MONASH University

MONASH BUSINESS SCHOOL

Department of Economics
ISSN number 1441-5429

Do Positive Externalities Affect Risk Taking? Experimental Evidence on Gender and Group Membership

Discussion Paper no. 2024-05

Carina Cavalcanti and Andreas Leibbrandt

Abstract:

Many positive externalities are created by risk-taking. We investigate whether risk-taking is affected by the presence of positive externalities. In our experiments, we study choices between investments in technologies that differ according to their level of risk and the extent to which they generate positive externalities for others. We find that even large positive externalities have little to no impact on individual risk-taking. We also find that women are generally less willing to take risks than men in the absence and presence of positive externalities and that they generate fewer positive externalities if they increase with risk but more positive externalities if they decrease with risk. Finally, we observe that groups invest more in technologies with larger positive externalities and that this is mainly driven by male group members. These findings provide a comprehensive view on the malleability of risk-taking in the presence of positive externalities.

Keywords: Risk aversion, positive externality, gender

JEL Classification: C91, C92, D81, H23, J17

Carina Cavalcanti: Department of Accounting, Finance and Economics, Griffith University, Southport and Nathan, QLD, Australia. (email: c.cavalcanti@griffith.edu.au); Andreas Leibbrandt: Department of Economics, Monash University, Clayton, VIC 3800, Australia. (email: Andreas.Leibbrandt@monash.edu).

Do Positive Externalities Affect Risk Taking? Experimental Evidence on Gender and Group Membership

By Carina Cavalcanti[a] and Andreas Leibbrandt[b†]

[a] Department of Accounting, Finance and Economics, Griffith University, Southport and Nathan, QLD, Australia.

[b] Department of Economics, Monash University, Clayton, VIC 3800, Australia.

This version: 17 July 2023

Abstract

Many positive externalities are created by risk-taking. We investigate whether risk-taking is affected by the presence of positive externalities. In our experiments, we study choices between investments in technologies that differ according to their level of risk and the extent to which they generate positive externalities for others. We find that even large positive externalities have little to no impact on individual risk-taking. We also find that women are generally less willing to take risks than men in the absence and presence of positive externalities and that they generate fewer positive externalities if they increase with risk but more positive externalities if they decrease with risk. Finally, we observe that groups invest more in technologies with larger positive externalities and that this is mainly driven by male group members. These findings provide a comprehensive view on the malleability of risk-taking in the presence of positive externalities.

Key words: Risk aversion, positive externality, gender

JEL codes: C91, C92, D81, H23, J17

† Corresponding author. E-mail address: Andreas.Leibbrandt@monash.edu.

1. Introduction

Risk taking is a core ingredient for innovation and entrepreneurship (Zahra and Covin, 1995; Garcia-Granero et al., 2015). Ventures of personalities like Elon Musk and Susan Wojcicki are not only prime examples for the relationship between risk taking and innovation, they are also examples of how such risk taking can translate into significant positive externalities.[1] While it seems clear that these two famous entrepreneurs have a high propensity to take risks, it is unclear to which extent they took more high risks because of positive externalities. Similarly, it is unclear to which extent their customers are more willing to purchase new products that involve high risks because of positive externalities. For example, we know little whether individuals are significantly more willing to switch to electric vehicles because they reduce the carbon footprint.[2] More generally, we know very little whether the possibility of positive externalities has any bearing at all on individual risk taking.

Our study is a first attempt to experimentally investigate the causal impact of positive externalities on risk taking. We present a laboratory experiment in which subjects make decisions on how to invest in technologies, which not only differ in terms of risk, but also in the extent to which they impose positive externalities. To comprehensively explore how positive externalities impact risk taking we study two treatments in which we vary whether more risk taking causes more or less positive externalities. In addition, we investigate the role of gender in risk taking with positive externalities and how individuals invest on their own and as part of a group.

There are reasons to believe that positive externalities affect risk taking. While standard economic theory does not consider a relationship between individual risk taking and externalities because selfish agents do not care about the impact of their actions on others in one shot interactions, theories relaxing the assumption of selfishness predict that agents adjust their risk-taking to increase positive externalities. These theories are formulated based on experimental evidence that many individuals are not selfish but have social preferences (Fehr and Schmidt, 1999; Charness and Rabin, 2002), are reciprocal (Gouldner, 1960; Dufwenberg

[1] It is also possible that the avoidance of risk-taking can lead to positive externalities. For example, strict safety procedures constraining risk-taking in aviation or nuclear power can contribute to a safer and more secure environment for everyone.

[2] The early purchasers of electric vehicles arguably took high risks because of the uncertainty of the functioning of the new technology, the uncertain availability of battery recharging networks, and the reliability and resale value of these vehicles.

and Kirchsteiger, 2004; Falk and Fischbacher, 2006), altruistic (Andreoni et al., 2010), follow social norms (López-Pérez, 2008) and that externalities affect behavior.[3]

There are also reasons to believe that gender plays an important role for risk taking when there are positive externalities. There is significant evidence for gender differences in risk taking (Croson and Gneezy, 2009) and that the context matters particularly for women when affecting others (Greig and Bohnet, 2009; Rivas, 2013). Women are more risk-averse than men, which is widely documented in field data (Halek and Eisenhauer, 2001), surveys (Guiso and Paiella, 2008; Dohmen et al., 2011; Byrnes et al., 1999), and laboratory experiments (Eckel and Grossman, 2008; Charness and Gneezy, 2012). The difference between women and men in risk-taking has often been cited as an explanation for differences in entrepreneurial activities (Caliendo et al., 2009; Cramer et al., 2012). However, to the best of our knowledge, there is no experimental literature systematically investigating the relationship between risk-taking, positive externalities, and gender.

Finally, there are reasons to believe that the impact of positive externalities on risk taking is different when decisions are made in groups. Many risky decisions are made in groups and there is substantial research on whether groups make 'better' risky decisions than individuals presenting mixed evidence (Bone et al., 1999 & 2004; Rockenbach et al., 2007; Masclet et al., 2009; Sutter, 2009; Ertac and Gurdal, 2012; Bogan et al., 2013). Relatedly, there is substantial research suggesting that groups act more selfishly than individuals (Bornstein et al, 2004; Kocher and Sutter, 2007; Kugler et al., 2012). Our study investigates risk taking in groups in a decision environment that involves both risk and social considerations.

This paper reports several novel findings. *First*, we find only weak evidence that positive externalities affect risk taking as there is only a marginal shift towards investments in technologies with positive externalities. *Second*, women are in general less willing to take risks than men, regardless whether there are positive externalities. Men generate more positive externalities if they increase with risk while women generate more positive externalities if they decrease with risk. *Third*, groups invest more in technologies that generate larger positive externalities than individuals which is mainly driven by male group members who generate large positive externalities.

[3] Positive externalities are modelled in many games. For example, in public goods games, individual contributions are multiplied by a factor larger than one resulting in a growing resource other individuals can draw from. In trust games (Berg et al., 1995), individual trust is modelled by the sending of money which gets multiplied by a factor larger than one resulting in social welfare and higher possible earnings for trustees.

This study contributes to different research fields. It is not only related to the extensive literature on risk taking and gender, and risk-taking in groups, it is also related to the literature on risk-taking on behalf of others (Chakravarty et al., 2011; Eriksen et al., 2020 provides a comprehensive overview) and the experimental literature on the willingness to impose externalities (Plott, 1983; Abbink et al., 2002; Barr and Serra, 2009, Bland and Nikiforakis, 2015; Bartling et al., 2019; Sutter et al., 2020). The key contribution of our study is that we systematically investigate the link between risk taking and positive externalities. Thus, we go beyond existing experimental work that simplifies risk-taking and externalities as independent. This paper complements Cavalcanti et al. (2022) who study the link between risk taking and negative externalities and find relatively strong impacts of negative externalities on individual and group risk taking.

This study is also related to research combining risk and social preferences (Bohnet and Zeckhauser, 2004; Dohmen and Falk, 2011; Chuang and Schechter, 2015; Gneezy et al., 2016), which typically measure different economic preferences in a set of games such as lottery and trust games. These studies show that many individuals are both risk averse and prosocial but treat risk taking as a purely individual decision choice. This contrasts with our experimental design, in which risk taking involves a social dimension because it can impose positive externalities on others.

