Social Interaction Effects: The Impact of Distributional Preferences on Risky Choices*

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Abstract

This paper identifies convex distributional preferences as a possible cause for the empirical observation that agents belonging to the same group tend to behave similarly in risky environments. Indeed, convex distributional preferences imply social interaction effects in risky choices in the sense that observing a peer to choose a risky (safe) option increases the agent's incentive to choose the risky (safe) option as well, even when lotteries are stochastically independent and the agent can only observe the lottery chosen by the peer but not the corresponding outcome. We show this theoretically and confirm our theoretical predictions experimentally.

Keywords: Peer Effects, Social Interaction Effects, Social Preferences, Risky Choices

JEL Classification: C91, D03, D63, D64, D81

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1 Introduction

People mostly act in social contexts rather than isolation, and thus social comparison – that is, comparison with what others do or achieve in similar situations – is typically part of an individual's decision making process. A possible consequence of social comparison is that a decision maker (DM, he) makes his choice dependent on what he observes others in his reference group do. We shall refer to the latter as a *social interaction effect* if (i) the dependence is positive, i.e. if the DM's propensity to choose a given activity is higher when (more) peers engage in the corresponding activity; and (ii) the dependence results from an increase in the DM's utility payoff but not his material payoff when (more) peers engage in the corresponding activity.[1] Social interaction effects have been invoked to explain correlations in risky choices in a great variety of different domains, for instance, in savings and investment decisions (see, e.g., Madrian and Shea 2001, Kelly and Gráda 2000, Duflo and Saez 2002 and 2003, or Hong et al. 2004), in employment choices (see Araujo et al. 2007), in college entry and schooling decisions (see Fletcher 2006, or Lalive and Cattaneo 2009), in hospital choices (see Moscone et al. 2012), in shirking behavior on the workplace (Ichino and Maggi 2000), in substance use (Amuedo-Derantes and Mach 2002), in drinking and smoking behavior (Jones 1994 and Fletcher 2010) and in criminal activity (Glaeser et al. 1996 and 2003, Katz et al. 2001, Ludwig et al. 2001, Kling et al. 2005).

Social comparison might not only affect decision making in risky environments, it is also a core element of some prominent models of *distributional preferences.* Such models have been developed in response to a large body of empirical evidence

[1] There are several reasons for which a positive correlation between a DM's choice and the observed peers' choices may not meet part (ii) of our definition. For instance, if there are *informational externalities,* the DM can learn something about the consequences of a given choice by observing his peers' behavior possibly leading to correlation in decisions, even though both the DM's material and his utility payoff of a given choice are unaffected by the peers' choices, as in the literature on social learning (or herd behavior, or informational cascades; see, for example, Banerjee 1992, Bhikchandani et al. 1992, Lee 1993, Smith and Sorenson 2000, and Vives 1997; Gale 1996 surveys some of the literature). Or, if there are direct *material-payoff complementarities*, an action becomes more profitable for the DM in material terms if others choose the same action– as, for instance, in the models studied in the network externality literature (see Farrell and Saloner 1985, Katz and Shapiro 1985 and 1986, and Liebowitz and Margolis 1990, among others). Finally, *correlation of individual characteristics* and *influence of* group characteristics or of *a common environment* on behavior might lead to a positive correlation in decisions (see Manski 1993 for a discussion).

showing that observed behavior in the lab and the field is inconsistent with the joint hypothesis that all individuals are rational and exclusively interested in their own material payoff (and that this fact is common knowledge). Their defining feature is that DMs care not only about their own (material) well-being, but also about the (material) well-being of others.[2]

For distributional archetypes whose general attitude towards others (i.e., benevolence, neutrality, or malevolence) depends on whether others have a higher or lower monetary payoff compared to themselves, social comparison is an indispensable ingredient. Preferences featuring inequality or inequity aversion (Fehr and Schmidt 1999, Bolton and Ockenfels 2000) have this property, as do maximin (Charness and Rabin 2002, Engelmann and Strobel 2004) or Leontief preferences (Andreoni and Miller 2002, Fisman et al. 2007) and envy (Bolton 1991, Kirchsteiger 1994, Mui 1995). In principle, other archetypes could be modelled without any reference to social comparison. For instance, altruism (Becker 1974, Andreoni and Miller 2002) and surplus maximization (Engelmann and Strobel 2004), as well as spite (Levine 1998) and concerns for relative income (Duesenberry 1949) may simply be modelled using an affine function by putting a constant weight on the material payoff of another person independent on the size of one's own and the other's material payoff. However, even for those archetypes there is ample empirical evidence indicating that social comparison influences behavior. For instance, in their pathbreaking experimental investigation on whether subjects' behavior in dictator games is consistent with the General Axiom of Revealed Preference, Andreoni and Miller (2002) find that the choices of a large majority of givers are consistent with convex altruistic preferences. Similarly, Kerschbamer (2015) reports that almost all subjects reveal (weakly) more benevolent (less malevolent) preferences in the domain of advantageous than in the domain of disadvantageous inequality – a pattern implied by convex distributional preferences. *Convexity* here refers to the property that a DM's benevolence towards another individual increases (or that malevolence decreases) as the income of the other individual decreases along an indifference curve, and its strict incarnation obviously calls for

[2]The fact that only material payoffs enter a DM's utility function distinguishes distributional preference models from other models of other-regarding concerns; the latter include arguments such as others' expected or observed behavior, others' payoff expectations or others' other-regarding concerns.

social comparison.[3]

Convex distributional preferences have been invoked as potential explanation for non-standard behavior in important market and non-market environments – see Sobel (2005) and Fehr and Schmidt (2006) for excellent surveys of theoretical models and empirical evidence, and Cox et al. (2008) for an elegant theoretical investigation of the implications of convexity. The main focus of previous studies, however, has been on deterministic choices, while the effects of distributional preferences on behavior when choices are risky have found much less attention in the literature.

The novelty of this paper is to bring social interaction effects and distributional preferences together in a framework where the consequences of choices are risky and where lotteries are stochastically independent. More specifically, our main research question is whether and how the behavior of a DM with a concern for the material welfare of others is affected when risky choices are made in context where the DM has the possibility to observe the choices of others in similar situations before making a decision. Our main theoretical result is that convex distributional preferences imply social interaction effects in risky choices. In particular, when a DM has convex distributional preferences and knows that a reference person (the "peer") chooses a risky or safe option, following the peer's choice increases the DM's utility payoff while his material payoff remains unaffected. We show this for a situation in which the DM and the peer face independent lotteries and the DM can only observe the peer's choice but not the corresponding outcome. The intuition for this result is that with convex distributional preferences an increase (decrease) in the material payoff of a peer increases (decreases) the relative weight the DM puts on own income. This introduces an asymmetry in the evaluation of unequal outcomes and thereby gives an incentive to behave similarly in risky environments.

To obtain support for our theoretical predictions, we search empirically for social interaction effects in the risky environment studied in the theory part of

[3]Here and throughout the paper *convexity* refers to the shape of upper counter sets. Considering a two person context, where m denotes the DM's own and o the peer's material payoff, and assuming that the DM's well-being is strictly increasing in m, upper contour sets are to the right of the DM's indifference curves in (m, o)-space. Increasing benevolence (or decreasing malevolence) as o increases (that is, as one moves southward) along an indifference curve is then equivalent to convexity of upper contour sets (see Cox et al. 2008 for details).

the paper. Even though there is a large empirical literature on social interaction effects in risky choices, most existing studies are based on field data suffering from severe identification problems, as was pointed out in the seminal paper by Manski (1993). We therefore set up our empirical investigation as a laboratory experiment, as such experiments allow for more control than other data sources. More specifically, since we are interested in the impact of information regarding a peer's decisions on a DM's choices in a risky environment without informational externalities and material payoff complementarities, the ideal data source would contain observations of the same DM's choices in two such environments which differ only in the DM's information regarding the action choice of the peer. While it seems almost impossible to get such data points in the field, in a lab experiment we can create an artificial environment that generates such points.

In our experiment, we compare the choices of subjects in two risky environments that differ only in the information regarding the choices of a peer. We find large peer group effects in the aggregate data even though a subject's decision has no impact on the peer's monetary payoff, lotteries are stochastically independent, and the subject can only observe the lottery chosen by the peer but not the corresponding outcome. The problem of correctly identifying the relevant reference group of the subject is circumvented by providing only information about the behavior of a *single* peer. Since information externalities and material payoff complementarities are absent in the implemented environment, these potential sources for a positive correlation in the choices of the subject and the peer cannot explain our data. The fact that we observe the behavior of the *same* subject in two different environments in a within-subject design controls for self-selection and exogenous correlation of individual characteristics, and the fact that the two environments differ only in the information about the peer's decisions excludes contextual and correlated effects as possible explanations. We therefore conclude that social interaction effects caused by convex distributional preferences are a plausible source for the observed correlation between the risky choices of DMs and their peers in the aggregate data.

In risky environments, conformity has often been quoted as an explanation for differences between individual decision making and decisions within groups or with peers (see e.g. Bolton et al. 2015, Kocher et al. 2013, or Lahno and Serra-Garcia 2015). As Cialdini and Goldstein (2004) put it, "conformity refers to the act of changing one's behavior to match the responses of others." Defined that way, conformity is not a motivation but rather an observed behavior based on some other underlying motivation. Thus, while it might be called conformity what we observe, we provide an explanation for the observed behavior based on existing models of preferences. Specifically, in the theory part of the paper we show that existing models of social preferences imply a motive for conformist behavior when distributional preferences are convex; and in the experimental part we provide results that document social interaction effects in risky choices.

To obtain further evidence in support of our hypothesis that social interaction (or conformity) effects are driven by convex distributional preferences, we also test our main predictions on the individual level. Using a non-parametric procedure to classify subjects regarding their distributional preferences, we find that social interaction effects are more pronounced for subjects with convex than for subjects with linear distributional preferences – which corresponds to the theoretical prediction. We also find some evidence in support of the theoretical prediction that the size of the social interaction effect is smaller for risk-neutral DMs than for risk-averse or risk-loving ones.

