Making Up for Harming Others — An Experiment on Voluntary Compensation Behavior

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Abstract

We investigate in a controlled laboratory setting if and to what extent buyers are willing to offset negative real-world externalities that their purchasing decisions create. In one set of treatments, the externality associated with a purchase is irreversible, whereas in another set of treatments, buyers are offered the possibility to voluntarily compensate for the externality. The other set of treatment variations refers to the matching of buyers and third parties, inducing diffusion of harm among third parties or diffusion of responsibility among buyers.

We find that subjects are on average willing to compensate for the externalities they create, and that compensation decisions are sensitive to the surplus from buying. Yet, experimental buyers are highly heterogeneous, and some of them never compensate. Overall, while the introduction of voluntary compensation significantly reduces the harm created by consumption, the net externality still remains high across all treatments. In particular, diffused responsibility among buyers reduces the amounts paid for compensation and leads to larger overall net externalities compared to the case without diffusion. At the same time, diffusion of the harm among third parties does not significantly change compensation choices and externalities.

Keywords: voluntary compensation, moral behavior, socially-responsible consumption, diffused responsibility, diffused harm
JEL Codes: D91, D62, H41, Q58

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1 Introduction

We investigate in a controlled laboratory experiment if and to what extent participants in the role of buyers are willing to offset the harm that their purchasing decisions create. If subjects buy a virtual good in our setting, a negative real-world externality is imposed on a third party. In one set of treatments, the externality associated with buying the good is irreversible whereas in another set of treatments buyers are offered the possibility to voluntarily compensate for the externality, thus reducing the harm for the third party ex-post. The other set of treatment variations refers to the matching of buyers and third parties. In our baseline condition, one buyer is matched with one harmed subject. By changing the matching structure of buyers and harmed subjects, we manipulate both diffusion of harm and diffusion of responsibility in two treatments. In addition to individual patterns of voluntary compensation, we investigate buyers' purchasing decisions and the resulting net externalities with and without the possibility to compensate.

Voluntary offsetting tools can be an efficient tool to internalize externalities for consumers who wish to diminish their contribution to a public bad (Kotchen, 2009), for example to environmental pollution. These tools rely on individuals' willingness to pay to reduce externalities they have caused, for instance by financing emission reductions elsewhere in the world. As such, offsetting tools may be welfare enhancing, allowing individuals who otherwise would have abstained from the consumption of certain goods due to concerns for the externality to consume because they can now offset the externality. The relevance of voluntary (carbon) offsetting tools is evidenced by their global market volume, which was estimated to be $748 million in the first half of 2021 alone, offsetting around 239 Mt CO_2 equivalents (Forest Trends' Ecosystem Marketplace, 2021). In recent years, a large number of organizations have started to offer buyers the possibility to compensate negative environmental externalities themselves, for instance through donations to climate change mitigation projects. Besides a large number of private organizations that offer this service (e.g., Carbon Footprint Ltd., Atmosfair, myclimate), there are also publicly funded institutions (e.g., climateneutralnow.org by the UN) as well as organizations linked to the church (e.g., Klimakollekte in Germany). Given the increasing popularity of such offsetting tools, it is vital to understand the determinants of the willingness to engage in compensation. While recent field experiments have provided insights into consumers' responses to measures aimed at promoting offsetting, such as matching or rebate schemes (Kesternich et al., 2016), or changes in the choice architecture (Kesternich et al., 2019), further evidence is required to assess the circumstances in which voluntary offsetting may be an effective means to mitigate climate change. Insights into individuals' preferences for compensation are the basis for these assessments.

Measuring preferences for compensation is, however, very difficult in the field. In field data sets, it is nearly impossible to isolate the extent to which the introduction of compensation services changes individual consumption patterns, since consumers cannot easily be tracked according to their choices of similar products with and without the possibility of compensating. Among other things, this is due to the fact that buying and compensation choices are often made separately from each other. Laboratory experiments can therefore be an important complement to field data analysis as they allow preferences for compensation to be elicited in a controlled way, holding the size and severity of the externality constant and, in the case of our study, only varying the matching of buyers to harmed parties across the experimental conditions. This characteristic of our design additionally allows us to control subjects' beliefs of the size and severity of the externality, which might vary widely in field settings and create substantial noise in decisions about whether to compensate.

Our study makes two contributions to the literature: First, we elicit an incentivized laboratory measure for the willingness of buyers to voluntarily compensate for the negative externalities they are responsible for. The previous literature in the field of environmental economics mostly relies on survey measures for compensation preferences or focuses on field experiments conducted in specific contexts. In contrast to these approaches we measure compensation preferences in a controlled and abstract setting, also testing to what extent these preferences respond to diffusion. Diffusion may be a decisive factor for individuals' real-world compensation decisions, given, for example, the low tangibility of the damages caused by consumption patterns. In particular, we investigate to what extent compensation preferences respond to the diffusion of responsibility for the externality (by introducing free-riding incentives between buyers) and to the diffusion of the externality itself (by varying the concentration of induced harm). To assess the role that voluntariness can play in achieving significant reductions of negative real-world externalities, it is important to understand better how these factors shape compensation preferences.

Second, we extend the literature on moral behavior in market settings by focusing on a specific type of moral decisions that has received little attention before: the motivation to make good the damages one's actions have caused. The decision situation in our experiment gives buyers the possibility to compensate negative externalities ex-post. This option is relevant in practice, because abstaining from consumption entirely or purchasing a good with a lower or no externality might often not be possible (for example, long-distance flights). For a decision-maker who trades off personal benefits of consumption against a loss of utility due to the creation of harm (which is sometimes conceptualized as "moral costs" in the literature), the introduction of ex-post compensation makes a difference compared to the case where externalities from trading are fixed and irreversible, as it is the case in most of the previous related literature. Moreover, given that buyers in our experiment can behave morally in two dimensions - either in the ex-ante abstention from buying or in choosing to compensate ex-post - it is unclear per se whether total externalities will be more or less pronounced than in settings where externalities cannot be offset. Comparing treatments with and without the possibility to compensate allows us to analyze moral behavior and the resulting externalities in both dimensions.

Our results are as follows: First, subjects are on average willing to significantly compensate for the externalities they create, and compensation decisions are sensitive to the surplus at stake. Yet, experimental buyers are highly heterogeneous, and some of them never compensate. Furthermore, the introduction of the compensation possibility tends to increase the frequency of buying in our baseline condition without diffusion. Overall, the introduction of voluntary compensation significantly reduces the net externality in all treatments by between 13 and 18%. Average net externalities, however, remain on a high level, still accounting for 64 to 79% of the maximum possible externality.

Second, neither diffusion of harm nor diffusion of responsibility change the likelihood of compensating per se relative to our baseline condition without diffusion. We do, however, find an effect on the intensive margin in the *DiffusedResponsibility* treatment: conditional on compensating at all, buyers pay significantly less for compensation than in *NoDiffusion*. Moreover, externality-sensitive subjects are significantly more likely to buy and thus to cause the externality in both diffusion treatments than in the baseline condition. Finally, the resulting net externalities in the *DiffusedResponsibility* treatment are higher than in the baseline condition.

The remainder of our paper is organized as follows: we review the literature related to our study in Section 2. In Section 3, we describe our experimental design and the hypotheses. We present the experimental results in detail in Section 4; Section 5 briefly discusses the results and concludes.

2 Related Literature

First, our study links to previous research in the field of environmental economics that investigates individual motivations to invest resources in order to mitigate climate change. Some studies in this area collect incentivized measures for individuals' willingness to pay for climate protection per se: For instance, the studies by Löschel et al. (2013) and Diederich and Goeschl (2014) based on data gathered with non-laboratory subjects from Germany indicate a generally low willingness to pay for climate change mitigation as well as a large heterogeneity in preferences among subjects. A recent study by Andre et al. (2021) analyzes the willingness to donate in order to fight climate change in a representative sample from the US, showing that information interventions highlighting a norm for climate protection can significantly increase donations. Feldhaus et al. (2022) find in an artefactual field experiment that highlighting individual responsibility increases donations to climate change mitigation projects. Most closely related to our study, research focusing on the nature of individual motivations behind ex-post compensation of environmental externalities typically use evidence from surveys and vignette studies (Blasch and Farsi, 2014, Blasch and Ohndorf, 2015, Schwirplies and Ziegler, 2016, Lange and Ziegler, 2017).[1] In contrast to these studies, we elicit an incentivized measure for the voluntary ex-post compensation of negative externalities, thereby obtaining insights into revealed preferences for reducing the harm generated through one's own actions. Measuring revealed preferences for compensation is important as there might be a discrepancy between stated and revealed preferences in the sense that answers from survey questions may exaggerate the true willingness to bear costs in order to reduce one's own negative externalities (see, for instance, related evidence from dictator games reported by Schier et al. 2016). The study by Berger et al. (2021) that investigates the choices of customers to offset CO_2 emissions from flights with observational field data indicates this potential discrepancy, as less than 5% of the flight passengers in their data set choose to offset the CO_2 emissions.

