understood the process.