The rest of the paper is organized as follows. Section 2 discusses the related literature. Section 3 introduces the model and derives the theoretical results. Section 4 details the design, the predictions and the results of our experiment and compares the actual choices in the lab to the predicted behavior. Section 5 concludes.

2 Related Literature

In discussing related research we distinguish three dimensions that are relevant for the influence of social comparison on choices in risky environments: (1) Does the choice of the DM affect the material payoffs of other agents? We refer to this as the *material externalities* dimension, the two extremes being "no externalities" and "the DM chooses the lottery for other agents". (2) If two or more agents choose the same lottery, are the outcomes of the lotteries stochastically dependent of each other? We refer to this as the *stochastic dependence* dimension, the two extremes being "individual gambles" (lotteries are stochastically independent) and "common gambles" (there is perfect positive correlation in realized outcomes). (3)

Does the DM observe only the choice of the peer or also the outcome of this choice before making his own decision? This latter dimension is referred to as the *information on outcomes* dimension, the two extremes being no information and perfect information on the peer's payoff. Our focus in this paper will be on a setting with (1) *no material externalities*; (2) *no stochastic dependence* of lotteries; and (3) *no information on outcomes*.

We are aware of only one study investigating a constellation that is similar to ours in all three of the mentioned dimensions: In Cooper and Rege (2011) subjects face individual gambles that differ in their ambiguity – for 'simple' gambles subjects receive graphical information on the probabilities of the different outcomes, for others they receive almost no information on probabilities; in both cases a subject's choice has no impact on the material payoffs of other subjects and different treatments control for a subject's information regarding the choices of his peers. Cooper and Rege find large peer group effects in their aggregate data and present an explanation for these effects based on "social regret". While the "regret" part of their theory refers to a disutility experienced by the DM when a non-chosen action would have led to higher payoffs ex post (as in "regret theory" proposed by Bell 1982, Fishburn 1982, and Loomes and Sugden 1982), the "social" part of their model is reflected in the assumption that regret is less intense if others have chosen the same action. Social regret then yields the result that observing a peer make a risky (safe) choice increases the incentive for the DM to choose the risky (safe) option as well. By contrast, we derive social interaction effects in a risky environment directly from existing models of distributional preferences and test the theoretical prediction both with aggregate data and on the individual level.

The field experiment by Bursztyn et al. (2014) and the lab experiment by Lahno and Serra-Garcia (2015) also document peer effects in risk taking, however, in contrast to our setting with individual gambles, those studies investigate scenarios with common gambles. In a high-stakes field experiment involving the purchase of an asset, Bursztyn et al. implement a clever experimental design aimed at separately identifying the impact of two potentially important drivers for peer effects in financial decision making – "social learning" and "social utility". Specifically, their design randomizes (i) whether a peer who reveals the intention to purchase the asset has that choice implemented; and (ii) whether the DM paired with the peer receives no information about the peer, or is informed about the peer's desire to purchase the asset and the result of the randomization that determines possession. This allows the authors to separately identify the joint impact of learning and possession and the impact of learning alone, compared to the no-info control. The authors find that both social learning and social utility have an important impact on investment choices. However, their design does not – and is not intended to – allow for discrimination between different potential explanations for the observed social utility effect. In this respect, our study is complementary by (i) theoretically showing that convex distributional preferences produce social interaction (or "social utility") effects; and (ii) experimentally providing evidence in support of the hypothesis that this channel is important for risky choices. Lahno and Serra-Garcia (2015) also try to disentangle different channels for peer effects. Having the peer actively choose a lottery in one treatment while randomly assigning a lottery choice to the peer in another treatment allows them to distinguish between conformism and social preferences as possible explanations for the observed peer effects. Their results suggest that both channels contribute to the observed peer effects.

Other studies on risk taking in a social context investigate substantially different research questions and environments: Corazzini and Greiner (2007) study whether inequality aversion can explain herding behavior in a social learning environment with common gambles; Linde and Sonnemans (2012) ask whether and how the payoff (rather than the decision) of a peer affects risk taking when the peer's payoff is fixed either at a higher or a lower level than all possible lottery outcomes; and Bolton and Ockenfels (2010), Güth et al. (2008) and Brennan et al. (2008) investigate situations where DMs' choices produce material externalities for their peers (in the sense that they affect timing, risk or expected values of their payoffs).

3 Theoretical Model

3.1 Basic Model: Risk Neutrality in Isolation

Our workhorse model throughout the theory part of the paper is the piecewise linear utility or motivation function originally introduced by Fehr and Schmidt (1999) as a description of self-centred inequality aversion and later extended by

Charness and Rabin (2002) to allow for other forms of distributional concerns. For simplicity, we concentrate on the case of two agents and two binary lotteries in the main text, deferring the more general case with more than two agents and more than two lotteries to Appendix A. For the two-agents-case, the reciprocity-free version of the Charness and Rabin model reads

$$u_{\rho,\sigma}(m,o) = (1 - \sigma I_{m\leq o} - \rho I_{m>o})m + (\sigma I_{m\leq o} + \rho I_{m>o})o,$$

where m (for "my") stands for the material payoff of the DM, and o (for "other's") for the material payoff of the peer, and where ρ and σ are two parameters of the model for which we assume $\rho < 1$ and $\sigma < 1$ to guarantee strict monotonicity of utility in own material payoff. Note that this functional form is equivalent to the more familiar form

$$u_{\rho,\sigma}(m,o) = \begin{cases} m + \sigma(o-m) & for \quad o \geq m \\ m + \rho(o-m) & for \quad o < m \end{cases} \quad \forall\ \sigma < 1, \rho < 1. \tag{1}$$

Depending on the relation between the two parameters ρ and σ we distinguish between the following three cases:

(i) $\rho > \sigma$: under this condition the functional form above implies indifference curves in the (m,o)-space that are convex; preferences satisfying this condition are therefore referred to as *convex distributional preferences*;

(ii) $\rho = \sigma$: under this condition indifference curves in the (m,o)-space are linear; preferences satisfying this condition are therefore referred to as *linear distributional preferences*;

(iii) $\rho < \sigma$: under this condition indifference curves in the (m,o)-space are concave; preferences satisfying this condition are therefore referred to as *concave distributional preferences.*

Convex indifference curves in the (m,o)-space imply that the DM is more benevolent (or less malevolent) in the domain of advantageous compared to the domain of disadvantageous inequality. Many well-known distributional preference models – such as inequity or inequality aversion, envy, as well as maximin, Rawlsian or Leontief preferences – necessarily have this property, while some less prominent ones – such as equity or equality aversion – necessarily violate it.[4] Altruism, surplus

[4] A DM is inequity or inequality averse if he incurs a disutility when other agents have either

maximization and social welfare maximization, as well as spiteful or competitive preferences and concerns for relative income may or may not have this property.[5]

Suppose now a DM with preferences represented by the utility function (1) faces the choice between the two lotteries L_r ("riskier") and L_s ("safer"). L_r yields outcome x_r with probability p_r and zero with probability $1 - p_r$, and L_s yields outcome x_s with probability p_s and zero with probability $1 - p_s$, where $x_r > x_s$ and $p_r < p_s$ (note that we allow for $p_s = 1$). Throughout we assume that when both agents – DM and peer – choose the same lottery, each agent faces idiosyncratic risk, as our main research question is how the mere observation of the peer's choice affects the DM's decision between the two lotteries. Our first result summarizes how the DM's risk attitudes are affected by social comparisons.

Proposition 1. ***(Distributional Preferences and Risk Attitudes with Risk-Neutrality in Isolation)*** *Suppose the preferences of a DM can be represented by a utility function as defined in Eq. (1). Then the DM displays the following behavior in a social context:*

(i) Given that the DM observes the peer choose lottery L_r, he makes a risk-neutral choice independently of whether his distributional preferences are convex, linear, or concave.

(ii) Given that the DM observes the peer choose lottery L_s, he makes a risk-averse choice if his distributional preferences are convex, a risk-neutral choice if his distributional preferences are linear, and a risk-loving choice if his distributional

higher or lower payoffs; in the piecewise linear two-player framework above this translates to the parameter restriction *min* $\{-\sigma, \rho\} > 0$, with the special case of $-\sigma \geq \rho > 0$ for the Fehr and Schmidt model. For an envious DM, utility decreases in the payoffs of agents who have more but is unaffected by the payoffs of agents who have less, which implies $-\sigma > \rho = 0$. The utility of a DM with maximin preferences, Rawlsian preferences, or Leontief preferences increases in the lowest of all agents' payoffs, which in the present framework requires $\rho > \sigma = 0$. Note that all distributional archetypes mentioned up to now fit into the parameter restriction $\rho > \sigma$. This is not the case with equity aversion (Charness and Rabin 2002), or equality aversion (Hennig-Schmidt 2002), which are characterized by benevolence in the domain of disadvantageous and malevolence in the domain of advantageous inequality, thus implying *min* $\{\sigma, -\rho\} > 0$, and therewith $\rho < \sigma$. See Kerschbamer (2015) for details.

[5] The utility of an altruistic DM increases in the payoffs of other agents, the utility of a surplus maximizing DM as well as that of a DM with social welfare preferences increases in the (weighted or unweighted) sum of payoffs; thus, in all those cases, well-being increases in o everywhere implying the parameter restriction *min* $\{\sigma, \rho\} > 0$. A DM is spiteful, competitive, status-seeking or interested in relative income if his well-being decreases in the payoffs of others everywhere, which implies *max* $\{\sigma, \rho\} < 0$.

preferences are concave.