To the best of our knowledge, there are only two studies so far that investigate the individual

[1] In particular, three factors are commonly found to correlate with stated demand for carbon offsets: environmental preferences, warm glow and the perceived responsibility in the creation of the externality.

motivation to remove negative externalities ex-post in controlled laboratory settings, and their designs differ markedly from the present study: The study by Jakob et al. (2017) tests concerns for moral responsibility in a real-effort experiment in which some participants work on a task that creates a real-world externality. The authors show that a significant share of participants exhibit moral responsibility in the sense that they have a preference for removing this externality themselves rather than delegating it to another participant, despite efficiency losses associated with this choice. Moreover, Kuhn and Uler (2019) conduct a laboratory experiment in which subjects act as buyers and sellers in double auction markets, and realized trades impose a negative externality on all market participants. After the double auction markets, former traders can purchase carbon offsets that reduce the externality equally for all participants, thus transforming the choice to offset into a public goods game. Among other things, Kuhn and Uler find that the demand for offsets is price-sensitive, and individual choices to offset the externality are linked to a survey measure for personal responsibility. Different from these laboratory studies, our setting focuses on buyers who stay unaffected by the externality themselves, resembling situations in which the negative effects are not (directly) experienced by those who cause the externality. In addition, unlike the previous studies, voluntary compensation in our baseline condition directly reduces the harm for the third party and is not subject to potential free-riding. Moreover, by comparing compensation behavior within subject between our baseline condition and our treatment with responsibility diffusion, we can directly investigate the effect of free-riding incentives on the willingness to compensate and the resulting externalities.

Second, our study is related to research on moral concerns related to economic behavior. The study by Andre et al. (2021) mentioned above highlights the moral dimension of choices related to the reduction of environmental externalities; a higher degree of universal moral values is significantly correlated with donations to fight climate change. Previous literature in this area focuses on the determinants of moral behavior when (potential) traders on markets have to weigh personal payoffs against negative externalities, investigating for example the role of market institutions and market structure in fostering moral behavior (see, for example, Falk and Szech, 2013, Bartling et al., 2015, Kirchler et al., 2016, Pigors and Rockenbach, 2016b, Ockenfels et al., 2020, Sutter et al., 2020, Bartling et al., 2021a, Riehm et al., 2022).[2] In these studies, participants have to choose whether

[2]Several studies focus on buyers' selection processes when there are both goods with a negative externality and

or not to engage in trading activities or choose between products that vary in their degree of social responsibility. In contrast to the present experiment, however, choices then determine whether or not a negative externality is created which is irreversible afterwards. Hence, previous studies do not consider the option to make good the damage created by one's actions and thus cannot investigate to what extent this option influences moral consumption behavior in the first place.

The option to offset harm ex-post in our setting enables decision-makers to "scale" moral behavior in the sense that compensation can be chosen in a way that balances private benefits and moral costs, as the degree of their social responsibility can be adjusted endogenously by compensating either fully or only partially. Moreover, previous studies on altruistic and ethical behavior would suggest that the separation of buying and compensation decisions central to the present setting might make a difference from the buyer perspective compared to the situation in which buying triggers an irreversible externality. In particular, Gneezy et al. (2014) formalize the idea of "conscience accounting" when subjects face a sequence of choices that have ethical and prosocial components and balance own consumption, the consumption of others and feelings of guilt when violating moral constraints. As a result of conscience accounting, the guilt that arises after an unethical action increases the likelihood of a subsequent prosocial action. In the context of ex-post compensation, this would suggest that buying the good and causing the harm for the third party might then eventually trigger the willingness to compensate. If buyers behave in line with conscience accounting, the anticipation of the possibility to behave in a prosocial way through compensating might lead to more frequent buying, and thus, to higher (initial) externalities.[3]

Third, our study builds on previous experimental literature focusing on the behavioral effects of diffusion of cause and effect. Diffusion of responsibility has been found to significantly reduce prosocial behavior in dictator games (see, for instance, Dana et al., 2007, Hamman et al., 2010, Cryder and Loewenstein, 2012). Related to our setting, Branas-Garza et al. (2009) find that reduced responsibility makes dictators less likely to equalize highly unequal payoff distributions ex-post. In the context of moral behavior on markets, some studies have suggested that diffusion

fair goods without a negative externality. In general, the fair good has a significant positive market share, despite coming at a higher price (Bartling et al., 2015, Pigors and Rockenbach, 2016a, Friedrichsen, 2017, Bartling et al., 2021b). Moreover, Pace and van der Weele (2021) investigate the willingness to buy a product with a negative CO_2 externality, focusing on the interaction with prices and beliefs about the externality. In particular, the authors find that beliefs about the CO_2 externality are significantly negatively related to the decision to buy the product.

[3] Gneezy et al. (2014) find evidence similar to this conjecture: If experimental subjects foresee that the possibility to donate to charity is available at a later stage, they become more likely to behave in a dishonest way.

might have a detrimental effect but the evidence is mixed so far: Falk et al. (2020) test whether diffusion of responsibility in simultaneous and sequential decision making in groups leads to a higher willingness to impose negative externalities. They observe that individuals who decide in groups are significantly more likely to choose in a selfish way regardless of the nature of the externality. Irlenbusch and Saxler (2019) find no significant difference in the willingness to accept a negative externality when an individual's decision is compared to the case when two decision-makers share responsibility. Relatedly, Bartling and Özdemir (2022) observe that subjects do not make use of a "replacement excuse" (i.e., choosing an immoral action because someone else would have done so otherwise) in situations where a clear social norm exists that classifies the behavior causing an externality as immoral. Finally, the only study we are aware of that focuses on the diffusion of harm is the study by Bartling et al. (2019) that investigates the effect of diffused harm on the outcomes of markets in which goods with and without externalities can be traded. Holding the absolute magnitude of the externality constant, the authors vary how many subjects are harmed by the externality (one versus six subjects) and find that diffused harm only weakly affects the market share of fair goods. [4] Given the differences in the nature of moral behavior that previous studies focus on (either the choice to directly impose externalities or the choice between socially responsible products and products with externalities), it is unclear to what extent the diffusion of harm and the diffusion of responsibility change voluntary ex-post compensation in the present setting. Moreover, unlike previous research in this area, we investigate the impact of the two potential types of diffusion on both purchasing and offsetting decisions within the same setting.

3 Experimental Design and Hypotheses

3.1 Basic Setup

We employed a 2×3 experimental design. To assess the effect of the introduction of compensation, the possibility of compensation was varied within subjects, so that every subject participated in the two conditions *NoCompensation* and *Compensation*. Between subjects, our three main treatments

[4] In addition, in a series of distributional games by Schumacher et al. (2017), participants decide about whether or not a good is provided that imposes a certain cost for each payer in a group of payers. Here, a large fraction of subjects are insensitive to the size of the group who is bearing costs, which results in ignorance of large provision costs when these are spread among many payers.

then varied the degree of diffusion of the negative externality: *NoDiffusion*, *DiffusedHarm* and *DiffusedResponsibility*.

We first describe our baseline condition *NoDiffusion* before we move to the treatment variations in the next subsection. The structure of the basic decision situation in the *NoCompensation* $\times$ *NoDiffusion* condition was as follows: There were two players, one buyer and one harmed party. It was randomly determined prior to the start of the experiment who would act in the role of buyers and in the role of harmed parties. The role assignment was kept constant throughout the entire experiment.

In every round, both the buyer and the harmed party received an endowment of 75 Experimental Currency Units (ECU). The buyer could then decide whether she wanted to buy a fictitious good at price p from the experimenter. This price was randomly drawn from a uniform distribution with $p \in \{1, 2, ..., 100\}$ ECU. If the buyer decided not to buy the good, both players kept their endowment and no externality was created. When buying the good, on the other hand, the buyer received a payoff equal to her valuation of the good, which was fixed throughout the experiment at 100 ECU. The gains from buying were thus between 0 (if the price was 100) and 99 (if the price was 1) ECU. At the same time, buying imposed a real-world negative externality on the harmed party. In our setting, the externality referred to the obligation for the harmed party to work on a tedious effort task after the end of the experiment. In case a buyer decided to buy the good and the externality was created, a harmed party (another subject in the same experimental session) had to correctly place 240 sliders in the slider task (Gill and Prowse, 2012) in order to receive their payment, after all other subjects who did not have to work on any sliders had left.[5] We chose the parameters of the experimental decision task such that it was optimal for a buyer not concerned about the externality to buy the good at all price realizations; a profit-maximizing buyer would only be indifferent between buying and not buying at the highest possible price (100 ECU). However, by varying the surplus available to buyers from their buying decisions, we can gain insights if and to what extent buyers trade-off material gains and negative externalities.

In the *Compensation* $\times$ *NoDiffusion* treatment, we added a second stage after the buying

[5]In this task, subjects were confronted with a number of movable sliders which could be dragged to all possible positions between 0 and 100. The computer randomly allocated the starting position of the slider. The subjects' task was then to drag all sliders to the middle position (in our case 50). Solving 240 sliders took between 10 and 18 minutes in our experiment.

decision in each round. If a buyer decided not to buy the product, the consequences stayed the same as in the *NoCompensation* condition, i.e., both buyer and harmed party kept their endowments and no externality was created. Yet, once a buyer bought the good, she moved to the second stage and had the opportunity to use between 0 and 30 ECU of her experimental payoff to reduce the externality on the harmed player with whom she was matched. This decision resembles the choice of a buyer to compensate for the negative externality created by her purchase. In particular, each ECU spent by the buyer reduced the workload for the harmed player by eight sliders. Moreover, the parameters in our experiment ensured that at least for price realizations below 70 ECU buying and fully compensating was Pareto-efficient, as the realization of trade in these cases leaves buyers with positive payoffs even after completely offsetting the externality (and thus, entirely avoiding extra working time for the third party).[6]

After playing 12 rounds of the game in the *NoCompensation* condition, participants in all treatments played the game for another 12 rounds in the *Compensation* condition. In each round, prices were drawn randomly and independently for each buyer. To rule out the possibility that accumulated gains of trade would affect buying and compensating decisions in latter parts of the experiment, one round was randomly determined for payment at the end of a session. Furthermore, to avoid that the history of the game would affect beliefs about the compensation behavior of other buyers in the *DiffusedResponsibility* treatment, we did not give any feedback in between rounds about buying and compensation decisions as well as the resulting payoffs and externalities. It was made clear in the instructions that harmed parties were other subjects who participated in the same session as subjects in the role of buyers. Moreover, subjects knew that buyers and harmed parties would be re-matched in every round, ensuring that no subjects would be matched to each other in two consecutive rounds. We used a market frame labeling the players as Person A and Person B, with Person A being described as a buyer who had to decide whether to buy a good. Example instructions can be found in the Appendix.