Our findings may provide insights for the literature on innovation and entrepreneurship (Zahra and Covin, 1995; Garcia-Granero et al., 2015) on technology adoption (Doss and Morris, 2000; Venkatesh et al., 2000; Liu, 2013; Barham et al., 2014), which suggests that risk taking plays an important role. While some of this literature directly collects and relates individual measures of risk to outcomes, it does not consider risk externalities, which may oversimplify the presumed causal relationships from risk taking to investments as they do not take into account reverse causality in the sense that potential positive externalities affect risk taking.

2. Experimental Design

We use a laboratory experiment to study the causal impact of positive externalities on risk-taking. The experiment was conducted in an economics laboratory at a major university in Australia. The experiment was programmed in z-Tree (Fischbacher, 2007) and subjects were students from different faculties, which we recruited with the software SONA. They earned an average of A$36.7 for participating in an experimental session that lasted less than one hour. There were 15 experimental sessions with a total of 194 subjects. Subjects read an information sheet and signed a consent form before the start of the experiment. Then, general instructions and instructions for the first task were handed out. After subjects had finished the first task, instructions for the second task were handed out and so forth. Sessions finished with a short exit survey and payment in cash. Sample experimental instructions are reproduced in Appendix A.

2.1 The four different tasks and technologies and the two treatments

The experiment consists of four tasks. Each subject completes all four tasks in the same order and starts with an endowment of $30. Subjects knew that they were paid by choices in one of the tasks, which was randomly chosen after they made all their investment choices such that choices in previous tasks should not affect choices in consecutive tasks.[4] The outcomes (gain, loss) were determined independently for each technology by a lottery. Subjects could invest $20 in each task. For all four tasks, they had to decide how to allocate these $20 between four different investments, which we called technology A, B, C, and D. The default investment was technology A. Subjects could invest all $20 in one technology or split the money and invest in two, three, or four technologies.

The four tasks and the characteristics of the four technologies are reported in Table 1. The four tasks were designed such that the experiment follows a 2 x 2 within subject design: whether choices involved positive externalities and whether they were made individually or as part of a two-person group. Task 1 was individual and did not involve positive externalities. Task 2 was individual and involved positive externalities. Task 3 was in groups and did not involve positive externalities. Finally, task 4 was in groups and involved positive externalities.

[4] Although subjects knew that their choices in each task were independent, it is possible that the order of the tasks affects choices. We chose the order of the tasks such as to maximize the saliency of positive externalities via their introduction in task 2. Thus, it is possible that the impact of positive externalities that we observe between task 1 to 2 is more pronounced than if the order was reversed. However, we observe no clear evidence for corresponding order effects in our new study with fishers in Brazil where we randomize the order of similar tasks where positive externalities are positively correlated with risk-taking: when positive externalities are introduced instead of removed, there is more risk-taking in the former but the difference is not statistically significant.

Table 1: Overview of Experimental Design

	Task			
	1	**2**	**3**	**4**
Positive externalities?	no	yes	no	yes
Choice in teams?	no	no	yes	yes
	Available technologies in each task			
	A	**B**	**C**	**D**
Possible loss (50% chance)	0%	-10%	-40%	-100%
Possible gain (50% chance)	0%	50%	100%	200%
	Increasing externality treatment			
Positive externality:	0%	5%	20%	50%
Certain impact on one other subject		each $1 invested increases 5 cents	each $1 invested increases 20 cents	each $1 invested increases 50 cents
Expected individual return	0%	20%	30%	50%
Expected social return	0%	25%	50%	100%
	Decreasing externality treatment			
Positive externality:	50%	20%	5%	0%
Certain impact on one other subject	each $1 invested increases 50 cents	each $1 invested increases 20 cents	each $1 invested increases 5 cents	
Expected individual return	0%	20%	30%	50%
Expected social return	50%	40%	35%	50%

The technologies have different levels of risk and expected rates of return. Technology A has no risk (return of 0%). Technologies B, C, and D materialized with equal probability (50%) gains and losses. If there was a loss, investments in B were reduced by 10%, if there was a gain, they increased by 50%, resulting in an expected individual return of 20%. Investments in C could be reduced by 40% or increased by 100%; the expected individual return is 30%. Investments in D could be completely lost or tripled; the expected individual return is 50%.

We conducted two treatments (*Increasing Positive Externality Treatment* and *Decreasing Positive Externality Treatment*) where we implemented positive externalities in tasks 2 and 4. Three of the four technologies involved positive externalities. In the *Increasing Positive Externality Treatment*, Technology B had a positive externality of 5%; i.e., 5% of each invested amount in B increased the endowment of one other randomly chosen subject in the same experimental session. For example, if a subject invests $10 in B, one subject's payment will be increased by 50 cents. We clarified to the subjects that their investment choices could only impact one other subject and that the investment choices of one other randomly chosen subject could also increase their own endowment. Technology C had a positive externality of 20% and D of 50%, i.e., it could result in a positive externality of up to $10. The expected social return (individual return plus externality) was 0% for technology A, 25% for technology B, 50% for technology C, and 100% for technology D. Thus, both, in the absence and presence of externalities, the most socially efficient choice was to invest everything in technology D.

In contrast, in the *Decreasing Positive Externality Treatment*, Technology C had a positive externality of 5%, B 20% and A of 50%, i.e., it could result in a positive externality of up to $10. The expected social return (individual return plus externality) was 50% for technology A, 40% for technology B, 35% for technology C, and 50% for technology D. Thus, in the presence of externalities, the most socially efficient choice was to invest everything in either technology A or D.

There are several reasons for the specific choice of technologies and their parameters. First, we wanted to have a safe technology as a baseline that has no risks, zero returns and causes no externalities. Second, we wanted to give subjects choices between a limited number of technologies for which there is a systematic – either positive or negative – relationship between risk and positive externalities. It is plausible that these two variables are linked. For example, new medicines or vaccines involve high (and potentially catastrophic) risks for the investor but may also cause large positive externalities. Third, we wanted to have a very risky as well as a riskless technology that have a very high social rate of return to see whether this could encourage / discourage risky investments. Fourth, we wanted to include two intermediate technologies that are less risky but still have a substantial positive social rate of return to capture technologies that are in both the individual and the social interest.

In tasks 3 and 4, we investigate risk-taking as part of a group. Subjects were told that they would make their individual choices in groups of two and there would be no communication between group members. Each subject was randomly matched with another and was informed that both group member's choices would be summed and returns shared equally. For example, if subject 1 invests everything in A and subject 2 invests everything in D, then potential outcomes for each subject in this group can be between $10 (if a loss is materialized for investments in D: {20 + 0*20}/2) and $40 (if a gain is materialized for investments in D: {20 + 3*20}/2). In addition, we investigate whether risk-taking depends on the gender of the group member. Thus, subjects made two choices each in tasks 3 and 4. One choice in case their randomly allocated group member was a woman and another choice in case it was a man. The order of the gender was randomized across subjects.

2.2 Hypotheses

The experimental design enables us to experimentally investigate the role of positive externalities in investments and the intersection with gender. As a theoretical benchmark, we use a risk-neutral and selfish investor. We gradually relax these two strong assumptions to formulate three main hypotheses. In our setting, the standard prediction for a risk-neutral and selfish investor is that they invest the maximum amount of $20 in technology D, which maximizes the individual expected payment, regardless of the task, regardless of whether they impose positive externalities on others.

There is significant evidence that many individuals derive utility if they increase other individuals' payoffs and have social preferences (Fehr and Schmidt, 1999; Charness and Rabin, 2002). Relatedly, there is manifold evidence of substantial contributions in public goods experiments, that suggest individuals are willing to forego earnings to contribute to a growing resource (Andreoni, 1995; Chaudhuri, 2011). Translated to our setting, this implies that there is a tendency to invest more in technologies that have large positive externalities. In consequence, we conjecture that some individuals shift investments from technologies that impose fewer (or no) positive externalities to technologies that impose substantial externalities. For example, in the increasing positive externality treatment by shifting from C to D, they would agree to a substantial higher risk of significant loss because they can increase externalities to 50%. That is, subjects, who place a sufficiently high utility on positive externalities, will shift investments to technology D in task 2, even though D has a 50% chance of total loss. Similarly, in the decreasing positive externality treatment participants can increase externalities by 50% if they shift investments from technology D to A.