Proof. Let u_{ln} denote the DM's expected utility when he chooses lottery L_l, with $l = r, s$, while his peer chooses L_n, with $n = r, s$. That is, u_{rr} denotes the DM's expected utility when both agents choose L_r, u_{rs} denotes the DM's expected utility when the DM chooses L_r while the peer chooses L_s, etc. Then we have

$$
\begin{aligned}
u_{rr} &= p_r^2 x_r + p_r(1-p_r)(x_r - \rho x_r) + (1-p_r)p_r \sigma x_r; && (2)\\
u_{rs} &= p_r p_s[x_r - \rho(x_r - x_s)] + p_r(1-p_s)(x_r - \rho x_r) + (1-p_r)p_s \sigma x_s; && (3)\\
u_{sr} &= p_s p_r[x_s + \sigma(x_r - x_s)] + p_s(1-p_r)(x_s - \rho x_s) + (1-p_s)p_r \sigma x_r; && (4)\\
u_{ss} &= p_s^2 x_s + p_s(1-p_s)(x_s - \rho x_s) + (1-p_s)p_s \sigma x_s. && (5)
\end{aligned}
$$

For (i), suppose the peer chooses the riskier lottery L_r. Then the DM prefers L_s to L_r if and only if $u_{sr} > u_{rr}$, which simplifies to

$$p_s x_s[1 - \rho + p_r(\rho - \sigma)] \quad > \quad p_r x_r[1 - \rho + p_r(\rho - \sigma)]. \tag{6}$$

It is now straightforward to verify that independent of whether the DM has convex, linear, or concave distributional preferences the term in brackets is strictly positive. For convex distributional preferences this follows directly from $\rho < 1$ and $\sigma < \rho$, for the linear case it follows from $\rho < 1$ and $\sigma = \rho$. For concave distributional preferences note that $1 - \rho + p_r(\rho - \sigma) > 0$ can be restated as $1 - \sigma p_r > \rho(1 - p_r)$, and that the LHS of the latter condition is decreasing in σ and has its infimum at $1 - p_r$, while the RHS is increasing in ρ and has its supremum at $1 - p_r$. Thus, for all three considered cases of distributional preferences, condition (6) is equivalent to $p_s x_s > p_r x_r$, implying that if the peer chooses the riskier lottery, the DM chooses the lottery with the higher expected value, i.e. his choice is independent of the distributional parameters σ and ρ.

For (ii), suppose that the peer chooses the safer lottery L_s. Then the DM prefers L_s over L_r if and only if $u_{ss} > u_{rs}$, which simplifies to

$$\frac{\rho - \sigma}{1 - \rho} \quad > \quad \frac{p_r x_r - p_s x_s}{p_s x_s(p_s - p_r)}. \tag{7}$$

For a DM with convex distributional preferences the LHS is strictly positive since $\sigma < \rho < 1$, for a DM with linear distributional preferences the LHS is zero since

$\sigma = \rho < 1$, and for a DM with concave distributional preferences the LHS is strictly negative since $\rho < \sigma < 1$. Thus, as long as the safer lottery has the higher expected value, a DM with convex distributional preferences prefers it. He may even prefer the safer lottery with a lower expected value, as long as it is not too much lower than that of the riskier lottery, where the exact condition is specified by Eq. (7). He thus makes a risk-averse choice in a social context, even though he was assumed to be risk-neutral in isolation. The argument for the other two cases is similar. □

Proposition 1 shows that social comparisons affect the risky choices of a DM with non-linear distributional preferences even when the DM is an expected-value maximizer when acting in isolation. Social information can thus be an independent source driving risky choices. Proposition 1 has several important implications. An immediate one is that the well-known inequality aversion model of Fehr and Schmidt (1999) – which corresponds to the parameter restrictions $\rho > 0 > \sigma$ and $-\sigma \geq \rho$ in the functional form (1) – implies risk averse behavior in a social environment when the peer chooses the safer of two lotteries, even though risk neutrality is assumed when acting in isolation. The same is true for the quasi-maximin model of Charness and Rabin (2002) – which corresponds to the parameter restriction $\rho > \sigma > 0$ in (1) – and for many other distributional preference models in use in experimental economics and beyond. This is an important insight because it might help explain why subjects in the lab tend to behave in a risk-averse manner despite the low stakes involved. As Rabin (2000) and Rabin and Thaler (2001) have convincingly argued, this is a paradox within expected utility theory because anything but virtual risk-neutrality over small stakes implies an absurd degree of risk-aversion over large stakes. Since the overwhelming majority of DMs who are not exclusively interested in the maximization of their own material income has convex distributional preferences (for experimental evidence see, e.g., Fehr and Schmidt 1999, Bolton and Ockenfels 2000, Andreoni and Miller 2002, Charness and Rabin 2002, Engelmann and Strobel 2004, Fisman et al. 2007, or Cox and Sadiraj 2007), Proposition 1 predicts risk-averse behavior, on average, even if all subjects would behave in a risk-neutral manner in isolation. Thus, this result can potentially help to reconcile plausible degrees of risk-aversion over large stakes with nontrivial risk-aversion over small stakes.

Our next result summarizes the impact of the peer's behavior on the choices of the DM in a risky environment.

Proposition 2. ***(Distributional Preferences and Social Interaction Effect with Risk-Neutrality in Isolation)*** *Suppose a DM whose preferences can be represented by a utility function as in Eq. (1) is indifferent between lotteries L_r and L_s when he observes the peer choose L_s (L_r). Then observing the peer choose L_r (L_s) instead implies the following orderings over the two lotteries for the DM: If his distributional preferences are*

(i) convex then $L_r \succ L_s$ ($L_s \succ L_r$);

(ii) linear then $L_r \sim L_s$;

(iii) concave then $L_s \succ L_r$ ($L_r \succ L_s$).

Proof. For (i), we have to show that for a DM with convex distributional preferences we have

(a) $u_{rr} = u_{sr} \Rightarrow u_{rs} < u_{ss}$, and

(b) $u_{rs} = u_{ss} \Rightarrow u_{rr} > u_{sr}$.

Consider part (a): Recall from Proposition 1 that in a social context the DM makes risk-neutral choices if the peer chooses L_r. Thus, we can have $u_{rr} = u_{sr}$ if and only if $p_s x_s = p_r x_r$. Then, using (3) and (5), we have

$$u_{rs} < u_{ss} \iff p_r x_r(1-\rho) < p_s x_s[1-\rho+(p_s-p_r)(\rho-\sigma)], \tag{8}$$

which is satisfied since $\rho > \sigma$ by convexity, $\rho < 1$ by monotonicity, and $p_r x_r = p_s x_s$ by risk-neutrality of the DM. Now consider part (b): Recall from Proposition 1 that in a social context a DM with convex distributional preferences makes risk averse choices if the peer chooses L_s. Thus, we can have $u_{rs} = u_{ss}$ only if $p_r x_r > p_s x_s$. Then, using (2) and (4), we have

$$u_{rr} > u_{sr} \iff p_r x_r[1-\rho+p_r(\rho-\sigma)]+p_r x_r\sigma > p_s x_s[1-\rho+p_r(\rho-\sigma)]+p_r x_r\sigma, \tag{9}$$

which is satisfied since $\rho > \sigma$ by convexity, $\rho < 1$ by monotonicity, and $p_r x_r > p_s x_s$ by risk-aversion of the DM. The proofs for (ii) and (iii) follow similar lines. □

Remark: Proposition 2 extends to the case of common gambles, i.e. when the lottery outcomes are perfectly correlated across agents. We show this in Appendix A.

Proposition 2 contains our main theoretical result regarding social interaction effects. It states that convex distributional preferences imply social interaction effects in risky choices in the sense that observing a peer choose a risky (safe) option increases the agent's incentive to choose the risky (safe) option as well, even when lotteries are stochastically independent and the agent can only observe the lottery chosen by the peer but not the corresponding outcome. This is a result with important empirical implications if one takes into account the ample existing evidence for convex distributional preferences. So far, however, we have only considered the case where agents are risk-neutral in isolation. In the next section it will be shown that Proposition 2 extends to the case where the DM has non-linear risk attitudes in isolation.

3.2 Extended Model: Departures from Risk-Neutrality in Isolation

In this section we extend our model by allowing for more general risk attitudes in isolation. For this purpose, suppose that a DM values his own monetary payoff m according to the von-Neumann-Morgenstern utility function $v(m)$ when acting in isolation. In order to avoid imposing unnecessary structure on $v(.)$, we exploit the fact that in the basic model of Subsection 3.1 the DM decides between lotteries whose support consists of only three monetary payoffs: x_r, x_s and 0. With only three possible monetary payoffs we can normalize the utility associated with two payoffs and use the number representing the utility of the third payoff as an index for the DM's risk attitude. Let $v(m) = m$ for $m \in \{0, x_r\}$ and $v(x_s) = v$. Then v gives information about the DM's risk attitude when acting in isolation: for $v < x_s$ the DM is risk-loving, and a larger difference $x_s - v$ means more risk-loving; for $v = x_s$ the agent is risk-neutral; and for $v > x_s$ the agent is risk-averse, and a larger difference $v - x_s$ means more risk-averse. In a social comparison context we assume that the DM is risk-neutral regarding the difference between his own and his peer's payoff, but may display other risk attitudes regarding his own material payoffs, as described above. More specifically, we assume that the DM's preferences are represented by the function

$$u_{\rho,\sigma,v}(m,o) = \begin{cases} v(m) + \sigma(o-m) & for \quad o \geq m \\ v(m) + \rho(o-m) & for \quad o < m \end{cases} \quad \forall\ \sigma < 1, \rho < 1, \tag{10}$$

where $v(0) = 0$, $v(x_r) = x_r$ and $v(x_s) = v$.[6] With this functional form, a DM's trade-off between the first component of the utility function, which accounts for his preferences over the own monetary payoff, and the second component, which accounts for social preferences, is distorted by the DM's risk attitude regarding his own payoff, but this distortion remains within narrow bounds, as we keep the highest and lowest possible payoff untransformed. To preserve monotonicity of the agent's utility with regard to his own material payoff (independent of the peer's material payoff) we impose the following parameter restrictions:[7]

R1: $\forall v < x_s : max\{\sigma,\, \rho\} < v/x_s$

R2: $\forall v \geq x_s : max\{\sigma,\, \rho\} < (x_r - v)/(x_r - x_s)$.