[6]For prices between 70 and 100 ECU the evaluation of the efficiency of buying and compensating depends on the (unknown) social costs of the externality, in our setting the individual disutility of working on the sliders task. Moreover, we allowed buyers to spend money from their endowment to compensate the harmed party for the negative externality when the surplus created from buying was not sufficient to fully compensate. Full compensation (reducing the externality to zero) was therefore always feasible for any realization of the prize.

3.2 Treatments

To manipulate diffusion of the consumption externalities, we changed the matching structure in the treatments *DiffusedHarm* and *DiffusedResponsibility* holding the total working time following purchases constant. As before, buyers took the decisions in these treatments with and without the possibility to compensate. While in *NoDiffusion* one buyer was matched with one harmed party, we varied the number of buyers and harmed parties in *DiffusedResponsibility* and *DiffusedHarm*, respectively. In *DiffusedHarm*, one buyer was matched with two harmed parties who had to solve 120 sliders each if the good was bought. In the *Compensation* condition, each point spent as compensation would then reduce the number of sliders each harmed party had to solve by four so that the efficiency of the compensation technology was identical to the other treatments. To keep things comparable across treatments, buyers were not allowed to allocate compensation freely between the two harmed parties. In *DiffusedResponsibility*, two buyers were matched with one harmed party who had to solve 240 sliders whenever at least one of the two buyers bought the good, which is similar to the implementation rule in Falk et al. (2020). This means that, if one buyer decided to purchase the good, already the full externality was imposed on the third party; whether or not the second buyer bought was then irrelevant for the externality.[7] The fact that immoral behavior of one buyer is already sufficient to generate the full externality resembles many examples related to voluntary compensation in field settings. For instance, the CO_2 emission of a flight or a bus trip is already generated when the first passenger books the trip.

In our *DiffusedResponsibility* treatment, each point spent as compensation reduced the number of sliders by eight. However, if the two buyers together spent more than 30 ECU in total, excess points expired, as the externality could not be reduced to less than zero. As mentioned above, we did not give any feedback to buyers at the end of a round, in order to prevent updating of beliefs about other buyers' behavior, which would have influenced the incentives to buy and to compensate in the first place. Again, we made sure that in any consecutive round buyers were not matched with the same subjects (harmed parties and/or buyers). Therefore, it was not possible for buyers in the *DiffusedResponsibility* treatment to coordinate; for instance, a pattern where two buyers would always buy and take turns in compensating the third party was ruled out by the matching

[7]We acknowledge that by modelling diffusion of responsibility in this way, the ratio between potential gains to buyers and externality increases relative to the other treatments.

protocol.

3.3 Hypotheses

Our first hypothesis concerns buying and compensation choices. If buyers experience moral costs as a result of creating the externality on the third party, compensation provides a possibility to assuage this moral cost. Hence, buyers who experience disutility due to their moral concerns can be expected to choose positive compensation levels to reduce the moral costs of consumption. This pattern would be in line with the positive voluntary compensation levels observed in the field and in the patterns of moral behavior found in market settings in the presence of negative externalities.

At the same time, the possibility of compensating the externality (at least partially) may have the effect of increasing buying frequencies. As argued above, if buyers exhibit conscience accounting Gneezy et al. (2014) and anticipate the compensation stage, they can be expected to become more likely to purchase the good in the first stage, thus making it more likely that the externality is created. A related example from the field is the study by Harding and Rapson (2019), who found an increase in energy consumption by 1-3% among buyers after signing up for a green energy program that would offset the CO_2 effects.[8] Overall, we pose a two-part hypothesis:

Hypothesis 1

a) *Buyers choose positive compensation levels on average.*

b) *The introduction of compensation leads to a higher buying frequency compared to the case when compensation is not possible.*

It is important to note that it is unclear ex-ante whether an increased frequency of buying after the introduction of the compensation possibility will lead to higher or lower net externalities compared to the case in which compensation is not possible, as the resulting externality depends on the strength of the buyers' compensation preferences. As described in the previous subsection, given the parameters of our experiment, buying and fully compensating the externality would be efficiency enhancing for prices below 70 ECU.

[8] A related phenomenon is the rebound effect reported in the field of energy economics which is defined as an increase in energy consumption after an increase in energy efficiency, which may even offset efficiency driven energy savings (Sorrell and Dimitropoulos, 2008). While the size of the rebound effect is still debated in the literature, its existence is well-documented (Gillingham et al., 2016).

Our treatment variations focus on two additional factors, which may hamper social responsibility by reducing the tangibility of the externality: diffusion of harm and diffusion of responsibility. First, many negative externalities share the characteristic that their harm is borne by many people at the same time, e.g., carbon emissions, water pollution or noise pollution all affect many people simultaneously. That many are harmed at once reduces the identifiability of victims and hence may lead to "compassion fade", the psychological phenomenon that the likelihood to help decreases when the number of victims increases. This effect has been found in many studies in humanitarian contexts (see Butts et al. 2019 for a meta-analysis), and was also confirmed in a study which comprising vignette and behavioral results for a sub-group of non-environmentalist subjects in various environmental donation contexts (Markowitz et al., 2013). Transferred to our setting, this leads us to hypothesize that diffusion of harm reduces compensation levels relative to the baseline condition.

Similarly, diffusion of responsibility is a frequent characteristic of markets where negative externalities are created, for example in the transport sector where voluntary offsetting schemes are currently often implemented. Diffusion of responsibility may increase the moral wiggle room for buyers at both stages of the decision situation: First, if both buyers choose to buy the good and the externality is imposed, the link between one's individual action and the harm for the third party becomes weaker. Second, and related, the (potentially self-serving) belief that the other buyer buys the good and triggers the externality may reduce the perceived guilt from consuming, as the harm is created irrespective of one's own decision. Third, if both buyers have decided to buy the good, the compensation decision becomes a free-riding problem, and the belief of one buyer that the other buyer will compensate may lead to a reduction of one's perceived necessity for compensation relative to a situation in which the buyer decides on the compensation alone. Indeed, diffusion of responsibility has been shown to reduce prosocial and moral behavior for example in dictator games and in the study by Falk et al. (2020); please see the discussion of the related research in the previous section. Taken together, these findings lead us to hypothesize that diffusion of responsibility decreases social responsibility in the context of voluntary compensation.

Importantly, as described above, decision-makers in our setting can respond to the reduction of tangibility along two dimensions. They can either buy the good more frequently or reduce voluntary compensation. As it is difficult to predict ex-ante on which dimension the behavioral response should be stronger pronounced, we formulate our hypothesis about the effect of the treatments in terms of social responsibility, integrating both buying and compensation choices.

Hypothesis 2

Diffusion of harm/responsibility reduces social responsibility: It increases buying and decreases compensation (conditional on buying), relative to the situation without diffusion.

3.4 Experimental Procedures

The experiment was run in June 2019 at the BEELab at Maastricht University, after we conducted a pilot in April 2019 to calibrate experimental parameters. In total, seven experimental sessions were conducted with altogether 150 subjects. Subjects were recruited using ORSEE (Greiner, 2015) and the experiment was programmed in oTree (Chen et al., 2016). The experiment lasted on average for 1 hour and 45 minutes and payments were made in Euro with the exchange rate 10 ECU = EUR 2.50. Average earnings were EUR 24.14 (SD 7.75), with buyers earning on average EUR 29.48 (SD 7.95) and harmed parties earning EUR 18.80 (SD 0). When all subjects who were registered for a session showed up, all experimental treatments were conducted in this session. Upon arrival, subjects were randomly assigned to their seats in the lab by drawing a numbered card from a shuffled deck. In a session with full participation, we had 6 participants in the *NoCompensation* treatment (3 buyers, 3 harmed parties) and 9 participants in either of the diffusion treatments (3 buyers and 6 harmed parties in *DiffusedHarm*, 6 buyers and 3 harmed parties in *DiffusedResponsibility*). We call each of these treatment groups a cohort. Subjects were re-matched within their cohort, making sure that no one interacted repeatedly in two consecutive rounds. When not all registered subjects showed up for a session, we dropped one of these cohorts and consequentially conducted the session only with the remaining two treatment cohorts.