Hypothesis 1: *Some individuals adjust investments in technologies because of positive externalities. If riskier technologies cause larger positive externalities, they take more risks. If less riskier technologies cause larger positive externalities, they take less risks.*

The tendency to adjust investments in technologies with large positive externalities applies to investors regardless of their risk preferences. For example, a risk-averse investor who prefers technology B (or C) in the absence of positive externalities, shifts investments to technology C (or D) if they were generating sufficient utility from generating positive externalities. Relatedly, there is significant evidence that women are more risk-averse than men and thus generate lower individual investment returns (Watson and McNaughton, 2007). We also expect these gender differences in task 1 and to observe that men invest more in risky technologies than women. For example, men might invest everything in technology D and thus achieve an investment efficiency of 100% (efficiency is here calculated by the expected individual return {50%} divided by the maximal potential individual return {50%} * 100), whereas women might invest in technology C and thus achieve a lower investment efficiency of 60% (individual return of 30% divided by maximal return of 50% * 100).

Further, gender differences in certain investment returns may systematically change in task 2 where positive externalities are present. There is a rich body of evidence showing gender differences in altruism and social preferences that also report gender differences in responsiveness to experimental variations (Croson and Gneezy, 2009). Interestingly, these gender differences in responsiveness differ. For example, there is evidence that men are more responsive to costs of altruism (Andreoni and Vesterlund, 2001), while other evidence suggests that women are relatively more responsive (Cox and Deck, 2006). Cavalcanti et al. (2022) finds no significant gender differences in responsiveness in individual risk-taking that varies the extent of negative externalities. Thus, we hypothesize that if risks are positively associated with positive externalities (i.e., in the increasing positive externality treatment), we should observe that women generate fewer positive externalities than men, which then leads to an even worse investment performance relative to men. However, if risks are negatively associated with positive externalities (i.e., in the decreasing positive externality treatment), we should observe the reverse and women generating more positive externalities than men.

Hypothesis 2: *If riskier investments cause more positive externalities, then men generate more positive externalities than women. If riskier investments cause fewer positive externalities, then women generate more positive externalities than men.*

A rich literature in experimental economics compares individual to group risk-taking (Kocher and Sutter, 2005). Some studies report more risk aversion and lower returns in groups (Ertac and Gurdal, 2012), others report no differences (Harrison et al., 2005; Baker et al., 2008) or higher investment returns in groups (Rockenbach et al., 2007). Shupp and Williams (2008) find that these differences may be related to the winning probabilities of lotteries. In lotteries with 10-40% winning probabilities, they find more risk aversion in groups, whereas in lotteries with 70-90% winning probabilities, they observe less risk aversion in groups. We chose a 50% winning probability in our experiment and thus do not expect significant differences in risk-taking and investment returns when acting as an individual (task 1) or as a group member (task 3).

There is a gap of experimental evidence comparing the willingness to impose externalities as individuals and in groups. An exception is Cavalcanti et al (2022), which finds that groups impose more negative externalities than individuals. Studies capturing social preferences often find that individuals act more selfishly in groups than when alone (Bornstein et al, 2004; Kocher and Sutter, 2007; Luhan et al., 2009; Gillet et al., 2009). Based on this evidence, we speculate that groups take positive externalities less into account than individuals, and can manifest in lower investments in technology D in the increasing positive externality treatment and in technology A in the decreasing positive externality treatment when comparing investments in task 4 to task 2.

Hypothesis 3: *Less positive externalities are generated when individuals make choices in groups as compared to when they make choices on their own.*

3. Experimental Findings

3.1 Overview

Table 2 presents the investment choices in the four tasks for each technology in the two treatments. Several interesting patterns emerge. We observe substantial investments in all four technologies. Subjects invest on average between ($)3 – ($)6.9 out of ($)20 for a given technology. A closer look at the individual level shows that most subjects invest in more than one technology. For example, in task 1 of the increasing positive externality treatment, 84.9% invest in at least two technologies, 40.7% in three, and 23.2% in all four technologies.

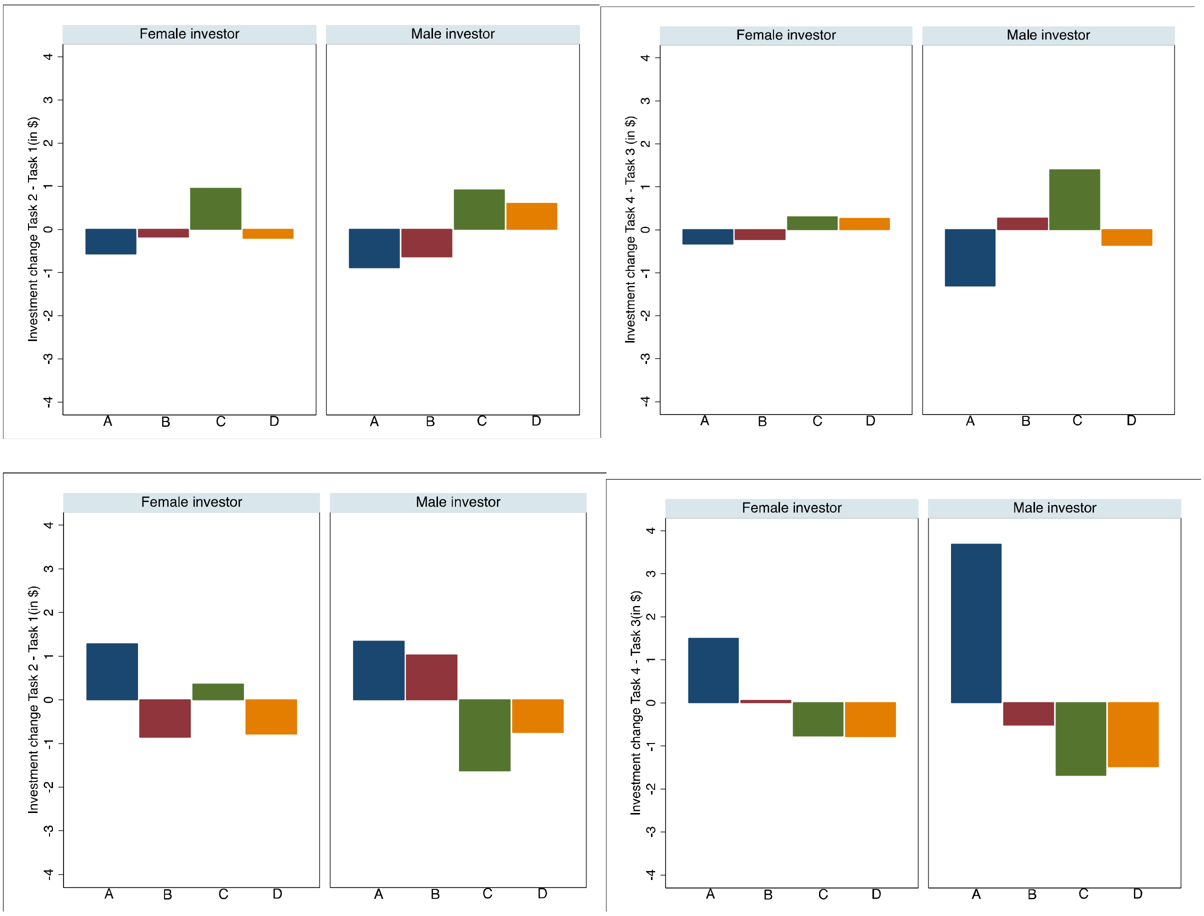
Table 2: Overview of Investment Choices depending on Treatment