Given the modified functional form from (10), the DM's expected utility u_{ln} from choosing lottery L_l, with $l = r, s$, while his peer chooses lottery L_n, with $n = r, s$, is

$$u_{rr} = p_r^2 x_r + p_r(1-p_r)(x_r - \rho x_r) + (1-p_r)p_r\sigma x_r; \tag{11}$$

$$u_{rs} = p_r p_s[x_r - \rho(x_r - x_s)] + p_r(1-p_s)(x_r - \rho x_r) + (1-p_r)p_s\sigma x_s; \tag{12}$$

$$u_{sr} = p_s p_r[v + \sigma(x_r - x_s)] + p_s(1-p_r)(v - \rho x_s) + (1-p_s)p_r\sigma x_r; \tag{13}$$

$$u_{ss} = p_s^2 v + p_s(1-p_s)(v - \rho x_s) + (1-p_s)p_s\sigma x_s. \tag{14}$$

Given that the peer chooses L_r, the DM now prefers L_s over L_r if and only if $u_{sr} > u_{rr}$. Using (13) and (11), this simplifies to

$$p_s x_s + \frac{p_s(v - x_s)}{1 + p_r(\rho - \sigma) - \rho} \quad > \quad p_r x_r. \tag{15}$$

Given that the peer chooses L_s, the DM now prefers L_s over L_r if and only if

[6]There are other plausible ways of extending the functional form (1) to lotteries – see Fudenberg and Levine (2012), or Saito (2013), for instance. We chose this simple form mainly for parsimony and transparency, and to stay as close as possible to our baseline functional form (1).

[7]For an agent who is risk-neutral in isolation, those conditions correspond exactly to our original monotonicity restrictions – that is, to $\sigma < 1$ and $\rho < 1$, or $max\{\sigma,\, \rho\} < 1$.

$u_{ss} > u_{rs}$. Using (12) and (14), this simplifies to:

$$\frac{\rho-\sigma}{1-\rho} \quad > \quad \frac{p_r x_r}{p_s x_s (p_s - p_r)} - \frac{v - \rho x_s}{x_s(p_s-p_r)(1-\rho)}. \tag{16}$$

Conditions (15) and (16) extend those found earlier for an agent who is risk-neutral in isolation – it is easy to see that for $v = x_s$ they correspond precisely to our earlier conditions (6) and (7). To identify the impact of a change in the choice of the peer on the incentives of a DM behaving in accordance with the functional form (10) with preference parameters ρ, σ and v, we calculate – for given values of x_r, x_s and p_s and given choice of the peer – the critical probability p_r^* for which the DM is just indifferent between lotteries L_s and L_r. We shall refer to p_r^* as the DM's 'indifference probability'. Let $p_r^*(L_r)$ denote the value of the DM's indifference probability when the peer chooses L_r, and $p_r^*(L_s)$ the corresponding value when the peer chooses L_s. From (15) and (16) it is immediately seen that for $\rho = \sigma$ we have $p_r^*(L_r) = p_r^*(L_s) = \frac{p_s(v-\rho x_s)}{x_r(1-\rho)}$, implying that the indifference probability of a DM with linear distributional preferences is not affected by the peer's choice. For $\rho \neq \sigma$, condition (15) yields the following equation:

$$p_r^*(L_r) = \frac{x_r(\rho-1) + p_s x_s(\rho-\sigma) \pm \sqrt{-4x_r(\rho-\sigma)p_s(\rho x_s - v) + [x_r(1-\rho) - p_s x_s(\rho-\sigma)]^2}}{2x_r(\rho-\sigma)}. \tag{17}$$

Thus, for $\rho \neq \sigma$ the value for $p_r^*(L_r)$ is the solution to a quadratic equation, which, in general, is not unique. However, taking the parameter restrictions R1 and R2 for monotonicity of utility in own material payoff into account, it can be shown that only the solution with the positive root is admissible.

Turning to the case where the peer chooses L_s, condition (16) yields the following equation:

$$p_r^*(L_s) = \frac{p_s(v-\rho x_s) + p_s^2 x_s(\rho-\sigma)}{x_r(1-\rho) + p_s x_s(\rho-\sigma)}. \tag{18}$$

To evaluate the impact of a change in the peer's choice on the incentives of a DM with given distributional parameters ρ and σ and given risk attitude v in isolation, we define the difference in indifference probabilities as $d(\rho,\sigma,v) = p_r^*(L_s) - p_r^*(L_r)$.

Then $d(\rho, \sigma, v) > 0$ indicates that if the peer chooses L_s, the DM will require a larger p_r to prefer L_r over L_s, compared to the situation where the peer chooses L_r, i.e., he will choose L_s for a larger range of probabilities. Thus, with $d(\rho, \sigma, v) > 0$ the DM has the tendency to follow the peer, with $d(\rho, \sigma, v) < 0$ the DM has the tendency to deviate from the behavior of the peer, and with $d(\rho, \sigma, v) = 0$ the DM's choice is not affected by the decision of the peer. Furthermore, the absolute value of $d(\rho, \sigma, v)$ is a measure for the size of the impact of a change in the peer's choice on the DM's indifference probability. In Appendix B we show that for $\rho > \sigma$ the difference in indifference probabilities $d(\rho, \sigma, v)$ is positive for each admissible value of v; furthermore, $d(\rho, \sigma, v)$ is convex and it obtains its (unique) minimum at $v = x_s$. By contrast, for $\rho < \sigma$ the difference in indifference probabilities is negative for each admissible value of v; furthermore, $d(\rho, \sigma, v)$ is concave in this case and it obtains its (unique) maximum at $v = x_s$. Together with the observation that for $\rho = \sigma$ we have $p_r^*(L_s) = p_r^*(L_r)$, these findings imply the following result:

Proposition 3. ***(Distributional Preferences and Social Interaction Effect with General Risk Attitudes in Isolation)*** *Suppose a DM whose preferences can be represented by a utility function as in Eq. (10) is indifferent between lotteries L_r and L_s when he observes the peer choose L_s (L_r). Then observing the peer choose L_r (L_s) instead implies the following orderings over the two lotteries for the DM: If his distributional preferences are*

(i) convex then $L_r \succ L_s$ ($L_s \succ L_r$);

(ii) linear then $L_r \sim L_s$;

(iii) concave then $L_s \succ L_r$ ($L_r \succ L_s$).

Furthermore, for given distributional preference parameters ρ and σ, the size of the impact of a change in the peer's choice on the DM's indifference probability is smaller for a DM who is risk-neutral in isolation than for a DM who is risk-averse or risk-loving in isolation.

Proof. See Appendix B. □

The first part of Proposition 3 shows that our main result regarding the impact of the peer's behavior on the DM's choices in a risky environment (i.e., Proposition 2) extends to the case where the DM has more general risk attitudes in isolation. The second part of the proposition extends the result by stating that the impact of the peer's behavior on the DM's choice in a risky environment is larger for a DM who is not risk-neutral in isolation. The DM does not need to know the peer's risk preferences, as he only relies on the peer's actual choices, irrespective of the motivation behind the choices. Next we test these predictions in an experimental setting.

4 Experiment

4.1 Experimental Setup

Our experimental design features three treatments which differ in the information provided to subjects regarding a peer's choices in a risky environment. Within each of the three treatments, there are two distinct parts: In Part 1 we elicit subjects' distributional preferences using a non-parametric elicitation procedure. In Part 2 subjects are exposed to 30 binary choices between a sure payoff and a lottery. We first describe the decision tasks in the two parts (which are identical across treatments), then the treatments (differing in the information subjects receive in Part 2 of the experiment), and finally the experimental procedures.

Decisions in Part 1: To elicit the distributional preferences of the subjects we implemented the nonparametric procedure developed by Kerschbamer (2015). This procedure exposes each subject to a series of choices between two allocations, each specifying a payoff for the subject ("the DM") and a payoff for a randomly matched anonymous second subject ("the passive agent"). In each choice one of the two allocations is symmetric (i.e., involving equal material payoffs for both agents) while the other is asymmetric (involving unequal payoffs for the two agents). In one half of the choice tasks (labelled as Advantageous Inequality Block in Table 1, but not in the instructions) the asymmetric allocation implies advantageous inequality for the DM (i.e., the DM would be ahead of the passive agent in monetary terms), in the other half it implies disadvantageous inequality (i.e., the DM would be behind the passive agent in monetary terms). For both cases the procedure systematically varies the price of giving (or taking) by increasing the material payoff of the DM in the asymmetric allocation while keeping all other payoffs constant.

We used the parametrization of the procedure displayed in Table 1, with an exchange rate of 0.10 Euro per Experimental Currency Unit (ECU). When making

Disadvant. Inequality Block				Advant. Inequality Block			
LEFT		RIGHT		LEFT		RIGHT	
You	Other	You	Other	You	Other	You	Other
15	30	20	20	15	10	20	20
19	30	20	20	19	10	20	20
20	30	20	20	20	10	20	20
21	30	20	20	21	10	20	20
25	30	20	20	25	10	20	20

Table 1: Test for Distributional Preferences: Paired Choices

their choices, subjects knew that (i) their earnings for this part of the experiment would be determined at the end of the experiment; (ii) they would receive two cash payments for this task, one as a DM and one as a passive agent; (iii) for their earnings as a DM one of the 10 decision problems would be selected by a random draw made separately for each participant and the alternative chosen in this decision problem would be paid out; and (iv) their earnings as a passive agent would come from another participant (i.e., not from the passive agent of the subject under consideration).[8] Given the design of the test, in each of the two blocks a rational DM switches at most once from the symmetric to the asymmetric allocation (and never in the other direction).[9] As shown by Kerschbamer (2015) the switch points in the two blocks are informative about the DM's archetype and intensity of distributional preferences and they can also be used to obtain estimates of the two parameters ρ and σ of the functional form (1). This is the information we are interested in, and we use this information to classify subjects as having either convex ($\rho > \sigma$), linear ($\rho = \sigma$), or concave ($\rho < \sigma$) distributional preferences.