The structure of a session is depicted in Figure 1. At the beginning of the experiment, subjects received general instructions about the procedure of the session. All instructions were handed out on paper. We then explained the slider task and subjects had to solve 120 trial sliders in order for all of them to become familiar with what would later become the externality. For working on the slider task, they received 100 ECU. After the working task was over, we elicited subjects' willingness to pay to avoid having to solve another set of sliders at the end of the experiment with

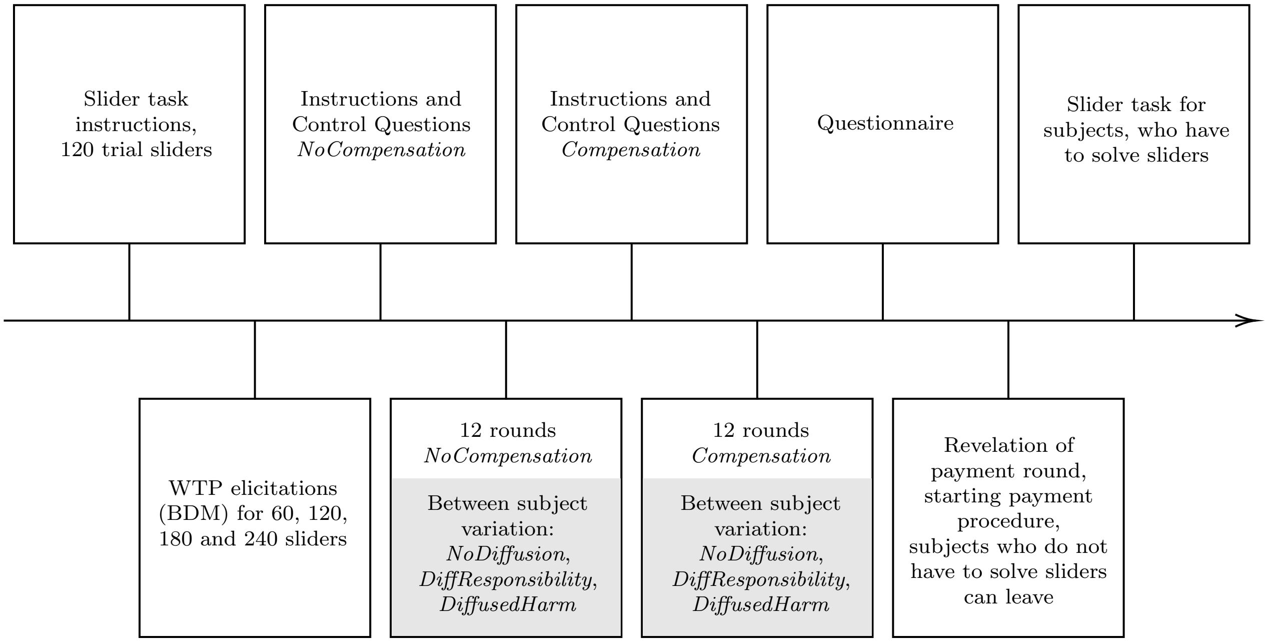

Figure 1 – Structure of an experimental session, which was the same for all subjects. Differences stemming from between subject treatments are indicated in shaded boxes. WTP refers to the willingness to pay to avoid having to solve sliders.

the help of the Becker-DeGroot-Marschak (BDM) mechanism (Becker et al., 1964). Subjects had to state their willingness to pay for four different numbers of sliders (60, 120, 180, and 240); they could bid up to their endowment of 100 ECU in each case. After the willingness to pay elicitations, subjects received the instructions for *NoCompensation* and then had to answer control questions with example calculations. They could only proceed to the 12 rounds of the main experiment once they had correctly answered each of the control questions. Only then, subjects were informed of their role (buyer or harmed party). At the end of the *NoCompensation* part, this procedure was repeated with the instructions for the *Compensation* condition. One round was randomly chosen to determine the payoffs for the subjects and possibly the externalities. Here, each of the BDM choices was as likely to be implemented for payments as each of the decision rounds in *NoCompensation* and *Compensation*. Before the payment round was revealed, every subject had to fill in a questionnaire with demographics stated attitudes, for example related to general altruism and the attitudes towards ethical consumption. Subjects who had to work on the slider task then had to solve the sliders before they would receive their payments, while we already started handing out the payments of subjects who did not have to work.

4 Results

We start our analysis with aggregate buying and compensation patterns before we focus on potential effects of the experimental treatments and the determinants of individual choices. In the first step, we group participants into categories depending on their decisions in all rounds of the experiment; Figure 2 lists this classification and the corresponding shares of participants assigned to each category. The first observation is that, despite it would be optimal from a profit-maximizing perspective to buy the good in every round, only a minority of buyers (35%) do so. Moving to compensation behavior, we find that of those subjects who always buy, 65% never compensate. Hence, these subjects (some 23% of all buyers) behave in a fully selfish way and do not seem to take into account the harm they create for the third party. On the contrary, 45% of the subjects who buy only in some rounds (29% of the total buyer population) always compensate the third party. Overall, while we observe a strong heterogeneity in buying and compensation decisions among subjects, the two experimental treatments do not differ from the baseline condition in the shares of buyers assigned to a specific category (all $\chi 2$-tests yield significance levels of $p > 0.200$).

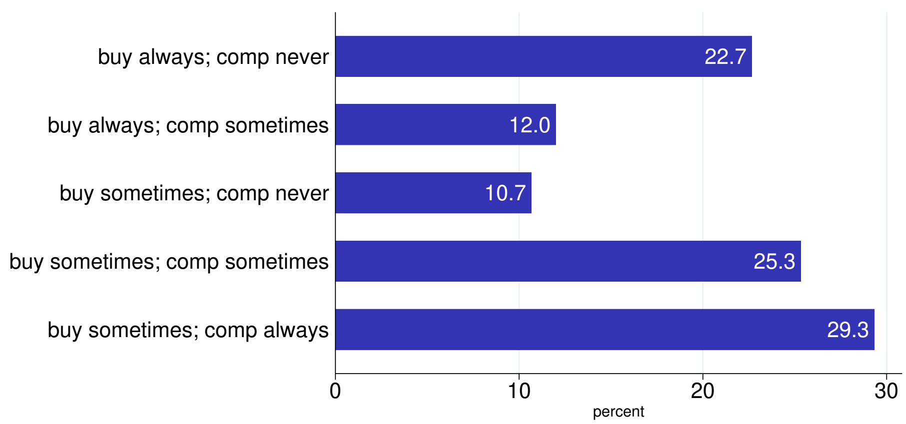

Figure 2 – Proportions of subjects type classification based on their buying and compensation behavior.

In the next step, we take a closer look on buying behavior. Table 1 depicts buying frequencies in the different treatment conditions. First, we observe in line with the previous analyses that in all treatments buyers are on average willing to forego private earnings by refraining from buying, i.e., the buying frequency significantly differs from one in all treatments ($p < 0.003$ in all two-sided Wilcoxon signed-rank tests comparing individual buying rates without or with compensation; unless otherwise stated, all statistical tests are two sided). Once compensation is available, subjects

	Buying rate (SD)		
	NoCompensation	*Compensation*	Wilcoxon signed-rank test
NoDiffusion	73.81%	80.95%	0.059
	(0.31)	(0.21)	
DiffusedHarm	83.33%	88.43%	0.666
	(0.24)	(0.13)	
DiffusedResponsibility	87.04%	88.43%	0.198
	(0.21)	(0.18)	
Mann-Whitney U tests			
DiffusedHarm	0.396	0.398	
DiffusedResponsibility	0.105	0.121	

Table 1 – Average buying rates per treatment using subject mean buying rates across rounds, standard deviation in parentheses. The bottom two rows give the p-values of Mann-Whitney U tests, comparing buying rates in *NoDiffusion* with the respective treatments. The fourth column reports the p-values for a Wilcoxon signed-rank test of differences in buying rates between the *NoCompensation* and *Compensation* condition.

use on average around 6 ECU to voluntarily reduce the harm they created, which is about 20% of the 30 ECU required to compensate for the full externality. In all treatments, this amount differs significantly from zero ($p < 0.001$, Wilcoxon signed-rank test comparing mean individual compensation amounts), confirming our Hypothesis 1.a).

To test whether abstaining from buying in the *NoCompensation* condition can indeed be interpreted as taking social responsibility rather than as errors of subjects who do not care about the externality, we look at the correlation between an individual's buying frequency in *NoCompensation* and an individual's compensation behavior in the second part of our experiment. We find that average compensation in the second part is highly negatively correlated with an individual's average frequency of buying in the first part when compensation is unavailable (Spearman's rho = -0.6504, $p < 0.001$). Hence, subjects who choose relatively high amounts for compensation are less likely to buy when the possibility to compensate does not exist. This result suggests that these subjects indeed account for the externality in their buying decisions.

As described in subsection 3.3, we expected the introduction of compensation to increase the likelihood of buying (Hypothesis 1.b)). When we compare buying frequencies in *NoCompensation* and *Compensation*, we find some evidence for this hypothesis in our *NoDiffusion* condition. In this treatment, the availability of compensation increases buying (marginally) significantly ($p =$ 0.059, Wilcoxon signed-rank test comparing individual buying rates between *NoCompensation* and

	NoDiffusion (1)	*DiffusedHarm* (2)	*DiffResponsibility* (3)
Compensation	1.768***	-0.194	0.271
	(0.573)	(0.563)	(0.385)
Price	-0.100***	-0.070***	-0.063***
	(0.016)	(0.013)	(0.018)
Round number	-0.034	0.073**	0.021
	(0.034)	(0.035)	(0.025)
Constant	8.837***	6.031***	5.961**
	(1.741)	(1.521)	(2.621)
Observations	504	432	864
# buyers	21	18	36
Session dummies	Yes	Yes	Yes

Table 2 – RE-Probit models using a binary dependent variable equal to one if the decision-maker chooses to buy the good in a particular round. *Compensation* treatment dummy takes the value of one in part 2 of the experiment, when compensation is available. Robust standard errors (clustered by subject) in parentheses, *** p=0.01, ** p=0.05

Compensation). At the same time, we do not find an effect of *Compensation* on the frequency of buying in the two diffusion conditions *DiffusedHarm* and *DiffusedResponsibility* where the probability of buying is already very high in the first part of the experiment (around 85%).