	Technology							
Increasing externality treatment								
	A		***B***		***C***		***D***	
positive externality	***0%***		***5%***		***20%***		***50%***	
Task 1 (individual)	**5.9**		**5.0**		**4.1**		**5.0**	
	f=7.3	m=4.7	f=4.9	m=5.0	f=3.4	m=4.7	f=4.3	m=5.6
Task 2 (individual & externality)	**5.2**		**4.5**		**5.1**		**5.2**	
	f=6.8	m=3.8	f=4.7	m=4.4	f=4.4	m=5.7	f=4.1	m=6.2
Task 3 (team)	**6.1**		**4.0**		**3.8**		**6.1**	
	f=7.8	m=4.6	f=4.4	m=3.6	f=3.5	m=4.1	f=4.3	m=7.7
Task 4 (team & externality)	**5.2**		**4.0**		**4.7**		**6.1**	
	f=7.5	m=3.3	f=4.2	m=3.8	f=3.8	m=5.5	f=4.6	m=7.4
Decreasing externality treatment								
	A		***B***		***C***		***D***	
positive externality	***50%***		***20%***		***5%***		***0%***	
Task 1 (individual)	**4.1**		**6.8**		**4.6**		**4.6**	
	f=5.0	m=3.2	f=8.1	m=5.6	f=4.1	m=5.1	f=2.8	m=6.1
Task 2 (individual & externality)	**5.4**		**6.9**		**3.9**		**3.8**	
	f=6.3	m=4.5	f=7.2	m=6.6	f=4.4	m=3.5	f=2.0	m=5.3
Task 3 (team)	**4.8**		**6.0**		**4.3**		**4.9**	
	f=6.3	m=3.5	f=6.1	m=6.0	f=3.9	m=4.6	f=3.8	m=5.9
Task 4 (team & externality)	**7.4**		**5.8**		**3.0**		**3.8**	
	f=7.8	m=7.2	f=6.1	m=5.5	f=3.1	m=2.9	f=3.0	m=4.5

Notes: Upper panel is for increasing externality treatment, lower panel of decreasing externality treatment. Numbers represent mean investments. $20 had to be invested in each task. f = mean female investment in a given technology. m = mean male investment in a given technology.

Figure 1 visualizes the impact of the presence of technologies with positive externality on investments. More precisely, the four panels show changes in investments (task 2 – task 1 and task 4 – task 3) for each of the four technologies when positive externalities are introduced depending on the gender of the investor. The left panels contrast investments in task 2 to task 1 and the right panels contrast investments in task 4 to task 3. The upper panel illustrates investment changes in the increasing positive externality treatment and the lower panel illustrates investment changes in the decreasing positive externality treatment. For example, the blue bars in the lower right panel show that females have on average increased investments in technology A by $1.5 (p=.088, one-sample 2-sided t-test) and males by $3.69 (p<.01).

Figure 1: Investment Changes when Risk-taking causes Positive Externalities depending on Treatment, Task, and Gender



Notes: The upper panel shows changes in investment when positive externalities increase with risk-taking for each available technology A-D where A entails no risks and D maximal risk. The lower panel shows changes in investment when positive externalities decrease with risk-taking for each available technology A-D where A entails no risks and D maximal risk. The left panel shows investment changes when individuals make choices as individuals (treatment 2 - treatment 1) and right panel shows investment changes when individuals make choices in teams (treatment 4 – treatment 3).

3.2 Investment as individuals (Tasks 1 & 2)

Our first finding is that the presence of positive externalities only has a marginal impact on individual investment choices. In particular, comparing behaviour in task 1 to 2 of the increasing externality treatment, we observe that investments in technology A (no positive externality) decrease from 5.9 to 5.2 (n.s) and that investments in technology D (largest positive externality) increase only to 5.2 in task 2 as compared to 5.0 in task 1 (n.s). For the decreasing externality treatment, we observe that investments in technology D (no positive externality) decrease from 4.6 to 3.8 (n.s) and that investments in technology A (largest positive externality) increase from 4.1 to 5.4 (p=.025).

In Tables 3 and 4, we use individual random-effects models to estimate the statistical differences between technology choices across tasks. Table 3 for the increasing positive externality treatment, we observe that investments in technologies A and B are insignificantly smaller in task 2 as compared to task 1 (p=.11 and p=.28). Investments in the socially efficient technology D do not increase (p=.62) but investments in technology C increase (p=.011). In sum, we find little evidence for a socially inefficient response to risks with increasing positive externalities. In Table 4 for the decreasing positive externality treatment, we observe significant increases in technologies A (p=.023) and insignificant decreases for C and D (p>.203).

Finding 1: *Positive externalities only marginally affect individual risk-taking: While individuals tend to increase investments in technologies that incur positive externalities, the changes are not substantial.*

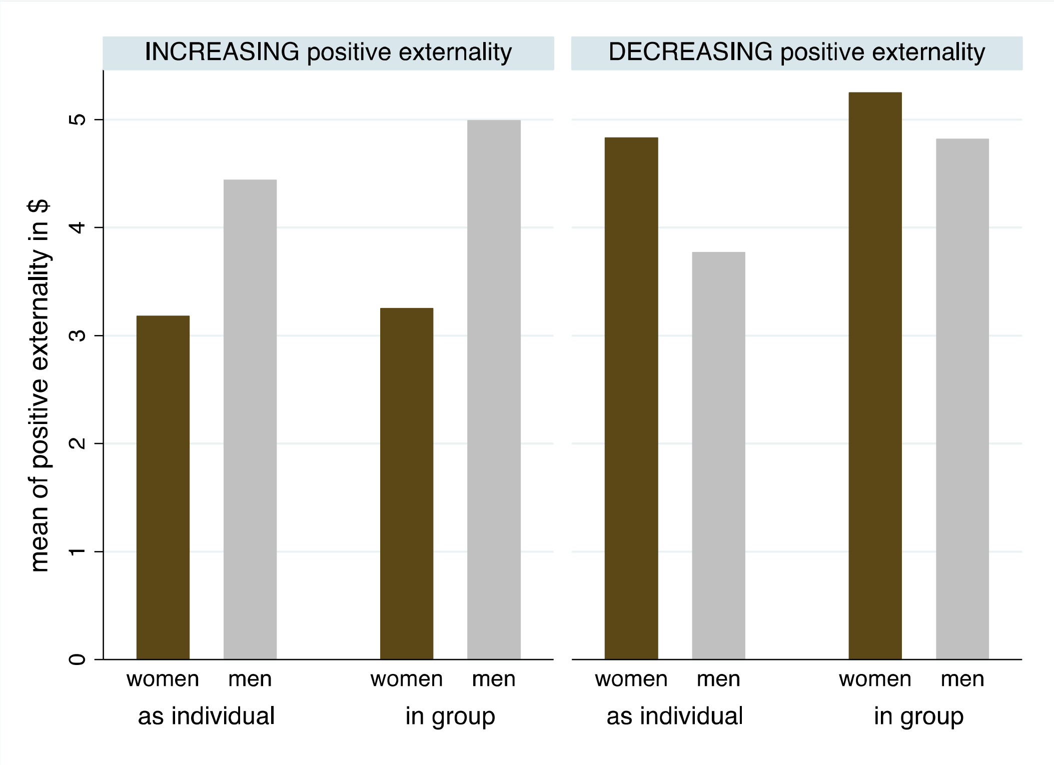
3.3 The role of gender in individual investments

There are stark gender differences in investments in the different technologies. Women are significantly less likely than men to invest in higher risk technologies. In Task 1 of the increasing positive externality treatment, women invest only ($)4.3 in technology D (men: 5.6) and 3.4 in technology C (men: 4.7) whereas they women invest more in technology A that carries no risk (7.3 vs. 4.7).

In upper right panel of Figure 1 we observe that both genders only marginally take positive externalities into account when making investments in the increasing positive externality treatment. Comparing the first two tasks, we find that both genders reduce investments in technology A (7.3 to 6.8 for women; 4.7 to 3.8 for men) and B (4.9 to 4.7 for women; 5 to 4.4 for men). In Figure 2 we can see that women generate on average $3.18 of positive externalities, which is clearly lower than men ($4.44, p<.01). The lower right panel of Figure 1 and Figure 2 illustrate the corresponding patterns in the declining positive externality treatment. Both genders similarly increase investments in technology A and decrease investments in technology D. The patterns for B and C differ: women reduce investments in B and increase investments in C whereas men increase investments in B and decrease investments C, a more socially efficient response. Women generate on average $4.83 of positive externalities, which is higher than men ($3.77, p=.087).

Tables 5 and 6 correspond to Tables 3 and 4; both control for the interaction between gender and tasks. In Table 5, we observe that men invest significantly less than women in technology A (p<.001) and more in C (p=.048). In Table 6, we observe that men invest significantly less than women in technology B (p=.04) and more in D (p<.01).