Decisions in Part 2: In Part 2 of the experiment subjects were exposed to a series of 30 binary choices between a cash gamble and a sure payoff. Subjects

[8]We employed the double role assignment protocol as used by Andreoni and Miller (2002), for instance, in their dictator games. This means that in our protocol each subject makes distributional choices as a DM, and each receives two payoffs, one as a DM and one as a passive agent.

[9]The procedure relies on minimal assumptions regarding the rationality of a DM. In terms of axioms on preferences the assumptions are ordering (completeness and transitivity) and strict (own-money) monotonicity – see Kerschbamer (2015) for details. In the main text, DMs whose preferences satisfy those two basic axioms are referred to as 'rational'.

were informed at the beginning that (i) their decisions in this part would have consequences for their own earnings only, and this was true also for all other participants; (ii) they would now face 30 binary choices (labelled 'decision rounds' in the instructions) between a sure payoff and a lottery; (iii) choices would be presented one by one on separate screens; (iv) all participants would face exactly the same pair of alternatives in each decision round; (v) actual earnings of a subject would be determined at the end of the experiment and would depend on the realization of two separate random variables – one session-specific determining which of the 30 decision rounds would be payoff-relevant for all subjects in that session, and the other subject-specific determining the personal lucky number for the subject under consideration in case this subject chose the lottery in the payoff-relevant pair.[10] Subjects were also informed that in some rounds they would be exposed to alternatives which they have already seen in previous rounds and that in such rounds (i) the screen would inform subjects which decision they have made the first time they saw this pair of alternatives; (ii) some subjects would have an active role while others would have a passive role; (iii) the screen would inform participants (in private) about their roles; (iv) participants in an active role would have to make a new decision while for subjects in the passive role the computer would automatically implement the decision they made the first time they saw this pair of alternatives; and (v) participants in an active role would also be informed about the decision some other participant (now in the passive role) made the first time he saw this pair of alternatives.[11] The instructions pointed out that a subject in the active role who is informed about the past decision of an (anonymous) other subject knows precisely how this other subject decides in the current round.[12] Subjects were also made aware that the two-stage procedure for the determination of the earnings for Part 2 ensures that subject and peer receive their earnings from Part 2 from the same decision task and that in case that both subjects decided for the risky option in that task, the realizations are stochastically independent. The

[10]This design feature makes sure that (i) all subjects are paid for the same decision task; and (ii) if two or more agents decide for the same lottery the realizations are stochastically independent ('individual gambles').

[11]As will be explained below, we had one treatment without peer, in which points (ii)-(v) are not relevant, and thus they were not part of the instructions.

[12]This is due to the fact that this other subject has a passive role in the current round and thus cannot make a new decision; the computer implements his past decision for the current round.

Pair No.	**Sure Payoff**	**Lottery**
1	50	100 with $p = 0.40$, 0 with $1 - p$
2	50	100 with $p = 0.45$, 0 with $1 - p$
3	50	100 with $p = 0.50$, 0 with $1 - p$
4	50	100 with $p = 0.55$, 0 with $1 - p$
5	50	100 with $p = 0.60$, 0 with $1 - p$
6	50	100 with $p = 0.65$, 0 with $1 - p$
7	50	100 with $p = 0.70$, 0 with $1 - p$
8	50	100 with $p = 0.75$, 0 with $1 - p$
9	50	100 with $p = 0.80$, 0 with $1 - p$
10	50	100 with $p = 0.85$, 0 with $1 - p$

Table 2: Test for Risk Preference: Paired Choices

30 decision tasks (which are the same for all subjects and in all treatments) are then presented in 3 blocks.

Block 1 contained the 10 choices between a sure payoff and a lottery displayed in Table 2. Choices were presented in an ordered sequence, each on an own screen, starting with Pair No. 1 (a screen shot is provided in Appendix C). Since the sure payoff was always 50 ECUs while the lottery yielded 100 ECUs with probability p and 0 ECU with probability $1 - p$, and since the probability p increased from one pair to the next, a rational DM switches at most once from the sure payoff to the cash gamble (and never in the other direction) and the switch point is informative about the DM's risk attitude.[13] For simplicity, we will use the number of safe choices in Block 1 as a proxy for a subject's indifference probability in isolation.[14] Since a risk-neutral subject would be indifferent between the sure payoff and the cash gamble for pair 3 in Table 2, subjects who make two or three safe choices are classified as risk-neutral, subjects who make at most one safe choice are classified as risk-loving and subjects who make at least four safe choices are defined as risk-

[13]Again ordering (completeness and transitivity) and strict monotonicity are the two requirements for rationality. Note that we will not be able to identify a subject's precise indifference probability (as defined in the theory section), as the experiment features only discrete changes in probabilities. Instead, a lower and upper bound for the indifference probability of a rational subject is identified by the probability p in the last pair for which the subject decides for the sure payoff and the probability p in the first pair for which the subject decides for the cash gamble.

[14]Strictly speaking, the theoretical concept of an indifference probability would require consistent choices, implying at most one switch from the sure payoff to the lottery. Taking the number of safe choices as a proxy for the indifference probability allows us to include all observed choices.

averse. In Block 2 and Block 3 subjects faced the same 10 paired choices as in Block 1, now with the additional information on their own previous decision for the corresponding pair in Block 1 and in some treatments also with information about a peer's decision (as explained below).

Treatments: Our experimental design features three treatments: In treatments RLF (Risk Loving First) and RAF (Risk Averse First) information about the choices of a peer was presented to active subjects, while in treatment NOP (No Peer) peer information was absent. In each session of treatments with peer information, the computer program identified the most risk-loving and the most risk-averse subject from the decisions in Block 1. Each of these two subjects was in the passive role in one of the following two blocks, while all other subjects were in the active role. A subject in the passive role in a given block served as the peer for the other subjects in that block. In RLF the most risk-loving subject in Block 1 served as the peer in Block 2, and the most risk-averse subject in Block 1 served as the peer in Block 3. In treatment RAF this order was reversed – that is, the most risk-averse subject in Block 1 served as the peer in Block 2, and the most risk-loving subject in Block 1 served as the peer in Block 3.[15] Since a subject in the passive role in a given block could not make any new decisions in that block, subjects in the active role had information about the peer's decisions in the current block. By comparing the choices a subject in the active role made in Block 2 to those he made in Block 3, we address the question whether the peer's choice affected the decisions of the subject under consideration, as the choices in the two blocks differ only in the information about the peer's decisions. In treatment NOP, where peer information was absent, subjects faced the same 10 paired choices (as displayed in Table 2) in the three blocks, with information in Block 2 and Block 3 only about their own past choice in Block 1.

Procedures: The experiment was computer-based, using the software z-tree (Fischbacher 2007). It consisted of 9 sessions conducted at the Innsbruck-Econ-Lab. A total of 166 subjects were recruited amongst undergraduate students of any major at the University of Innsbruck in May 2012 via the software ORSEE (Greiner 2004). 55 subjects participated in RLF, 55 in RAF and 56 in NOP. Since

[15] By using the two subjects with the most extreme risk attitudes in Block 1 as peers in Block 2 and Block 3 we tried to maximize the number of choices for which the peer in Block 2 made a decision different from the peer in Block 3.

we conducted 3 sessions for each treatment, and each session except those for NOP included 2 peers, we remain with 49 subjects in the active role in treatments RLF and RAF, and 56 subjects in NOP, which gives a total of 154 subjects whose decisions will be analyzed below. Upon arrival, the instructions of Part 1 (identical for all subjects across all treatments) were read aloud to ensure common knowledge. Subjects then had time to read the instructions in private and to ask questions. After Part 1 was completed, instructions for Part 2 (identical for all subjects of a session) were distributed and read aloud, and subjects had then again time to read them in private and to ask questions. At the end of each session a bingo cage with numbered balls was used for the random draws in the lab, and all draws could be followed by all participating subjects of a session. Sessions lasted about 45 minutes and participants averaged earnings of 10.30 Euro.

4.2 Experimental Predictions

Our main hypothesis for the aggregate data is motivated by empirical evidence gathered by psychologists and experimental economists in the last decades showing that (i) distributional preferences are behaviorally relevant in many contexts (see Sobel 2005 and Fehr and Schmidt 2006 for excellent surveys); and (ii) the overwhelming majority of subjects who are not exclusively interested in the maximization of their own material income has convex distributional preferences (see, e.g., Andreoni and Miller 2002, Charness and Rabin 2002, Engelmann and Strobel 2004, Fisman et al. 2007, or Cox and Sadiraj 2007).[16] According to our theoretical results, convex distributional preferences imply that observing the peer choose a risky (safe) option increases the DM's propensity to choose the risky (safe) option as well, even when lotteries are stochastically independent and the agent can only observe the lottery chosen by the peer but not the corresponding outcome. Our

[16]There is some disagreement in the literature regarding the relative importance of different motives. For instance, there is a discussion on whether inequality aversion or quasi-maximin preferences (where the latter is defined as a combination of the two basic motives 'surplus maximization' and 'maximin'; see Charness and Rabin 2002) is empirically more relevant (see, e.g., the discussion between Fehr et al. 2006 on the one hand, and Engelmann and Strobel 2006 on the other). Since inequality aversion and quasi-maximin both fit under the heading 'convex distributional preferences' (in the piecewise linear model of the previous section, inequality aversion translates to the parameter restriction $\sigma < 0 < \rho < 1$, while quasi-maximin translates to the parameter restriction $0 < \sigma < \rho < 1$) this discussion is not relevant for the arguments in the main text.

main prediction for the aggregate data is therefore:

Prediction 1. (Social Interaction Effect in Aggregate Data) *For two decision blocks with identical ordered pairs of lottery choice options for the DM and the peer, but different actual choices of the peer, subjects on average follow the behavior of the peer.*

We will test Prediction 1 by comparing the number of safe choices in Block 2 to the corresponding number in Block 3.[17] For treatment RLF, evidence indicating that this number is lower in Block 2 than in Block 3 is interpreted as evidence in support of the prediction, as is evidence in RAF indicating that this number is higher in Block 2 than in Block 3. An alternative way to test Prediction 1 is to ask – for those subjects who change their behavior between Block 2 and Block 3 – in which direction they change their behavior. If convex distributional preferences are the main driver for the changes in behavior, then more subjects should adjust their behavior in the direction of the peer than in the opposite direction, and we will search for evidence in support of this prediction.