Next, we conduct parametric analyses in which we also take into account the individual heterogeneity of experimental buyers (see Table 2). We estimate Probit models with the decision to buy as the binary dependent variable, including buyer-level random effects, separately for each of the three experimental conditions. As independent variables, we include a dummy variable equal to one if the compensation technology was available to the buyers, the price realized in the specific round, and the round number to control for (linear) time trends. Also here, the introduction of compensation is associated with an increased likelihood of buying in *NoDiffusion* (Model 1), as the coefficient of the *Compensation* dummy is positive and significant. For models concerning the other two treatments (Models 2 and 3), however, we do not find such an effect.[9]

Moreover, across all models we observe a negative and highly significant price coefficient, suggesting that the lower the price, the higher the probability to buy. Note that given our experimental design, profit-maximizing subjects should buy, irrespective of the price realization. This is because the price can be at most 100 ECU, which is exactly equal to the induced valuation.

[9] Generally, results are similar when using a linear model instead. The *Compensation* dummy in the *NoDiffusion* treatment is, however, not significant anymore.

Yet, the fact that subjects are price sensitive in all treatments seems to suggest that buyers bear a moral cost of imposing a negative externality on the harmed party on top of their individual consumption utility. This leads to a trade-off between their own monetary benefits and the moral costs, which can explain why subjects are less likely to buy the good at a high price (low potential gain from buying). Finally, we do not observe a robust effect of the number of rounds between the treatments.

In the next step, we compare buying rates across treatments. As apparent from Table 1, both *DiffusedHarm* and *DiffusedResponsibility* lead to higher buying rates compared to *NoDiffusion* when compensation is not possible (83% or 87%, respectively vs. 73%) as well as when it becomes possible (both 88% vs. 81%). Yet, the differences between either of the diffusion treatments and *NoDiffusion* are not significant when comparing observations from the entire sample ($p > 0.100$, Mann-Whitney U tests comparing individual mean buying rates).

Given the heterogeneity of decision-makers concerning buying and compensation decisions, we divide our sample into subjects who do not consider the externality when making their buying decisions and subjects who seemingly face moral costs due to the creation of the externality and thus potentially respond stronger to the treatment conditions that vary the tangibility of the externality.

In particular, we classify subjects as being sensitive to the externality, when they compensate at least once in the second part, and concentrate only on these subjects for the following analysis. This leaves us with the decisions of 13 buyers (62% of the sample) in *NoDiffusion*, 14 buyers (78%) in *DiffusedHarm*, and 23 buyers (64%) in *DiffusedResponsibility*. The first thing to note is that there is no significant difference between treatments in the share of subjects who are sensitive to the externality ($p > 0.200$, two sample tests of proportions comparing either of the diffusion treatments to *NoDiffusion*). At the same time, it turns out that the differences across treatments become more pronounced when we focus only on subjects who are sensitive to the externality. Comparing these subjects in the first part of the experiment when compensation is not possible, we find that buyers in *NoDiffusion* buy significantly less often (60% of the rounds on average) than in *DiffusedHarm* (84%, $p = 0.027$, subject level Mann-Whitney U test) and *DiffusedResponsibility* (81%, $p = 0.030$, subject level Mann-Whitney U test). This confirms that concerns against creating the externality keeps subjects away from buying. In addition, when compensation becomes available this difference in the buying rates is still weakly significant (*NoDiffusion* (71%) vs. *DiffusedHarm* (86%), $p = 0.053$;

	Only externality-sensitive subjects			
	NoCompensation		*Compensation*	
	(1)	(2)	(3)	(4)
DiffusedHarm	1.391***	4.199***	0.729***	1.594**
	(0.488)	(1.374)	(0.275)	(0.684)
DiffResponsibility	0.871**	2.560**	0.484*	1.136
	(0.357)	(1.006)	(0.279)	(0.701)
Price		-0.103***		-0.076***
		(0.022)		(0.026)
Round number		0.024		0.020
		(0.039)		(0.029)
Constant	0.363	6.344***	0.772**	5.665**
	(0.466)	(2.067)	(0.339)	(2.740)
Observations	600	600	600	600
# buyers	50	50	50	50
Session dummies	Yes	Yes	Yes	Yes

Table 3 – RE-Probit models using a binary dependent variable equal to one if the decision-maker chooses to buy the good in a particular round. *DiffusedHarm* and *DiffusedResponsibility* are dummy variables taking value 1 for the respective treatments. Subjects are classified as externality sensitive when they have compensated at least once. Model 1 and 2 (3 and 4) refer to the first (second) part of the experiment where compensation is not available (is available). Robust standard errors (clustered by subject) in parentheses. *** p=0.01, ** p=0.05, * p=0.1

NoDiffusion vs. *DiffusedResponsibility* (83%), $p = 0.052$, both using a subject level Mann-Whitney U test).[10]

In Table 3, we report the results of random effects Probit models that confirm these findings. It shows that for externality-sensitive subjects, the decreased tangibility of the externality in both treatments in most cases leads to a higher probability that the good is bought, both in the absence (Model 1 and 2) and the presence (Model 3 and 4) of the possibility to compensate.[11] Overall, we can summarize our results concerning buying patterns as follows:

Result 1

The introduction of the compensation technology significantly increases buying only in the NoDiffusion treatment. Diffusion of harm/responsibility increase buying significantly compared to NoDiffusion for subjects who are sensitive to the externality.

[10]It is noteworthy here that dropping selfish subjects who are not sensitive to the externality mainly leads to a reduction in the buying frequency in the *NoDiffusion* treatment, while the buying rates in *DiffusedHarm* and *DiffusedResponsibility* stay at the same level of around 85%.

[11]The exception here is Model 4 in which the dummy variable for treatment *DiffusedResponsibility* is insignificant.

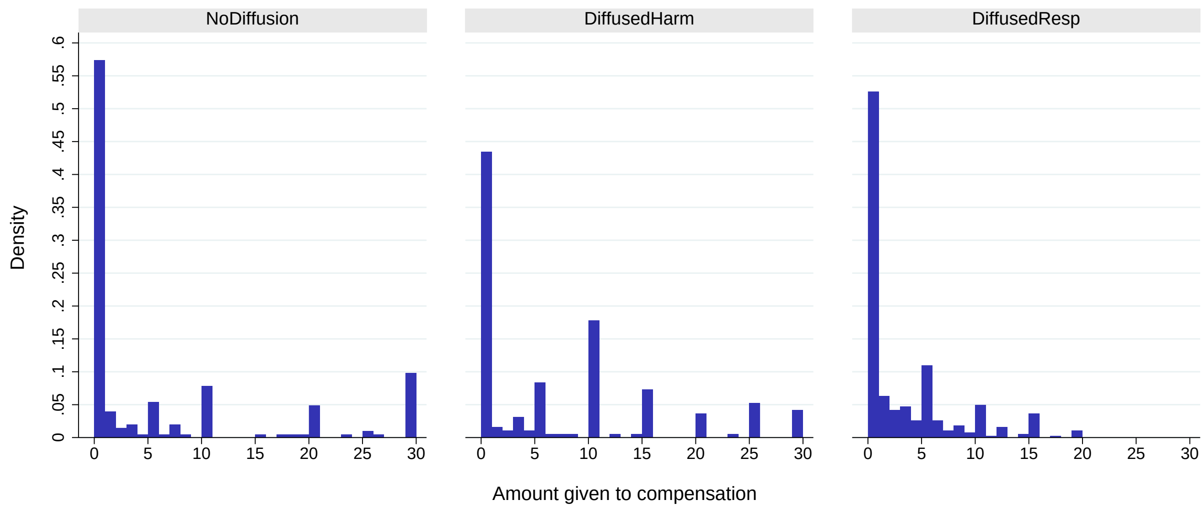

Figure 3 – Histograms of amounts given to compensation in all rounds by treatment conditional on having bought the good. Full compensation of the externality costs 30 ECU.

We now turn towards a more detailed analysis of compensation behavior. Comparing subject means of compensation across treatments, we find that subjects give on average 8.12 ECU (SD 10.83) in *NoDiffusion*, 7.78 ECU (SD 7.77) in *DiffusedHarm* and 3.71 ECU (SD 4.81) in *Diffused-Responsibility*. These differences are, however, not significant at conventional levels ($p > 0.200$ Mann-Whitney U test comparing subject means of diffusion treatments to *NoDiffusion*). In the next step, we test whether there are treatment differences in compensation for externality-sensitive subjects (i.e., who compensate at least once). We find that while there is still no significant effect of *DiffusedHarm* ($p = 0.645$), compensation is (weakly) significantly lower in *DiffusedResponsibility* ($p = 0.068$, Mann-Whitney U test comparing mean compensation for externality sensitive subjects).