Figure 2: Positive Externalities depending on Treatment, Task, and Gender



Finding 2: *Men take more risks than women in the absence and presence of positive externalities. Men generate more positive externalities if they increase with risk. Women generate marginally more positive externalities if they decrease with risk.*

3.3 Investment as a group member (Tasks 3 & 4)

Comparing tasks 3 to 4 allows us to investigate the impact of positive externalities when individuals invest as part of a group. In Table 2 we observe that individuals invest less in groups in technology A (from 6.1 to 5.2) and more in technology C (from 3.8 to 4.7) whereas investments in technology B (remain 4.1) and D (remain 6.1) do not change when positive externalities increase with risks. We do not observe that investments in group depend on the gender of the group member. Regardless of technology, subjects do not seem to adjust their investments on the gender of their group member in task 3. In the decreasing positive externality treatment, we observe that individuals invest more in groups in technology A (from 4.8 to 7.4) and less in technologies C (from 4.3 to 3) and D (from 4.9 to 3.8).

The two right panels of Figure 1 illustrate the corresponding investment changes for women and men. In both panels, we observe that men appear to react stronger and adjust their investments more than women. In the increasing positive externality treatment, they in particular increase investments in technology C whereas women show almost no average investment changes for any technology. In the decreasing positive externality treatment, we observe in general stronger adjustments and again that men react stronger than women. In particular, similar to women but more pronounced, they significantly increase investments in technology A and decrease investments in technologies C and D.

Comparing tasks 2 to 4 allows us to investigate the impact of investing in groups as compared to individual investments in the presence of positive externalities. Inconsistent with our third hypothesis, in the increasing positive externality treatment we observe that investments in technology D increase in groups in the presence of positive externalities (from 5.2 to 6.1) whereas investments in technologies A (remain 5.2) and B (from 4.5 to 4) barely change. In Table 3, we find that the investment increase in technology D is significant ($p=.016$). The changes in investments cause a higher investment efficiency in task 4 as compared to task 2 (2.7 percentage points, $p=.067$). Further inconsistent with our third hypothesis, we observe in the decreasing positive externality treatment that investments in technology A increase in groups in the presence of positive externalities (from 5.4 to 7.4) whereas investments in technologies B (from 6.9 to 5.8) and C (from 3.9 to 3) decrease. In Table 4, we find that the investment increase in technology A is significant ($p=.023$). The changes in investments cause a clearly higher investment efficiency in task 4 as compared to task 2 (Table 4, 2.5 percentage points, $p<.01$). In Table 4, we also observe that the investments in technology A are higher in the group task 4 than in task 2 ($p=.015$) and marginally smaller in technology C ($p=.058$). Finally, we can observe in Figure 2 that the size of positive externalities tends to be larger in groups than as individuals regardless of gender and treatment. Finally, we find no evidence that individuals in groups adjust their investments depending on the gender of their group member (Appendix Table A).

Finding 3: *As group members individuals invest more in technologies that generate larger positive externalities. This is mainly driven by male group members and leads to larger positive externalities in groups.*

4. Discussion

Risk-taking is a crucial element for innovations and technologies. Such risk-taking often creates social welfare and thus it is important to investigate whether the creation of positive externalities is a motivator for risk-taking. This is what we investigate in a laboratory experiment that brings risk-taking and positive externalities together. In our study, individuals decide how to invest in a portfolio of technologies with different risks and positive externalities. We observe that the presence of positive externalities moderately affects risk-taking. If positive externalities increase with risk, there is only marginally more risk-taking, regardless of gender. If positive externalities decrease with risk, we observe moderately less risk-taking. We also observe that groups are more willing than individuals to invest in the technology with the largest positive externality.

We frame risk-taking in the context of technology adoption. The literature on technology adoption often emphasizes that risk aversion can stand in the way of technology adoption, in addition to other factors such as credit constraints. However, this literature often neglects the role of externalities in risk taking. Our study is a first attempt to experimentally investigate the relationship between risk aversion and positive externalities. We simplify externalities as originating from one actor and affecting only one other actor. In many situations, and in particular in the context of technologies, externalities affect more actors as well as bystanders and this may cause the actor to increase her willingness to take risks. On the other hand, investments in technological innovations are often not just risky for the risk-taker but uncertain: they may or may not come to life and lead to positive externalities. Future research may investigate the demand for risk taking when multiple actors are affected and when it is uncertain that risk taking actually translates into positive externalities. It would also be interesting to investigate the demand curve for positive externalities under certainty for either gender, i.e., when risks are removed. Finally, it would be interesting to investigate the extent to which risk-taking for potentially social welfare increasing technologies can be nudged.

References

Abbink, K., Irlenbusch, B., & Renner, E. (2002). An experimental bribery game. *Journal of Law, Economics, and Organization*, *18*(2), 428-454.

Andreoni, J. (1995). Cooperation in public-goods experiments: kindness or confusion?. *The American Economic Review*, 891-904.

Andreoni, J., & Vesterlund, L. (2001). Which is the fair sex? Gender differences in altruism. *The Quarterly Journal of Economics*, *116*(1), 293-312.

Andreoni, J., Harbaugh, W. T., & Vesterlund, L. (2010). Altruism in experiments. In *Behavioural and experimental economics* (pp. 6-13). London: Palgrave Macmillan UK.

Baker, R. J., Laury, S. K., & Williams, A. W. (2008). Comparing small-group and individual behavior in lottery-choice experiments. *Southern Economic Journal*, *75*(2), 367-382.

Barham, B. L., Chavas, J. P., Fitz, D., Salas, V. R., & Schechter, L. (2014). The roles of risk and ambiguity in technology adoption. *Journal of Economic Behavior & Organization*, *97*, 204-218.

Barr, A., & Serra, D. (2009). The effects of externalities and framing on bribery in a petty corruption experiment. *Experimental Economics*, *12*(4), 488-503.

Bartling, B., & Fischbacher, U. (2012). Shifting the blame: On delegation and responsibility. *The Review of Economic Studies*, *79*(1), 67-87.

Bartling, B., Valero, V., & Weber, R. (2019). On the scope of externalities in experimental markets. *Experimental Economics*, *22*(3), 610-624.

Berg, J., Dickhaut, J., & McCabe, K. (1995). Trust, reciprocity, and social history. *Games and economic behavior*, *10*(1), 122-142.

Bland, J., & Nikiforakis, N. (2015). Coordination with third-party externalities. *European Economic Review*, *80*, 1-15.

Blau, F. D., & Kahn, L. M. (2017). The gender wage gap: Extent, trends, and explanations. *Journal of Economic Literature*, *55*(3), 789-865.

Bohnet, I., & Zeckhauser, R. (2004). Trust, risk and betrayal. *Journal of Economic Behavior & Organization*, *55*(4), 467-484.

Bogan, V. L., Just, D. R., & Dev, C. S. (2013). Team gender diversity and investment decision-making behavior. *Review of Behavioral Finance, 5*(2), 134-152.

Bone, J., Hey, J., & Suckling, J. (1999). Are groups more (or less) consistent than individuals? *Journal of Risk and Uncertainty*, *18*, 63-81.

Bone, J., Hey, J., & Suckling, J. (2004). A simple risk-sharing experiment. *Journal of Risk and Uncertainty*, *28*, 23-38

Bornstein, G., Kugler, T., & Ziegelmeyer, A. (2004). Individual and group decisions in the centipede game: Are groups more "rational" players? *Journal of Experimental Social Psychology*, *40*(5), 599-605.

Brick, K., & Visser, M. (2015). Risk preferences, technology adoption and insurance uptake: A framed experiment. *Journal of Economic Behavior & Organization*, *118*, 383-396.

Byrnes, J. P., Miller, D. C., & Schafer, W. D. (1999). Gender differences in risk taking: A meta-analysis. *Psychological Bulletin*, *125*(3), 367.

Caliendo, M., Fossen, F. M., & Kritikos, A. S. (2009). Risk attitudes of nascent entrepreneurs–new evidence from an experimentally validated survey. *Small Business Economics*, *32*(2), 153-167.

Cavalcanti, C., Fleming, C., & Leibbrandt, A. (2022). Risk externalities and gender: Experimental evidence. *Journal of Economic Behavior & Organization*, *196*, 51-64.

Chakravarty, S., Harrison, G. W., Haruvy, E. E., & Rutström, E. E. (2011). Are risk averse over other people's money? *Southern Economic Journal*, *77*(4), 901-913.