The next two predictions look at the individual level. First, individual data should confirm that subjects classified as having convex distributional preferences are more likely to change their behavior in the direction of the peer than subjects with linear distributional preferences (remember that this latter class includes material payoff maximizers). This is the content of our second prediction.

Prediction 2. (Distributional Preferences and Social Interaction Effect) *For two decision blocks with identical ordered pairs of lottery choice options for the DM and the peer, but different actual choices of the peer, subjects with convex distributional preferences have a more pronounced tendency to follow the behavior of the peer than other subjects.*

We will test Prediction 2 by comparing the changes in the number of safe choices from Block 2 to Block 3 of subjects classified as having convex distributional pref-

[17] Proposition 2 makes a statement about the impact of a change in the information about a peer's behavior on a DM's preferences and thereby provides the basis for a prediction regarding the change in behavior when moving from Block 2 to Block 3. Of course, one could also compare behavior in Block 1 to behavior in Block 2 or Block 3, arguing that this involves a comparison of a situation with less to one with more information about the peer's choice. Since we did not derive a formal result for this latter comparison, our main focus will be on the change in behavior from Block 2 to Block 3.

erences to those of subjects classified as having linear distributional preferences.[18]

Our last prediction regards the content of Proposition 3, that is, the impact of the own risk attitude in isolation on the size of the social interaction effect. It was shown in Proposition 3 that for any combination of the distributional preference parameters ρ and σ the impact of the peer's choice is less pronounced for risk-neutral DMs than for risk-loving and risk-averse agents. We formulate this as our third prediction:

Prediction 3. (Risk Preferences and Social Interaction Effect) *For two decision blocks with identical ordered pairs of lottery choice options for the DM and the peer, but different actual choices of the peer, risk-neutral subjects have a less pronounced tendency to follow the behavior of the peer than risk-loving or risk-averse subjects.*

We will test Prediction 3 by comparing the changes in the number of safe choices from Block 2 to Block 2 of subjects classified as having risk-neutral preferences to those of subjects classified as having either risk-loving or risk-averse preferences.

4.3 Experimental Results

We start by looking at the aggregate data. Table 3 displays summary statistics for the number of safe choices in blocks 1, 2 and 3, denoted as *b1safe, b2safe* and *b3safe*, for each of the three treatments. A comparison of *b1safe* across treatments shows no significant differences across populations (Kruskal-Wallis test: $p = 0.71$), indicating that the random assignment of subjects to the three treatments was successful. Since we are interested in the impact of a change in the information regarding the choice of a peer on subjects' decisions, our main comparison is that between the decisions in Block 2 and Block 3. To perform this comparison we define the variable *IPdiff= b2safe-b3safe*, which is a measure of the relevant shift in the indifference probability. Recall that in treatment RLF the peer in Block 2 makes fewer safe choices compared to the peer in Block 3. Thus, if subjects follow the peer's choice on average, then *IPdiff* should be negative. This is exactly what

[18] Proposition 2 would also predict that subjects with concave distributional preferences have a tendency to deviate from the behavior of the peer. However, since concave distributional preferences are empirically irrelevant, we do not search for evidence in accordance with this prediction in our data.

we find in the data – see Table 3. By contrast, in RAF the peer in Block 2 makes more safe choices compared to the peer in Block 3, thus following the peer would imply that *IPdiff* is now positive, which is again what we observe, on average. On the aggregate, we thus find that irrespective of the order in which peer choices are presented (RAF vs. RLF), subjects' behavior follows peers' behavior. Instead, our treatment without any peer (NOP), while also showing some change from Block 1 to Block 2, does not display a significant change in *IPdiff* from Block 2 to Block 3. The t-tests in Table 3 indicate that only in the two treatments with peers *IPdiff* is significantly different from zero and has the expected sign.

	Treatment RLF			Treatment RAF			Treatment NOP		
	b1safe	*b2safe*	*b3safe*	*b1safe*	*b2safe*	*b3safe*	*b1safe*	*b2safe*	*b3safe*
Mean	4.51	3.96	4.61	4.77	5.58	5.10	5.08	5.61	5.5
Median	4	3	4	4	6	5	4.5	6	5.5
Std.Dev.	2.64	2.31	2.40	2.99	2.89	2.91	3.27	2.77	2.74
IPdiff	-0.65			0.47			0.11		
t-test	$p < 0.01$			$p < 0.03$			$p = 0.38$		

Note: We define *IPdiff*= *b2safe*-*b3safe*.

Table 3: Number of Safe Choices by Block and Treatment

A more detailed picture is obtained by investigating the proportion of subjects who increased and decreased the number of safe choices and of those who left their choices unchanged when moving from one block to the next. Figure 1 displays the respective figures in a comparison between Block 1 and Block 2 (left graph), and between Block 2 and Block 3 (right graph). Again, our main focus is on the change in behavior when moving from Block 2 to Block 3.[19] Here, in RLF we find that 47% of subjects change the number of safe choices, of which all but one change their behavior into the peer direction; in RAF 41% change their behavior, and 80% of those who change move into peer direction. Finally, we observe that in NOP 39% of subjects also change their behavior, and that 73% of those who change move to more risk-loving choices in Block 3, even though they do not have any information except their own past choices. The Wilcoxon Signed Rank (WSR) test – a non-parametric test making ordinal within-subjects comparisons of *b2safe* and *b3safe*

[19]Figure 1 shows that subjects also tend to follow the peer when moving from Block 1 to Block 2. As mentioned earlier, this might be regarded as a comparison between behavior without information about the choice of a peer and behavior with a peer, which is related to, but not identical with, the comparison we are mainly interested in.

– confirms that our proxy for the indifference probability shifts into the predicted direction in the treatments with peers ($p < 0.01$ for both, RLF and RAF). However, our treatment NOP without peer also displays a significant shift in behavior from Block 2 to Block 3 towards more risky choices (WSR: $p < 0.07$). That is, subjects in NOP seem to display a change in behavior that is qualitatively similar to that in RAF. The shift in NOP, however, cannot be based on any exogenous factor, since subjects face identical decisions and identical information as in the previous block.

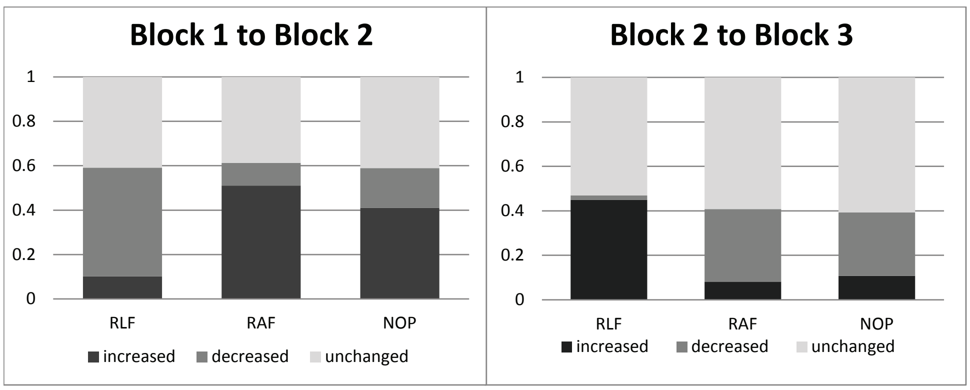

Figure 1: Change in Fraction of Safe Choices over Blocks

To obtain a more detailed picture, we performed a regression (see Table 4) in which the dependent variable *choice* – i.e. each individual's choice between sure payoff and lottery in Block 2 and Block 3 – is explained by *b1choice* – representing a subject's own past choice in Block 1 – and by the influence of the peer. In this regression we treat the observed choices in NOP *as if* the same peer information was present as in RAF, i.e. the variable *peerRA*, representing an indicator variable for a risk-averse peer, is set to 1 in Block 2 of RAF and NOP, while it is set to 1 in Block 3 of RLF. The variable *peer* indicates whether or not there was a peer present, and the cross-term *peerRA*peer* should then give an indication of whether the choices in NOP can be explained in the same way as the choices in RAF. In line with theory and experimental design, the results displayed in Table 4 show that the choices in RAF and those in NOP are not explained by the same model: While the coefficient for *peerRA* is not significant, the coefficient for the cross-term *peerRA*peer* is highly significant. That is, only if there is a real peer and the peer decides in a risk-averse manner, this increases the probability of making the safe choice.[20] We summarize our results based on aggregate data as

Result 1. (Social Interaction Effect in Aggregate Data) *In line with Prediction 1, subjects in treatments RLF and RAF follow, on average, the behavior of the peer.*

Variable	Coefficient	(Rob. SE)	$P > z$
b1choice	4.410	(0.203)	0.000
peerRA	0.113	(0.131)	0.387
peer	-0.678	(0.250)	0.007
*peer*peerRA*	0.504	(0.186)	0.007
cons	-1.732	(0.217)	0.000
N=3080, Std. Err. adjusted for 154 clusters			
$Prob > \chi^2 = 0.000$, Pseudo $R^2 = 0.5247$			

Table 4: Regression of Individual Choices

One might try to explain Result 1 by arguing that social information helps subjects operationalize their risk attitudes. While they are unsure what to prefer initially, they know better what to do when they receive information about the peer's choice. This would be in line with social learning theory (see Bandura 1977) and with findings from social psychology (see, e.g., Yechiam et al. 2008). In our setting, however, little can be learned from the peer's choice for one's own risk preferences, since the peer's motivation – that is, the risk attitude that has stipulated the peer's choice – remains unknown to the DM. It therefore seems rather unlikey that social learning is the main driver behind Result 1. More importantly, a learning story is hard to bring in line with the correlations on the individual level we report next.