When looking at the distributions of the amounts given to compensation, patterns seem to differ across treatments (Figure 3): In the *NoDiffusion* treatment, the externality is fully offset in 10% of the cases, while in the *DiffusedResponsibility* treatment the maximum amount that is ever given to compensation is 20 ECU (extinguishing two thirds of the externality). We therefore test whether there are treatment differences on the extensive and intensive margin.

The average propensity to compensate accounts for 50.10%, 59.24% and 51.44% in treatments *NoDiffusion*, *DiffusedHarm*, and *DiffusedResponsibility*, respectively (taking means of the subject averages across all rounds). These differences are descriptively small and statistically not significant ($p > 0.200$, Mann-Whitney U tests comparing subject means between the diffusion treatments and

	Amount given (1)	Compensate (yes/no) (2)	Amount given (if compensated) (3)
DiffusedHarm	3.125	1.628	-3.635
	(4.941)	(3.573)	(3.575)
DiffResponsibility	-3.992	0.058	-6.924***
	(3.975)	(3.545)	(2.963)
Price	-0.134***	-0.030***	-0.107***
	(0.009)	(0.006)	(0.020)
Round number	-0.137**	-0.069*	-0.082
	(0.063)	(0.039)	(0.065)
WTP 240 sliders	0.232***	0.060	0.031
	(0.077)	(0.123)	(0.043)
Constant	6.841	1.880	19.256***
	(5.804)	(3.874)	(3.957)
Observations	777	777	376
# buyers	75	75	50
Session dummies	Y	Y	Y
Model	Tobit	Probit	Linear
Clustered SE	N	Y	Y

Table 4 – RE-regressions with standard errors in parentheses. In model (2) and (3) robust standard errors (clustered by subject) are reported. The dependent variable in column (1) is the amount given for compensation, which is zero or positive whenever a subject bought a good. The dependent variable in column (2) is a dummy taking the value 1 when a subject, conditional on having bought the good, gave a positive amount to compensation. In column (3), the dependent variable is the amount given, when compensation was larger than zero. *** p=0.01, ** p=0.05, * p=0.1

the *NoDiffusion* treatment). Looking at the subject means of the amounts, however, we observe that buyers who choose to compensate, give on average 14.80 ECU (SD 10.49) in the *NoDiffusion* treatment, 11.42 ECU (SD 6.70) in *DiffusedHarm*, and 6.51 ECU (SD 4.62) in *DiffusedResponsibility*. The reduction of amounts paid for compensation between *NoDiffusion* and *DiffusedResponsibility* is in line with Hypothesis 2, and the difference is significant ($p = 0.023$, Mann-Whitney U test). At the same time, Hypothesis 2 is not supported in case of the *DiffusedHarm* treatment. Here, while compensation amounts are on average lower than in *NoDiffusion*, this difference is not significant ($p = 0.528$, Mann-Whitney U test).

Result 2

Neither diffusion of harm nor diffusion of responsibility affects the propensity to compensate. Diffusion of responsibility significantly reduces the amount of compensation.

Table 4 provides a parametric analysis of the determinants of compensation behavior. First, we do not find significant effects of the treatments on overall compensation (Model 1, random effects Tobit-model). When looking closer at the extensive margin (Models 2, random effects Probit-model) and the intensive margin (Models 3, linear models with random effects), our results from the non-parametric tests are supported. Both treatments have no effect on the likelihood to compensate. However, *DiffusedResponsibility* significantly lowers the amount paid to reduce the externality, conditionally on compensating at all. Moreover, the models reveal a negative price effect on both the propensity to compensate and the amount given when compensating. This can again be interpreted as an income effect, where a lower price implies a larger gain to the buyer, which then leads to both a higher likelihood and a larger amount of compensation. Finally, as a proxy for the perceived cost of the externality, we include the buyers' willingness to pay in order to avoid working on 240 sliders after the experiment as an independent variable (WTP 240 sliders). We find a positive and significant coefficient in Model 1, indicating that the amount paid for compensation increases with higher perceived harm associated with the externality. At the same time, in Models 2 and 3, the respective coefficients are also positive, but fail to reach significance.

The fact that subjects in *DiffusedResponsibility* give lower amounts to compensation raises the question how the resulting net externality is affected. Since the amount the two buyers pay for compensation are added together to determine the reduction in the externality for the harmed party, the total effect of shared responsibility on the net externality created is ex-ante not clear. To evaluate the effects of the treatments on the net externality after compensation, we convert the average number of sliders the harmed parties have to solve into the ECU amount necessary to offset them. In order to compare independent observations, we then calculate the mean net externality in ECU on cohort level where a cohort is composed of all the buyers in the same treatment within a session. As can be seen in Table 5, diffusion of responsibility leads to a significantly larger net externality both without and with the possibility of compensation ($p = 0.012$, and $p = 0.046$ respectively, cohort level Mann-Whitney U test) relative to the *NoDiffusion* treatment.

What is, however, also noteworthy from the descriptive results is that the introduction of compensation reduces the externality created substantially and significantly in all treatments. In *DiffusedHarm*, this effect is the strongest, reducing the externality by 19% ($p = 0.046$, cohort level Wilcoxon signed-rank test), while in *DiffusedResponsibility* the externality is reduced by 18% ($p = 0.028$), and in *NoDiffusion* the externality is reduced by 13% ($p = 0.022$). Yet, despite this non-

	Net externality (SD)		Wilcoxon signed-rank test
	NoCompensation	*Compensation*	
NoDiffusion	22.14	19.31	0.022
	(4.33)	(3.86)	
DiffusedHarm	25.00	20.22	0.046
	(3.84)	(2.00)	
DiffResponsibility	29.03	23.78	0.028
	(0.82)	(2.89)	
Mann-Whitney U tests			
DiffusedHarm	0.196	0.721	
DiffResponsibility	0.012	0.046	

Table 5 – Cohort means of net externality (after compensation) in ECU equivalents by treatment, standard deviation in parentheses. The bottom two rows give the p-values of Mann-Whitney U tests, comparing net externalities in *NoDiffusion* with the respective treatments. The last column reports p-values of a Wilcoxon signed-rank test comparing net externalities between *NoCompensation* and *Compensation* for each treatment.

negligible reduction, the externality remains at a high level in absolute terms. Across all treatments, two thirds or more of the maximum possible externality are still imposed on the harmed parties (64% in *NoDiffusion*, 67% in *DiffusedHarm* and finally, 79% in *DiffusedResponsibility*). Hence, the possibility to compensate on a voluntary basis does not remove the bulk of the negative externality in our setting.

Result 3

In all treatments, compensation significantly reduces the total externalities. DiffusedResponsibility leads to significantly higher externalities both without and with compensation.

The negative effect of *DiffusedResponsibility* can also be observed in parametric analyses. Table 6 reports the results of linear models with the mean net externality in ECU per cohort and round including random effects on the cohort level. Models 1 and 2 (3 and 4) refer to the first (second) part of the experiment. Across all models, we find that the net externality in *DiffusedResponsibility* is larger than in *NoDiffusion* which is consistent with the previous results. When no compensation possibility is available (Models 1 and 2), *DiffusedHarm* also tends to be associated with higher externalities. Moreover, when controlling for differences in prices (Models 2 and 4), it is interesting to see that the overall effect of prices on the net externality is negative in our setting. Given the previous analyses, the effect of prices is unclear ex-ante: While fewer goods are bought at higher prices (reducing the externality), higher prices also reduce both the likelihood

	NoCompensation		*Compensation*	
	(1)	(2)	(3)	(4)
DiffusedHarm	3.164*	3.046**	1.708	1.686
	(1.626)	(1.538)	(1.253)	(1.250)
DiffResponsibility	6.195***	6.089***	4.416***	4.448***
	(1.313)	(1.168)	(1.095)	(1.116)
Price		-0.153***		-0.040*
		(0.035)		(0.020)
Round number		0.086		0.115
		(0.088)		(0.096)
Constant	23.547***	30.467***	19.866***	19.766***
	(1.069)	(2.096)	(1.197)	(2.249)
Observations	228	228	228	228
# cohorts	19	19	19	19
Session dummies	Y	Y	Y	Y
Model	Linear	Linear	Linear	Linear

Table 6 – RE- Regressions on cohort level with robust standard errors (clustered by cohort) in parentheses. A cohort is the group of subjects within a session who were assigned to the same treatment and who interacted with each other repeatedly. The dependent variable is the mean net externality (after compensation) in ECU that is created in a cohort in a given round. *** p=0.01, ** p=0.05, * p=0.1

and the amount of compensation conditional on buying (increasing the externality). The analysis in Table 6 suggests that the effect of prices is stronger for the propensity to buy, leading to an overall negative effect of prices for the creation of the externality in our setting.