Charness, G., & Gneezy, U. (2012). Strong evidence for gender differences in risk taking. *Journal of Economic Behavior & Organization*, *83*(1), 50-58.

Charness, G., & Rabin, M. (2002). Understanding social preferences with simple tests. *The Quarterly Journal of Economics*, *117*(3), 817-869.

Chaudhuri, A. (2011). Sustaining cooperation in laboratory public goods experiments: a selective survey of the literature. *Experimental economics*, *14*(1), 47-83.

Chuang, Y., & Schechter, L. (2015). Stability of experimental and survey measures of risk, time, and social preferences: A review and some new results. *Journal of Development Economics*, *117*, 151-170.

Cramer, J. S., Hartog, J., Jonker, N., & Van Praag, C. M. (2002). Low risk aversion encourages the choice for entrepreneurship: an empirical test of a truism. *Journal of Economic Behavior & Organization*, *48*(1), 29-36.

Cox, J. C., & Deck, C. A. (2006). When are women more generous than men?. *Economic Inquiry*, *44*(4), 587-598.

Croson, R., & Gneezy, U. (2009). Gender differences in preferences. *Journal of Economic Literature*, *47*(2), 448-74.

Dohmen, T., & Falk, A. (2011). Performance pay and multidimensional sorting: Productivity, preferences, and gender. *American Economic Review*, *101*(2), 556-90.

Dohmen, T., Falk, A., Huffman, D., Sunde, U., Schupp, J., & Wagner, G. G. (2011). Individual risk attitudes: Measurement, determinants, and behavioral consequences. *Journal of the European Economic Association*, *9*(3), 522-550.

Doss, C. R., & Morris, M. L. (2000). How does gender affect the adoption of agricultural innovations? The case of improved maize technology in Ghana. *Agricultural Economics*, *25*(1), 27-39.

Dufwenberg, M., & Kirchsteiger, G. (2004). A theory of sequential reciprocity. *Games and Economic Behavior*, *47*(2), 268-298.

Eckel, C. C., & Grossman, P. J. (2008). Men, women and risk aversion: Experimental evidence. *Handbook of Experimental Economics Results*, *1*, 1061-1073.

Eriksen, K. W., Kvaløy, O., & Luzuriaga, M. (2020). Risk-taking on behalf of others. *Journal of Behavioral and Experimental Finance*, *26*, 100283.

Ertac, S., & Gurdal, M. Y. (2012). Deciding to decide: Gender, leadership and risk-taking in groups. *Journal of Economic Behavior & Organization*, *83*(1), 24-30.

Falk, A., & Fischbacher, U. (2006). A theory of reciprocity☆. *Games and Economic Behavior*, *54*, 293-315.

Fehr, E., & Schmidt, K. M. (1999). A theory of fairness, competition, and cooperation. *The Quarterly Journal of Economics*, *114*(3), 817-868.

García-Granero, A., Llopis, Ó., Fernández-Mesa, A., & Alegre, J. (2015). Unraveling the link between managerial risk-taking and innovation: The mediating role of a risk-taking climate. *Journal of Business Research*, *68*(5), 1094-1104.

Gillet, J., Schram, A., & Sonnemans, J. (2009). The tragedy of the commons revisited: The importance of group decision-making. *Journal of public Economics*, *93*(5-6), 785-797.

Gouldner, A. W. (1960). The norm of reciprocity: A preliminary statement. *American Sociological Review*, 25(2), 161-178.

Gneezy, U., Leibbrandt, A., & List, J. A. (2016). Ode to the sea: Workplace Organizations and Norms of Cooperation. *The Economic Journal*, *126*(595), 1856-1883.

Greig, F., & Bohnet, I. (2009). Exploring gendered behavior in the field with experiments: Why public goods are provided by women in a Nairobi slum. *Journal of Economic Behavior & Organization*, *70*(1-2), 1-9.

Guiso, L., & Paiella, M. (2008). Risk aversion, wealth, and background risk. *Journal of the European Economic Association*, *6*(6), 1109-1150.

Halek, M., & Eisenhauer, J. G. (2001). Demography of risk aversion. *Journal of Risk and Insurance*, *68*(1), 1-24.

Harrison, G. W., Lau, M. I., Rutström, E. E., & Tarazona-Gómez, M. (2013). Preferences over social risk. *Oxford Economic Papers*, *65*(1), 25-46.

Kocher, M. G., & Sutter, M. (2005). The decision maker matters: Individual versus group behaviour in experimental beauty-contest games. *The Economic Journal*, *115*(500), 200-223.

Kocher, M. G., & Sutter, M. (2007). Individual versus group behavior and the role of the decision making procedure in gift-exchange experiments. *Empirica*, *34*(1), 63-88.

Kugler, T., Kausel, E. E., & Kocher, M. G. (2012). Are groups more rational than individuals? A review of interactive decision making in groups. *Wiley interdisciplinary reviews: Cognitive science*, *3*(4), 471-482.

Le, A. T., Miller, P. W., Slutske, W. S., & Martin, N. G. (2011). Attitudes towards economic risk and the gender pay gap. *Labour Economics*, *18*(4), 555-561.

Liu, E. M. (2013). Time to change what to sow: Risk preferences and technology adoption decisions of cotton farmers in China. *Review of Economics and Statistics*, *95*(4), 1386-1403.

López-Pérez, R. (2008). Aversion to norm-breaking: A model. *Games and Economic behavior*, *64*(1), 237-267.

Luhan, W. J., Kocher, M. G., & Sutter, M. (2009). Group polarization in the team dictator game reconsidered. *Experimental Economics*, *12*(1), 26-41.

Masclet, D., Colombier, N., Denant-Boemont, L., & Loheac, Y. (2009). Group and individual risk preferences: A lottery-choice experiment with self-employed and salaried workers. *Journal of Economic Behavior & Organization*, *70*(3), 470-484.

Plott, C. R. (1983). Externalities and corrective policies in experimental markets. *The Economic Journal*, *93*(369), 106-127.

Rivas, M. F. (2013). An experiment on corruption and gender. *Bulletin of Economic Research*, *65*(1), 10-42.

Rockenbach, B., Sadrieh, A., & Mathauschek, B. (2007). Teams take the better risks. *Journal of Economic Behavior & Organization*, *63*(3), 412-422.

Shupp, R. S., & Williams, A. W. (2008). Risk preference differentials of small groups and individuals. *The Economic Journal*, *118*(525), 258-283.

Sutter, M. (2009). Individual behavior and group membership: Comment. *American Economic Review*, *99*(5), 2247-2257.

Sutter, M., Huber, J., Kirchler, M., Stefan, M., & Walzl, M. (2020). Where to Look for the Morals in Markets? *Experimental Economics*, *23*(1), 30-52.

Venkatesh, V., Morris, M. G., & Ackerman, P. L. (2000). A longitudinal field investigation of gender differences in individual technology adoption decision-making processes. *Organizational Behavior and Human Decision Processes*, *83*(1), 33-60.

Watson, J., & McNaughton, M. (2007). Gender differences in risk aversion and expected retirement benefits. *Financial Analysts Journal*, *63*(4), 52-62.

Zahra, S. A., & Covin, J. G. (1995). Contextual influences on the corporate entrepreneurship-performance relationship: A longitudinal analysis. *Journal of business venturing*, *10*(1), 43-58.