On the individual level, we first search for evidence in support of Prediction 2. For this purpose, we distinguish between two classes of distributional preference types: convex types ($\rho > \sigma$) and linear types ($\rho = \sigma$). While 64 of 154 subjects (42%) fall into the former class, 68 (44%) are found in the latter, implying that we cover 86% of all subjects with this classification. If we now compare our proxy for the changes in the indifference probability (*IPdiff*) across the two classes, we find that in treatments RLF and RAF 53% of subjects classified as having convex distributional preferences change behavior with changing peer information, while

[20] The fact that the coefficient for *peer* is significant and negative indicates that the choices in Block 2 and Block 3 of treatment NOP are more risk-averse than those of RLF and RAF.

the corresponding fraction for linear types is only 25%. Pooled data of the two treatments shows that this difference is significant (χ^2-test: $p < 0.05$). By contrast, this explanation fails in treatment NOP, as subjects with convex distributional preferences are not more likely to change behavior: 75% of convex types display unchanged behavior when moving from Block 2 to Block 3, while 47% of linear types display a change in the number of safe choices (χ^2-test: $p = 0.16$). This supports our hypothesis that the social interaction effect we found in the aggregate data is mainly caused by subjects with convex distributional preferences.

Variable	Coefficient	(Rob. SE)	$Prob > z$
b1safe	0.131	(0.063)	0.836
peer	-0.331	(0.544)	0.544
convex	-0.869	(0.688)	0.207
*peer*convex*	1.517	(0.827)	0.067
cons	-0.496	(0.495)	0.316
N=132, $Prob > \chi^2 = 0.02$, Pseudo $R^2 = 0.05$			

Table 5: Distributional Preferences and Social Interaction Effect

The regression shown in Table 5 based on the subset of data produced by subjects classified as having either convex or linear distributional preferences confirms this result. We define *peereffect* as 0 when the subject does not change his behavior when he faces a different peer's choice, 1 if he follows the peer's choice, and 2 if the change goes against the peer's choice. Again, we treat treatment NOP as if there was peer information just like in RAF, due to the apparent similarity in observed behavior. The regression results show that while the existence of a peer alone does not explain the peer effect, the cross-term *peer*convex* does. Only for subjects who are classified as having convex distributional preferences and who face a peer (in RLF and RAF) we can explain the peer effect. We therefore conclude:

Result 2. (Distributional Preferences and Social Interaction Effect) *In line with Prediction 2, the social interaction effect observed in the aggregate data is mainly caused by subjects with convex distributional preferences.*

Our approach in the theory part of the paper was to derive the social interaction effect directly from a DM's underlying preferences rather than referring to conformism that is not explicitly modeled on the preference level as an explanation. Given Result 2, we conclude that as long as we do not have a good theory about

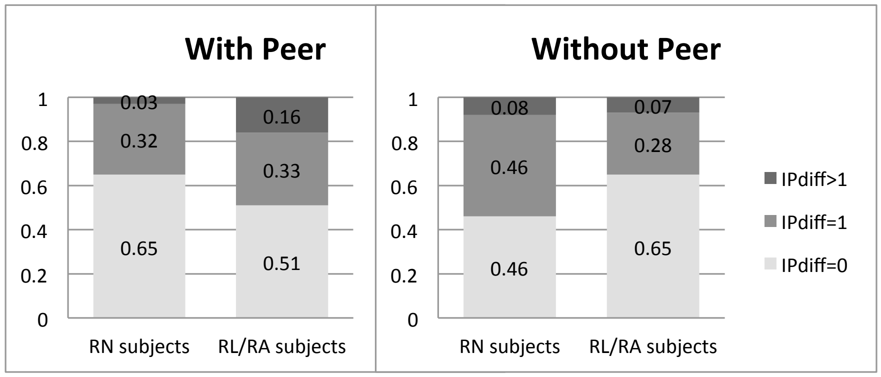

Figure 2: Risk Attitude and Social Interaction Effect

how conformism and convex distributional preferences are related, our approach offers a more direct preference-based explanation of the observed peer effect. Conformity – in the way the term it is used in the economics literature – does not seem to provide a preference-based explanation for why people make the choices we observe.[21]

In addition to the causal effect of convex distributional preferences on conformistic behavior our model predicts that the social interaction effect is less pronounced for a risk-neutral DM compared to a risk-loving or risk-averse DM. The left hand side of Figure 2 shows that in the two treatments with peers (RLF and RAF pooled), about two thirds of the subjects classified as risk-neutral display no change in the number of safe choices, while for subjects classified as risk-loving or risk-averse, about 50% display changes. This result, however, is not statistically significant (χ^2-test: $p = 0.14$).[22] One could argue that using *b1safe* to define risk-neutrality may not be appropriate since it allows a subject to behave inconsistently (by switching more than once between the safe and the risky alternative or by switching in the 'wrong direction'). If, instead, we consider only subjects behaving consistently, i.e. those who switch at most once from the safe to the

[21] Basic motivations that imply conformistic behavior are discussed in the psychology literature – see Cialdini and Goldstin (2004), for instance. None of the discussed motivations, however, predict a correlation between convex distributional preferences and conformity.

[22] The fact that our definition of risk-neutrality may include slightly risk-loving and slightly risk-averse subjects is perfectly consistent with the theory, since in theory the curve for the size of the difference in indifference probabilities as a function of risk attitude is U-shaped with the minimum at risk-neutrality. See Appendix B for details.

risky alternative (and never in the other direction), then 30 subjects are classified as risk-neutral. The resulting distribution of changes in the number of safe choices is similar to that displayed in Figure 2, but the χ^2-test becomes significant ($p = 0.05$). For treatment NOP, on the other hand, we observe no such correlations between risk attitudes and change in the number of safe choices, for either definition of risk-neutrality (χ^2-test: $p = 0.44$ in both cases).[23]

Result 3. (Risk Preferences and Social Interaction Effect) *Regarding Prediction 3, we find weak evidence that risk-neutral subjects in treatments RLF and RAF have a less pronounced tendency to follow the behavior of the peer than risk-loving or risk-averse subjects.*

5 Conclusion

The term social interaction effect refers to a particular form of strategic complementarity in which the action choices of agents in a reference group have a positive impact on the DM's propensity to choose the corresponding action without affecting the DM's material payoffs. As discussed in previous literature (see, e.g., Scheinkman 2008 and the references therein), social interaction effects potentially have important economic consequences. For instance, with social interaction effects any change in the environment has not only a direct effect on behavior but also an indirect effect (resulting from the change in behavior of the peers) of the same sign; consequently, with social interaction effects a small change in fundamentals might result in a large change in aggregate behavior via the so called "social multiplier". Also, social interaction effects might lead to multiple equilibria implying that different outcomes can result from exactly the same fundamentals.

In the theory part of this paper we have shown that convex distributional preferences imply social interaction effects in risky choices, even when the outcomes of a given lottery are stochastically independent across agents deciding for that lottery and even when the DM can only observe the lotteries chosen by the peers but not the corresponding outcomes. Indeed, convex altruistic, inequality averse, maximin, envious, and spiteful preferences all imply that observing (more) peers

[23]In fact, as shown in the right hand side of Figure 2, more subjects classified as risk-neutral change their behavior, while about two thirds of the risk-loving and risk-averse subjects leave their behavior unchanged.

to choose a risky (safe) option increases the DM's propensity to choose the risky (safe) option as well, although the DM's material payoffs for the different options remain unaffected by the peers' choices.

In the experimental part of the paper we have found strong peer group effects in the choices between pairs of lotteries in the sense that observing a peer choose a risky (safe) option increases the DM's propensity to choose the risky (safe) option as well, although in the experiment the outcomes of a given lottery are stochastically independent across agents and the DM can only observe the lottery chosen by the peer but not the corresponding outcome. Taking advantage of the controlled environment, we have excluded standard identification problems (self selection, correlated effects, and contextual effects), material payoff externalities and informational externalities as possible explanations and we have concluded that a plausible cause for the observed correlation in risky choices is social interaction effects caused by convex distributional preferences. Support for this conclusion comes from the data analysis on the individual level, which reveals correlations in line with our theory: The social interaction effect observed in the aggregate data is mainly caused by subjects with convex distributional preferences, and the effect seems to be more pronounced for subjects with non-linear risk attitudes than for risk-neutral subjects, although the evidence for this latter comparison is less conclusive.

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7 Appendix

7.1 Appendix A: Extensions within Basic Model

7.1.1 More than Two Agents and More than Two Binary Lotteries

We now consider the case where there are (at least potentially) more than two agents and more than two lotteries. For simplicity, we start with $K = 2$ agents and $N \geq 2$ lotteries, and extend our definitions then to more than two agents.