Finally, we try to disentangle what drives the effect of *DiffusedResponsibility* on the net externality. As we have seen in our previous analysis, buyers on average compensated lower amounts. At the same time, given our implementation rule in this treatment, the net externality is not purely determined by compensation behavior. Rather, the fact that the externality is created whenever at least one of the buyers buys the good already mechanically leads to a larger probability of the externality being created in the first place.[12] This can also be seen in the data: While the externality is created in the *NoDiffusion* treatment in 74% (81%) of the cases in the part without (with) compensation, this share accounts for 97% in *DiffusedResponsibility* in both parts taking cohort level averages. These differences are also statistically significant ($p = 0.012$ in part 1, $p = 0.002$ in part 2, cohort-level Mann-Whitney U test). To see whether the reduction in the amount individuals

[12] Even when assuming that there are no treatment differences in the propensity to buy, it is still more likely in *DiffusedResponsibility* that the externality is created. To see this note that $Pr(\text{externality created}) = Pr(\text{at least one player buys}) = 1 - Pr(\text{no player buys}) = 1 - (1 - Pr(\text{buying}))^2 \geq Pr(\text{buying})$.

gave to compensation in the *DiffusedResponsibility* condition also (partially) drives the result of the larger net externality, we look at the amount of compensation that was received by a given harmed player in *NoDiffusion* and *DiffusedResponsibility.* Using a cohort-level Mann-Whitney U test, we fail to find a significant difference between the amount of compensation that is received by a given harmed person ($p = 0.886$; 6.22 ECU on average in *NoDiffusion* and 5.48 ECU in *DiffusedResponsibility*). Hence, it seems that the individual reductions in compensation level out such that the overall compensation received by the harmed person is similar to the *NoDiffusion* treatment.

5 Discussion and Conclusion

We have conducted an experiment to analyze subjects' willingness to costly compensate for the negative externalities their buying decisions impose on others. While buyers are widely heterogeneous, positive compensation levels are chosen on average, suggesting that voluntary compensation can in principle be an effective means to reduce negative consumption externalities. However, in our setting, buyers pay substantially too small amounts for compensation, given the perceived harm that their choices create. Subjects' willingness to pay to avoid working on the task reveal non-negligible social costs associated with the externality. In fact, the mean willingness to pay to avoid having to solve 240 sliders at the end of the experiment - equal to the negative externality imposed on the harmed party - is 21.73 ECU, which is equivalent to EUR 5.43, a substantial share of the buyers' earnings in the experiment (some 18%). Taking the perspective of a social planner, these social costs would make it optimal (conditional on a price of 78 ECU or less) that the good is bought in each round and a compensation of 22 ECU is paid as compensation to offset the externality. Yet, even in our baseline condition, average compensation accounts for only 8.12 ECU, and thus for less than 40% of the perceived harm of the externality. Correspondingly, the net externality after compensation is still substantial in all treatments (between 64% and 79% of the maximum possible externality). [13]

Moreover, we find that compensation is price-sensitive - lower prices are associated with both higher probabilities to offset and higher amounts paid to the harm party. This price sensitivity

[13] This conclusion is similar to the results of Kuhn and Uler (2019), who find that although there is positive demand for compensation, it is inefficiently low as experimental traders free ride extensively.

suggests that buyers seem to trade off material gains against the moral cost of causing the externality, and are more willing to compensate when there is more surplus to distribute. At the same time, an alternative explanation for the correlation between prices and voluntary compensation might be possible. As the price in our setting is randomly determined and varies widely between periods, this might lead to moral licensing in the sense that having a "bad draw" in a previous round could be used as an excuse for the buyer for choosing not to compensate in a given round. While we cannot fully rule out this explanation for the patterns we observe, we note that a recent study by Bartling et al. (2021b) finds that income increases also lead to increases in the purchases of socially responsible goods and thus a price sensitivity of moral behavior.

Furthermore, we find that diffused responsibility for the creation of the negative externality reduces the amount given to compensation and thus significantly raises net externalities. At the same time, contrary to our initial hypothesis, we do not find a significant effect of diffused harm – neither on the propensity to buy nor on compensation behavior relative to the baseline condition. The question is then why one type of diffusion decreases voluntary compensation in our setting while the other type of diffusion does not. With our data, we can rule out one possible explanation for lack of an effect in *DiffusedHarm* based on the perceived costs of the externality. In principle, the observation that diffused harm does not lead to an increase in externalities could be explained by the fact that subjects base their decisions on a concave social cost function for the externality. In this case, imposing the 120 sliders on two harmed parties would lead to a higher total damage than imposing 240 sliders on one harmed party. Yet, calculating the average willingness to pay to remove different levels of the externality (60, 120, 180 and 240 sliders), we find no evidence for a concave aggregate social cost function. In fact, the aggregate social cost function appears to be convex, suggesting that the total perceived harm of 240 slides is lower when imposed on two subjects rather than when imposed on one subject only.[14] At the same time, a possible reason why diffusion of harm did not deteriorate social responsibility in our setting might be that the harm is not diffused enough to induce "compassion fade", given that we impose the externality on only two subjects, and not on a larger group. Still, our findings are in line with the results of Bartling et al. (2019) who find only weak evidence for diffusion of harm on the market share of a good without

[14] The average social cost function in our setting is convex, as 0.67*WTP(60) + 0.33*WTP(240) > WTP(0.67*60+ 0.33*240) and 0.33*WTP(60) + 0.67*WTP(240) > WTP(0.33*60+ 0.67*240)

an externality when comparing one versus six subjects who have to bear the externality.

Finally, our result that diffusion of responsibility among buyers leads to a decrease in voluntary compensation for the creation of negative externalities is in line with results on responsibility diffusion in settings focusing on moral and altruistic behavior. The necessary next step would then be to identify effective measures to increase prosocial behavior in the presence of responsibility diffusion, as is the case with voluntary CO_2 compensation. Given the evidence that the willingness to pay to offset CO_2 emissions or to mitigate climate change in the field in the absence of interventions is only low, more research into measures that induce higher voluntary payments in this area is required.

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Appendix A. Experimental Instructions

Below we include the full experimental instructions for the treatment condition *NoDiffusion*. Instructions for the other treatments were formulated in a similar way. We handed out the different parts of the instructions only once they were relevant.

I

General Instructions

Welcome to this experiment! In this experiment, you can earn money depending on the choices that are made by you and/or the other participants during the experiment. Therefore, please read the instructions carefully to make sure that you understand what decisions you can take and what the consequences of these decisions are. Your decisions during the experiment are entirely anonymous. If you have any questions about the instructions or during the experiment, please raise your hand and the experimenter will come to you to answer your question in private.

During the study, you are not allowed to talk to the other participants. Please also respect that no drinks or food are allowed inside the lab. Please switch off your mobile phone now.

Throughout the experiment, we will not talk of Euros but instead of points, you can earn. This means that your entire earnings will be, at first, calculated in points. At the end of the experiment, we will calculate your earnings in Euros, according to the following exchange rate

10 points = 2,50 Euro.

The experiment consists of three parts. The first part consists of one work task, which is followed by four rounds of a decision task. The second and third part then consist of twelve rounds each. In each of these rounds, you will face one decision task. At the end of the experiment, one of these 28 rounds (4 rounds from part 1 + 12 rounds from part 2 + 12 rounds from part 3) will be randomly selected, with each round being equally likely. The points resulting from the choices of the participants in this randomly selected round will be converted to Euro and paid out to you. No other participant will be informed about what you earn.

In the following, you find the instructions for the working task of the first part of the experiment. At the end of the work task, we will distribute the instructions for the decision task of part 1. The instructions for the second part of the experiment will be distributed after the end of the first part. At the end of the second part of the experiment, you will receive the instructions for the third part.

If you have understood this part of the instructions, please go on to the next page to read the instructions for the work task of part 1.

Instructions Part 1

The work task

The work task you have to solve is called slider task. In the slider task, a set of sliders is presented on your screen. You can adjust the slider to any number between 0 and 100 by clicking on the slider with your mouse and dragging it to the desired position. Your task is to drag the slider to the target position. The target position for each slider is the number 50. The red number on the right hand side of the slider tells you the current position of your slider. A slider is correctly adjusted when the current position is equal to 50.

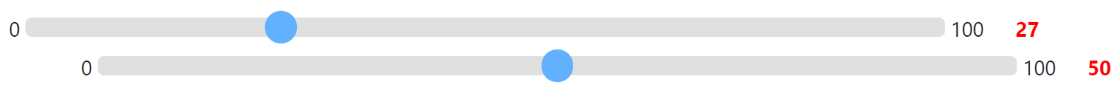

Figure 1 Two example sliders

For example, in the upper slider, the current position of the slider is 27. The slider is therefore not correctly placed yet. In the second example, you can see that the slider is correctly placed, as the position of the slider is directly at the target position. All sliders you have to solve will be displayed on one screen.

In the first part of the experiment, we ask you to solve 120 sliders to proceed to the next part of the experiment. You receive an initial payment of 100 points for working on the task.

Depending on the decisions you make in the four rounds of the decision task, your payment for part 1 of the experiment might differ from these 100 points, as will be explained after you have finished the slider task.

Do you still have any questions? If so, please raise your hand. We will then come to your seat to answer your question in private. If all the instructions are clear, please wait until we give you the password, which allows you to proceed.

I

Instructions Part 1

The decision task

Your initial payment for working on the slider task is 100 points.

In four rounds, we ask you now to state **the maximum number of points (between 0 points and 100 points) you are willing to pay** in order to avoid that you have to solve even more sliders at the end of the experiment.

In each round, a number X between 0 and 100 is drawn at random for each participant. Each number is equally likely to be drawn.

- If the number of points you stated is **greater than or equal to this randomly drawn number X, then you will pay X points**. In this case, you will not have to solve extra sliders at the end of the experiment. Instead, if the particular round is selected, we will give you your payoff for this round and you can leave the laboratory early. Your payoff for the round will then be:

  100 points – X points

- If the number of points you stated is **smaller than this randomly drawn number X, then you will keep the full 100 points from the working task**. However, you will then have to solve extra sliders at the end of the experiment, if the particular round is selected. Your payoff for the round will then be:

  100 points

Thus, the higher your answer in a given round, the lower the probability that you will have to solve additional sliders at the end of the experiment.