Tables

Table 3: Investment choice and efficiency depending on task (Increasing externality treatment)

	(1) Investment in A	(2) Investment in B	(3) Investment in C	(4) Investment in D
Task 2 (externality)	-0.7388	-0.4179	0.9328**	0.2239
	(0.4573)	(0.3828)	(0.3674)	(0.4466)
Task 3 (team)	0.1493	-1.0000***	-0.2799	1.1306***
	(0.3961)	(0.3724)	(0.3114)	(0.4342)
Task 4 (team & externality)	-0.6978	-0.9664**	0.6007	1.0634***
	(0.4286)	(0.4180)	(0.3870)	(0.4098)
Task 2 - Task 4 = 0 (F-test)	*0.92*	*0.15*	*0.39*	*0.016***
Constant	5.9254***	4.9552***	4.1194***	5.0000***
	(0.5214)	(0.4035)	(0.3509)	(0.4420)
N (observations)	536	536	536	536
N (groups)	134	134	134	134

Table 4: Investment choice and efficiency depending on task (Decreasing externality treatment)

	(1) Investment in A	(2) Investment in B	(3) Investment in C	(4) Investment in D
Task 2 (externality)	1.3167**	0.1500	-0.7000	-0.7667
	(0.5793)	(0.6811)	(0.6253)	(0.6044)
Task 3 (team)	0.7167	-0.7250	-0.3583	0.3667
	(0.5798)	(0.4914)	(0.5147)	(0.5843)
Task 4 (team & externality)	3.3833***	-0.9750	-1.6167**	-0.7917
	(0.9032)	(0.6848)	(0.6288)	(0.5581)
Task 2 - Task 4 = 0 (F-test)	*0.015***	*0.13*	*0.058**	*0.96*
Constant	4.0500***	6.7500***	4.6333***	4.5667***
	(0.6110)	(0.6148)	(0.4994)	(0.5938)
N (observations)	240	240	240	240
N (groups)	60	60	60	60

Table 5: Investment choice and efficiency depending on task and gender (Increasing externality treatment)

	(1) Investment in A	(2) Investment in B	(3) Investment in C	(4) Investment in D
Male investor	-2.6872***	0.1252	1.3338**	1.2283
	(1.0100)	(0.8027)	(0.6735)	(0.8672)
Task 2 (externality)	-0.5714	-0.1746	0.9524**	-0.2063
	(0.5957)	(0.5110)	(0.4282)	(0.5315)
Task 3 (team)	0.4365	-0.5000	0.1032	-0.0397
	(0.5679)	(0.5501)	(0.3861)	(0.4520)
Task 4 (team & externality)	0.1032	-0.7302	0.4048	0.2222
	(0.6069)	(0.5302)	(0.3956)	(0.4889)
Male investor x Task 2	-0.3159	-0.4592	-0.0369	0.8120
	(0.9084)	(0.7615)	(0.7235)	(0.8784)
Male investor x Task 3	-0.5421	-0.9437	-0.7229	2.2087***
	(0.7935)	(0.7457)	(0.6133)	(0.8289)
Male investor x Task 4	-1.5116*	-0.4459	0.3699	1.5876**
	(0.8499)	(0.8279)	(0.7549)	(0.7978)
Constant	7.3492***	4.8889***	3.4127***	4.3492***
	(0.6629)	(0.5310)	(0.3338)	(0.5363)
Task 2 - Task 4 = 0 (F-test)	*0.29*	*0.3*	*0.27*	*0.24*
Male investor x Task 2 - Male investor x Task 4 = 0 (F-test)	*0.17*	*0.98*	*0.59*	*0.25*
N (observations)	536	536	536	536
N (groups)	134	134	134	134

Table 6: Investment choice and efficiency depending on task and gender (Decreasing externality treatment)

	(1) Investment in A	(2) Investment in B	(3) Investment in C	(4) Investment in D
Male investor	-1.8482	-2.4777**	1.0536	3.2723***
	(1.2346)	(1.2071)	(0.9863)	(1.0658)
Task 2 (externality)	1.2857	-0.8571	0.3571	-0.7857**
	(0.8555)	(0.8411)	(0.6208)	(0.3669)
Task 3 (team)	1.2143	-2.0179**	-0.1607	0.9643
	(0.9831)	(0.7851)	(0.6342)	(0.6294)
Task 4 (team & externality)	2.7143***	-1.9643**	-0.9286	0.1786
	(0.9834)	(0.9124)	(0.6704)	(0.4892)
Male investor x Task 2	0.0580	1.8884	-1.9821*	0.0357
	(1.1711)	(1.3306)	(1.1952)	(1.1566)
Male investor x Task 3	-0.9330	2.4241**	-0.3705	-1.1205
	(1.1898)	(0.9583)	(1.0196)	(1.1378)
Male investor x Task 4	1.2545	1.8549	-1.2902	-1.8192*
	(1.7664)	(1.3489)	(1.2223)	(1.0580)
Constant	5.0357***	8.0714***	4.0714***	2.8214***
	(1.0150)	(0.9218)	(0.6455)	(0.4039)
Task 2 - Task 4 = 0 (F-test)	*0.14*	*0.21*	*0.019***	*0.016***
Male investor x Task 2 - Male investor x Task 4 = 0 (F-test)	*0.47*	*0.98*	*0.47*	*0.09**
N (observations)	240	240	240	240
N (groups)	60	60	60	60

Appendix A

General Instructions (for increasing externality treatment)

Welcome and thank you for participating!

We ask that you do not talk with other participants during the experiment. If you have questions at any time, please feel free to raise your hand and someone will come to you to answer them.

You are about to participate in a decision-making experiment. Please read the instructions carefully, as your payment depends on your choices.

The experiment consists of **four (4) tasks** and a short survey. You will receive detailed instructions before the beginning of each task. After you have finished with the fourth task, there is a short survey before your payment. The payment is done in private and in cash.

To start, you receive an **endowment of $30**.

You will use this endowment during the four tasks for different investments.

At the end of the experiment, one (1) of your four (4) completed tasks will be randomly selected to determine your payment. Because you will only get to know which of the four tasks was chosen at the end, you should take **all** tasks seriously.

For example, if your investment in Task 1 results in $20, in Task 2 results in $40, in Task 3 results in $50, and in Task 4 results in $5, and the randomly chosen task is Task 2, then you will receive a payment of $40.

You will be assigned a unique identification (ID) number. This ID number is used to maintain the anonymity of your decisions from other participants.

Please turn off your mobile phone now.

Task 1

In this Task you can invest any amount, up to a total of $20 (of your $30 endowment) into four different technologies.

The table below illustrates the possible returns from each technology.

As you can see, currently all $20 is invested in Technology A, which has no losses and no gains. That is, Technology A pays $20 for certain.

In contrast, the three other technologies *(B, C, D)* can lead to losses or gains, with equal probability (50% probability of a loss and 50% probability of a gain, which will be determined by the software).

Technology	Possible loss (50% chance)	Possible gain (50% chance)	Your default investment	Your choice
A	0%	0%	$20	
B	-10%	50%	$0	
C	-40%	100%	$0	
D	-100% (everything)	200%	$0	

Your choice in Task 1 is to decide how much of the $20 you want to invest in each technology. You can invest all of the $20 in a single technology, or split the money and invest in two, three, or four technologies.

Example 1:
You choose to keep nothing in Technology A and invest all $20 in Technology B. If Task 1 is randomly selected for payment and the software selects a loss, you will receive $18 (the investment of $20 minus the loss of 10%). If the software selects a gain, you will receive $30 (the investment of $20 plus the gain of 50%).

Example 2:
You choose to keep $5 in Technology A, invest $10 in Technology C, and $5 in Technology D (and nothing in Technology B). The software selects a loss for Technology C and a gain for Technology D. If Task 1 is randomly selected for payment, you will receive $26 ($5 from Technology A, $6 from Technology B because of the 40% loss, and $15 from Technology D because of the 200% gain).

Please raise your hand now if you have any questions.

Task 2

Like in Task 1, you can invest in Task 2 any amount up to a total of $20 (of your $30 endowment) into four different technologies.

In contrast to Task 1, **your investments can now affect one other subject in this experimental session, which is randomly chosen by the software. In addition, one other randomly chosen subject can affect you.**

The table below illustrates the possible returns for each technology and how the investments can affect you and other subjects.

As you can see, currently all $20 is invested in Technology A, which has no losses, no gains, and no impact on others. That is, Technology A pays $20 for certain and does not increase the payment of another subject.

In contrast, the three other technologies *(B, C, D)* can lead to losses or gains, with equal probability (50% probability of a loss and 50% probability of a gain, which will be determined by the software) and can increase the payment of one other randomly chosen subject.

Technology	Possible loss (50% chance)	Possible gain (50% chance)	Your default investment	Certain impact on one other subject	Your choice
A	0%	0%	$20	none	
B	-10%	50%	$0	each $1 invested, increases 5 cents	
C	-40%	100%	$0	each $1 invested, increases 20 cents	
D	-100% (everything)	200%	$0	each $1 invested, increases 50 cents	

Your choice in Task 2 is to decide how much of the $20 you want to invest in each technology. You can invest all of the $20 in a single technology, or split the money and invest in two, three, or four technologies.