- In the first round, we ask for the maximum number of points you are willing to pay to avoid 60 more sliders.
- In the second round, we ask for the maximum number of points you are willing to pay to avoid 120 more sliders.
- In the third round, we ask for the maximum number of points you are willing to pay to avoid 180 more sliders.
- Finally, in the fourth round, we ask for the maximum number of points you are willing to pay to avoid 240 more sliders.

Note that your answer in a given round must be at least as high as or higher than the number, you stated in the round before.

Do you still have any questions? If so, please raise your hand. We will then come to your seat to answer your question in private. If all the instructions are clear, please wait until we give you the password, which allows you to proceed.

Instructions Part 2

There are two types of participants in part 2: Person A and Person B. The roles of Person A and Person B will be randomly assigned prior to the start of this part of the experiment. Each participant will keep her role throughout the second part.

Person A acts in the role of a buyer. Person B does not make a decision herself but can be affected by the buying decision of Person A.

Part 2 comprises 12 rounds. In every round, one Person A will be randomly matched with one Person B. It is ensured that the same Person As and Person Bs will never interact with each other in two consecutive rounds.

The decision task

Person A's decision

In each round, Person A and Person B are endowed with 75 points. Person A must then decide whether or not she wants to buy a fictitious product. Getting the product is worth 100 points to Person A. This means that when Person A decides to buy the product, she will receive an additional 100 points.

If Person A decides to buy the product, she has to pay the price for the product. The price is randomly determined in every round and can range between 1 and 100 points. Every price is equally likely.

If Person A decides to buy the product, this has consequences for the Person B she is matched with. If Person A buys the product, Person B will have to work on a task: At the very end of the experiment, after Person A has received her payoff for the experiment and left the laboratory, Person B will have to stay longer in the laboratory and solve altogether 240 sliders of the slider task in order to receive her payoff. The slider task will work exactly like in the first part of the experiment.

If, on the other hand, Person A decides not to buy the product, both Person A and Person B will keep their 75 points endowment, and Person B does not have to work on the slider task at the end of the experiment.

I

Payoffs

The payoffs in points in each round are determined as follows:

Person A's payoff:

If Person A decides to buy the product,

- Person A will get the 75 points she was endowed with. Additionally, she will get the 100 points the product is worth to her and pay the price of the product. Hence, Person A's payoff is

$$75 + 100 - price$$

If Person A decides not to buy the product,

- Person A will get the 75 points she was endowed with.

Person B's payoff:

If Person A decides to buy the product,

- Person B will get the 75 points endowment only if she solves 240 sliders in the slider task at the end of the experiment, after Person A has left the laboratory. If she does not solve 240 sliders in the slider task, she will not get any payoff.

If Person A decides not to buy the product,

- Person B will get the 75 points she was endowed with.

Once Person A has made her choice, a round ends and Person B is informed of the choice of Person A in the current round. After that, Person A is matched to a different Person B and the next round starts.

At the end of the experiment, we will start with the payment of those participants who do not have to solve any sliders. Every participant who has received her payment can leave the laboratory. Participants, who have to solve sliders, will work on the task and be paid afterwards.

<u>Illustrative Example 1</u>

Suppose the price of the product is 30 points in a given round. Person A decides to buy the product for the current price of 30 points. The final payoff in this round for Person A is therefore 145 points (= 75 points endowment + 100 points value of the good – 30 points price of the good). The final payoff in this round for Person B is 75 points. Additionally, Person B has to solve 240 sliders in the slider task at the end of the experiment to receive her payoff.

<u>Illustrative Example 2</u>

Assume now that the price of the product is 57 points in a given round. Person A decides not to buy the product. The final payoff in this round for Person A is therefore 75 points (= endowment). Person B's final payoff will be 75 points and she does not have to solve any sliders at the end of the experiment.

Do you still have any questions? If so, please raise your hand. We will then come to your seat to answer your question in private. If all the instructions are clear, please wait until we give you the password, which allows you to proceed with a few comprehension questions on the screen.

I

Instructions Part 3

Part 3 comprises 12 rounds. You keep the role you were assigned in part 2 (Person A or Person B) also in this part.

In every round, one Person A will be randomly matched with one Person B. It is ensured that the same Person As and Person Bs will never interact with each other in two consecutive rounds.

The decision task

In this part of the experiment, the decision task consists of two stages. The first stage is the same as the decision task in part 2. In this part of the experiment, however, there will be a second stage if Person A decides to buy the product in the first stage.

Person A's decision

Stage 1

As in part 2, Person A and Person B will be endowed with 75 points in each round. Person A must then decide whether or not she wants to buy a fictitious product. Getting the product is, again, worth 100 points to Person A. This means that when Person A decides to buy the product, she will receive an additional 100 points.

If Person A decides to buy the product, she has to pay the price for the product. The price is randomly determined in every round and can range between 1 and 100 points. Every price is equally likely.

As in part 2, if Person A decides to buy the product, this has consequences for the Person B she is matched with. If Person A buys the product, Person B will have to work on a task: At the very end of the experiment, after Person A has received her payoff for the experiment and left the laboratory, Person B will have to stay longer in the laboratory and solve altogether 240 sliders of the slider task in order to receive her payoff.

If, on the other hand, Person A decides not to buy the product, both Person A and Person B will get their 75 points endowment, and Person B does not have to work on the slider task at the end of the experiment.

Stage 2

If Person A decided to buy the good in stage 1, she enters stage 2. In stage 2, Person A can decide to use points of her payoff to reduce the number of sliders Person B has solve at the end of the experiment. Specifically, for each point Person A spends, Person B has to solve 8 fewer sliders.

I

Payoffs

The final payoff in one round depends on Person A's choice in stage 1 and stage 2. The payoffs in points in each round are determined as follows:

Person A's payoff:

If Person A decides to buy the product,

- Person A will get the 75 points she was endowed with. Additionally, she will get the 100 points the product is worth to her and pay the price of the product. Moreover, she has to pay the points she decided to spend in order to reduce the number of sliders for Person B. Hence, Person A's payoff is

$$75 + 100 - price\ - points\ spent\ to\ reduce\ number\ of\ sliders\ for\ Person\ B$$

If Person A decides not to buy the product,

- Person A will get the 75 points she was endowed with.

Person B's payoff:

If Person A decides to buy the product,

- Person B will get the 75 points endowment only if she solves

$$(240 - 8 \text{ x } points\ spent\ by\ Person\ A)$$

  sliders in the slider task at the end of the experiment, after Person A has left the laboratory. If she does not solve the sliders in the slider task, she will not get any payoff.

If Person A decides not to buy the product,

- Person B will get the 75 points she was endowed with.

Once Person A has made her choice, a round ends and Person B is informed of the choice of Person A in the current round. After that, Person A is matched to a different Person B and the next round starts.

At the end of the experiment, we will start with the payment of those participants who do not have to solve any sliders. Every participant who has received her payment can leave the laboratory. Participants, who have to solve sliders, will work on the task and be paid afterwards.

<u>Illustrative Example 1</u>

Suppose the price of the product is 10 points in a given round. Person A decides to buy the product, which gives her a payoff of 165 points (= 75 points endowment + 100 points value of the product – 10 points price of the product). Since Person A bought the product, Person B will have to solve 240 sliders in the slider task at the end of the experiment to receive her payoff.
Person A decides to use 10 points of her payoff to reduce the number of sliders by 80 sliders (= 8 sliders per point x 10 points). Instead of 240 sliders, Person B therefore has to solve 160 sliders (= 240 sliders – 80 sliders) at the end of the experiment in order to get a payoff of 75 points. Person A's final payoff in this round is thus 155 points (= 165 points from stage 1 – 10 points from stage 2).

I

Illustrative Example 2

Suppose now the price of the product is 50 points in a given round. Person A decides to buy the good, which gives her a payoff of 125 points (= 75 points endowment + 100 points value of the product – 50 points price of the product). Therefore, Person B will have to solve 240 sliders at the end of the experiment to receive her payoff.
Suppose now that in stage 2, Person A decides to use 30 points of her payoff to reduce the number of sliders by 240 sliders (= 8 sliders per point x 30 points). Instead of 240 sliders, Person B therefore has to solve no sliders (= 240 sliders – 240 sliders) at the end of the experiment to get a payoff of 75 points. Person A's final payoff in this round will be 95 points (= 125 points from stage 1 – 30 points from stage 2).

Illustrative Example 3

Suppose now the price of the product is 23 points in a given round. Person A decides to buy the good, which gives her a payoff of 152 points (= 75 points endowment + 100 points value of the product – 23 points price of the product). Therefore, Person B will have to solve 240 sliders at the end of the experiment to receive her payoff.
Suppose now that in stage 2, Person A decides not to use any points of her payoff to reduce the number of sliders for Person B. Therefore, Person B has to solve the full 240 sliders at the end of the experiment to get a payoff of 75 points. Person A's final payoff in this round will be 152 points (= 152 points from stage 1 – 0 points from stage 2).

Do you still have any questions? If so, please raise your hand. We will then come to your seat to answer your question in private. If all the instructions are clear, please wait until we give you the password, which allows you to proceed with a few comprehension questions on the screen.