Example 1:

You choose to keep nothing in Technology A and invest all $20 in Technology B. If Task 2 is randomly selected for payment and the software selects a loss, you will receive $18 (the investment of $20 minus the loss of 10%). If the software selects a gain, you will receive $30 (the investment of $20 plus the gain of 50%).

*In addition, the payment of one other randomly chosen subject in this experimental session will be increased by 20 * 5 cents (Technology B) = $1, if Task 2 is randomly chosen for payment for this subject.*

Note also that your own payment can be increased by another randomly chosen subject depending on the type of investments of this subject.

<u>Example 2:</u>
You choose to keep $5 in Technology A, invest $10 in Technology C, and $5 in Technology D. The software selects a loss for Technology C and a gain for Technology D. If Task 2 is randomly selected for payment, you will receive $26 ($5 from Technology A, $6 from Technology B because of the 40% loss, and $15 from Technology D because of the 200% gain).

*In addition, the payment of one other randomly chosen subject in this experimental session will be increased by 10 * 20 cents (Technology C) + 5 * 50 cents (Technology D) = $4.50, if Task 2 is randomly chosen for payment for this subject.*

Note also that your own payment can be increased by another randomly chosen subject depending on the type of her/his investments.

Please raise your hand now if you have any questions.

Task 3

Task 3 is similar to Task 1, with the difference that **Task 3 is done in teams of two (2)**.

As before, you can invest any amount of up to a total of $20 (of your $30 endowment) into four different technologies. The table below illustrates the possible returns for each technology. As you can see, currently all of the $20 is invested in Technology A, which has no losses and no gains. That is, Technology A pays $20 for certain. In contrast, the three other technologies *(B, C, D)* can lead to losses or gains, with equal probability (50% probability of a loss and 50% probability of a gain, which will be determined by the software).

Technology	**Possible loss (50% chance)**	**Possible gain (50% chance)**	**Your default investment**	**Your choice**
A	0%	0%	$20	
B	-10%	50%	$0	
C	-40%	100%	$0	
D	-100% (everything)	200%	$0	

Your choice in Task 1 is to decide how much of the $20 you want to invest in each technology. You can invest all $20 in a single technology, or split the money and invest in two, three, or four technologies.

At the same time, your randomly chosen team member will make the exact same choice. After you have both made your choice, the software sums up your investments, calculates the total returns in your team, and then divides the returns equally between the two of you.

<u>Example 1:</u>
You choose to keep nothing in Technology A and invest all $20 in Technology B.
Your team member keeps everything in Technology A.
If Task 3 is randomly selected for payment and the software selects a loss, you and your team member will receive
    $20 from Technology A
\+ $18 from Technology B (the investment of $20 minus the loss of 10%)
divided by 2
= $19 for each team member.

If the software selects a gain, you and your team member will receive
    $20 from Technology A
\+ $30 from Technology B (the investment of $20 plus the gain of 50%)
divided by 2

= $25 for each team member.

<u>Example 2:</u>
You choose to keep $5 in Technology A, invest $10 in Technology C, and $5 in Technology D.
Your team member keeps $10 in Technology A and invests $10 in Technology D.
The software selects a loss for Technology C and a gain for Technology D. If Task 3 is randomly selected for payment, you and your team member will receive:

$15 from investments in Technology A
+ $ 6 from investments in Technology C (the investment of $10 minus the loss of 40%)
+ $ 45 from investments in Technology D (the investments of $15 plus the gain of 200%)
divided by 2
= $33 for each team member.

Please raise your hand now if you have any questions.

Task 4

Task 4 is similar to Task 2, with the difference that **Task 4 is done in teams of two (2)**.

Like in the previous tasks, you can invest in Task 4 any amount up to a total of $20 (of your $30 endowment) into four different technologies.

Similar to Task 2, **your investments can now affect another subject in this experimental session and one other subject can affect you.**

The table below illustrates the possible returns for each technology and how the investments can affect other subjects.

Technology	**Possible loss (50% chance)**	**Possible gain (50% chance)**	**Your default investment**	**Certain impact on one other subject**	**Your choice**
A	0%	0%	$20	none	
B	-10%	50%	$0	each $1 invested, increases 5 cents	
C	-40%	100%	$0	each $1 invested, increases 20 cents	
D	-100% (everything)	200%	$0	each $1 invested, increases 50 cents	

Your choice in Task 4 is to decide how much of the $20 you want to invest in each technology. You can invest all $20 in a single technology, or split the money and invest in two, three, or four technologies.

At the same time, your randomly chosen team member will make the exact same choice. After you have both made your choice, the software sums up your investments, calculates the total returns in your team, and then divides the returns equally between the two of you. In addition, it calculates the impact on another randomly chosen subject and the impact the decision of the other subject has on you.

Example 1:
You choose to keep nothing in Technology A and invest all $20 in Technology B. Your team member keeps everything in Technology A.

If Task 4 is randomly selected for payment and the software selects a loss, you and your team member will receive

$20 from Technology A
+ $18 from Technology B (the investment of $20 minus the loss of 10%)
divided by 2
= $19 for each team member.

If the software selects a gain, you and your team member will receive

$20 from Technology A
+ $30 from Technology B (the investment of $20 plus the gain of 50%)
divided by 2
= $25 for each team member.

*In addition, because you invested everything in Technology B, the payment of one other randomly chosen subject in this experimental session will be increased by 20 * 5 cents = $1, if Task 2 is randomly chosen for payment for this subject.*

Note that your payment can be increased by another randomly chosen subject depending on the type of investments of this subject.

<u>Example 2:</u>
You choose to keep $5 in Technology A, invest $10 in Technology C, and $5 in Technology D.
Your team member keeps $10 in Technology A and invests $10 in Technology D.
The software selects a loss for Technology C and a gain for Technology D. If Task 4 is randomly selected for payment, you and your team member will receive:

$15 from investments in Technology A
+ $ 6 from investments in Technology C (the investment of $10 minus the loss of 40%)
+ $ 45 from investments in Technology D (the investments of $15 plus the gain of 200%)
divided by 2
= $33 for each team member.

*In addition, because of your investments the payment of one other randomly chosen subject in this experimental session will be increased by 10 * 20 cents (technology C) + 5 * 50 cents (Technology D) = $4.50, if task 4 is randomly chosen for payment for this subject.*

*Similarly, because of the investments of your team members the payment of one other randomly chosen subject will be increased by 10 * 50 cents (technology D) = $5, if Task 4 is randomly chosen for payment for this subject.*

Note that your payment can be increased by another randomly chosen subject depending on the type of investments of this subject.

Please raise your hand now if you have any questions.

Appendix B

Table A: Investment in Tasks 3 and 4 depending on gender constellation in group

Technology								
Increasing externality treatment - by gender constellation in group								
	A		***B***		***C***		***D***	
Task 3	f,f=7.8	f,m=7.8	f,f=4.1	f,m=4.7	f,f=3.6	f,m=3.4	f,f=4.5	f,m=4.1
	m,f=4.5	m,m=4.6	m,f=3.5	m,m=3.6	m,f=4	m,m=4.3	m,f=8	m,m=7.5
Task 4	f,f=7.2	f,m=7.7	f,f=4.2	f,m=4.1	f,f=4	f,m=3.6	f,f=4.6	f,m=4.6
	m,f=3.3	m,m=3.2	m,f=3.7	m,m=3.9	m,f=5.5	m,m=5.6	m,f=7.5	m,m=7.2
Decreasing externality treatment - by gender constellation in group								
	A		***B***		***C***		***D***	
Task 3	f,f=6.1	f,m=6.4	f,f=5.9	f,m=6.2	f,f=4.1	f,m=3.7	f,f=3.9	f,m=3.7
	m,f=3.2	m,m=3.8	m,f=5.8	m,m=6.2	m,f=5.0	m,m=4.2	m,f=6.0	m,m=5.8
Task 4	f,f=7.4	f,m=8.1	f,f=6.0	f,m=6.3	f,f=3.2	f,m=3.1	f,f=3.5	f,m=2.5
	m,f=7.4	m,m=6.9	m,f=4.8	m,m=6.2	m,f=3.0	m,m=2.8	m,f=4.8	m,m=4.1

Notes: Numbers represent mean investments. $20 had to be invested in each task. f,f = female investor, female group member; f,m= female investor, male group member; m,f=male investor, female group member; m,m=male investor, male group member.