Definition 1. *Suppose that in the* ***two-player case*** *lottery L_n, with $n = 1, 2, ..., N$, yields outcome x_n with probability p_n and outcome zero with probability $1 - p_n$. Let $0 < p_1 < p_2 < ... < p_{N-1} < p_N \leq 1$ and $0 < x_N < x_{N-1} < ... < x_2 < x_1$, i.e. a lottery with a lower index is riskier than a lottery with a higher index. Let u_{ln} denote the expected utility of the DM if he chooses lottery L_l while his peer chooses L_n.*

If the DM has a utility function as given in Equation (1), u_{ln} can be expressed as

$$u_{ln} = p_l x_l(1 - \rho) + p_n x_n \sigma + p_l p_n(\rho - \sigma) \min\{x_l,\ x_n\} \tag{19}$$

For the **(K > 2) player case**, that is, for a social environment in which there are $K - 1 > 1$ peers, the Charness and Rabin function extends to:

$$u_{\rho,\sigma}(m, o_1, ..., o_{K-1}) = m + \frac{\sigma}{K-1}\sum_{k=1}^{K-1} \max\{o_k - m,\ 0\} - \frac{\rho}{K-1}\sum_{k=1}^{K-1} \max\{m - o_k,\ 0\}, \tag{20}$$

where $\max\{\rho, \sigma\} < 1$ and where o_k is the material payoff of peer $k \in \{1, ..., K - 1\}$.[24]

Definition 2. *Suppose that in the* ***K > 2 player case*** *we have $N \geq 2$ lotteries as in Definition 1. Let c_n be the fraction of peers that choose lottery n. Let $u_l(c)$ denote the expected utility of the DM if he chooses lottery L_l while his peers choose according to $c = (c_1, c_2, ..., c_{N-1}, c_N)$.*

Then $u_l(c) = \sum_{n=1}^{N} c_n u_{ln}$, and using the utility function as given in Equation (20),

[24] Here we use the convention that the DM is agent K. Note that dividing through $K-1$ ensures that the relative impact of distributional concerns on the DM's utility payoff is independent of the number of players in his reference group. See Fehr and Schmidt (1999) for a similar normalization.

we have

$$u_l(c) = p_l x_l(1-\rho) + \sigma \sum_{n=1}^{N} c_n p_n x_n + p_l(\rho - \sigma) \sum_{n=1}^{N} p_n c_n \min\{x_l, x_n\} \tag{21}$$

$$= p_l x_l(1-\rho) + \sigma \sum_{n=1}^{N} c_n p_n x_n + p_l(\rho - \sigma) \left(\sum_{n=1}^{l} p_n c_n x_l + \sum_{n=l+1}^{N} p_n c_n x_n \right)$$

Proposition 4. ***(Distributional Preferences and Risk Attitudes with*** N ***Lotteries and*** K ***Agents)****. Suppose a DM with a utility function as given in (20) has to choose between N lotteries which have the same expected value, that is, $\forall n \in \{1, 2, ..., N\}$ we have $p_n x_n = \kappa$ for some constant κ. Further suppose that the DM observes his peers choose according to $c = (c_1, .., c_{s-1}, c_s, c_{s+1}, .., c_N)$, where L_s denotes the safest lottery chosen by a strictly positive fraction of the peers. Then the DM' ordering over the N lotteries depends on his distributional preferences. If his distributional preferences are*

(i) convex then $L_N \sim L_{N-1} \sim ... \sim L_s \succ L_{s-1} \succ ... \succ L_1$;

(ii) linear then $L_N \sim L_{N-1} \sim ... \sim L_s \sim L_{s-1} \sim ... \sim L_1$;

(iii) concave then $L_N \sim L_{N-1} \sim ... \sim L_s \prec L_{s-1} \prec ... \prec L_1$.

Proof. First note that regardless of whether the DM has convex, linear, or concave distributional preferences, we have $u_l(c) = u_s(c)$ for $l \geq s$. To see this, note that $u_s(c) = p_s x_s(1-\rho) + \sigma \sum_{n=1}^{N} c_n p_n x_n + p_s(\rho - \sigma) x_s \sum_{n=1}^{s} p_n c_n$ (when the DM also chooses L_s), and $u_l(c) = p_l x_l(1-\rho) + \sigma \sum_{n=1}^{N} c_n p_n x_n + p_l(\rho - \sigma) x_l \sum_{n=1}^{s} p_n c_n$ (when the DM chooses L_l with $l > s$). Then $u_l(c) - u_s(c) = (p_s x_s - p_l x_l)[1 - \rho + \sum_{n=1}^{s} p_n c_n(\rho - \sigma)] = 0$, since $p_s x_s = p_l x_l$. Next, we show that for $s > l > r$ we have $u_s(c) > u_l(c) > u_r(c)$ if the DM has convex distributional preferences, $u_s(c) = u_l(c) = u_r(c)$ if the DM has linear distributional preferences, and $u_s(c) < u_l(c) < u_r(c)$ if the DM has concave distributional preferences. This is easily seen by noting that

$$\begin{aligned}
u_s(c) &= p_s x_s(1-\rho) + \sigma \sum_{n=1}^{N} c_n p_n x_n + (\rho - \sigma) \sum_{n=1}^{s} p_n c_n p_s x_s \\
u_l(c) &= p_l x_l(1-\rho) + \sigma \sum_{n=1}^{N} c_n p_n x_n + (\rho - \sigma) \left[\sum_{n=1}^{l} p_n c_n p_l x_l + \sum_{n=l+1}^{s} p_n c_n p_l x_n \right] \\
u_r(c) &= p_r x_r(1-\rho) + \sigma \sum_{n=1}^{N} c_n p_n x_n + (\rho - \sigma) \left[\sum_{n=1}^{r} p_n c_n p_r x_r + \sum_{n=r+1}^{s} p_n c_n p_r x_n \right].
\end{aligned}$$

Thus, for $s > l$ and $p_n x_n = \kappa, \forall n$ we have

$$u_s(c) - u_l(c) = (\rho - \sigma) \sum_{n=l+1}^{s} p_n c_n (p_s x_s - p_l x_n)$$

.

For a DM with convex (linear; concave) distributional preferences this equation is strictly positive (zero; strictly negative) since $\rho - \sigma > 0$ ($\rho - \sigma = 0$; $\rho - \sigma < 0$) and $p_s x_s = p_n x_n > p_l x_n$ for $p_n > p_l$. The argument for $l > r$ is similar. □

Proposition 4 tells us that in a world with N binary lotteries with equal expected values and K agents, a DM with convex (concave) distributional preferences is risk-averse (risk-loving) when comparing lotteries that are more risky than the safest lottery chosen by a strictly positive fraction of peers, but risk neutral when comparing lotteries that are less risky.

Proposition 5. ***(Distributional Preferences and Social Interaction Effects with N Lotteries and K Agents)****. Suppose a DM with a utility function as given in Equation (20) is indifferent between two lotteries L_r and L_s with $r < s$ when he observes that the peers choose according to $c = (c_1, ..., c_r, ..., c_s, ..., c_N)$. Then observing at least one of the peers switch from L_s to L_r (L_r to L_s) and no peer switch in the opposite direction implies the following orderings over the two lotteries for the DM: If his distributional preferences are*

(i) convex then $L_r \succ L_s$ ($L_s \succ L_r$);

(ii) linear then $L_r \sim L_s$;

(iii) concave then $L_s \succ L_r$ ($L_r \succ L_s$).

Proof. If at least one peer switches from L_s to L_r (L_r to L_s) and none switches in the opposite direction, let this be denoted by $\hat{c} = (\hat{c}_1, ..., \hat{c}_r, ..., \hat{c}_s, ..., \hat{c}_N)$, where $\hat{c}_n = c_n$ for $n \neq r, s$, and $\hat{c}_r > c_r$ ($\hat{c}_r < c_r$, respectively), and $\hat{c}_s = c_s - \hat{c}_r + c_r$. We show that for $\hat{c}_r > c_r$ the difference $[u_r(\hat{c}) - u_s(\hat{c})] - [u_r(c) - u_s(c)]$ is strictly positive for convex, strictly negative for concave, and zero for linear distributional preferences. This is easily seen by noting that

$$\begin{aligned} u_r(c) &= p_r x_r(1-\rho) + \sigma \sum_{n=1}^{N} c_n p_n x_n + p_r(\rho - \sigma)\left[\sum_{n=1}^{r} p_n x_n x_r + \sum_{n=r+1}^{N} p_n c_n x_n\right] \\ u_s(c) &= p_s x_s(1-\rho) + \sigma \sum_{n=1}^{N} c_n p_n x_n + p_s(\rho - \sigma)\left[\sum_{n=1}^{s} p_n x_n x_s + \sum_{n=s+1}^{N} p_n c_n x_n\right]. \end{aligned}$$

Thus, we have

$$\begin{aligned} u_r(\hat{c}) - u_s(\hat{c}) \quad &- \quad u_r(c) - u_s(c) \\ &= (\rho - \sigma)\left[(\hat{c}_r - c_r)(p_r x_r - p_s x_s)p_r + (c_s - \hat{c}_s)p_s x_s(p_s - p_r)\right] \\ &= (\rho - \sigma)(\hat{c}_r - c_r)\left[(p_r x_r - p_s x_s)p_r + (p_s - p_r)p_s x_s\right] \\ &= (\rho - \sigma)(\hat{c}_r - c_r)\left[(p_s - p_r)^2 x_s + p_r^2(x_r - x_s)\right]. \end{aligned}$$

Since for $s > r$ we have $x_r > x_s$ and $p_s > p_r$, the sign of $(\rho - \sigma)$ yields the desired results. □

7.1.2 Proof for the Remark following Proposition 2: The Case of Common Gambles

Proof. To see that Proposition 2 extends to the case of common gambles, note that with perfect correlation $u_{rr} = p_r x_r$ and $u_{ss} = p_s x_s$, while u_{rs} and u_{sr} remain as given in (3) and (4). Then, for case (i) of Proposition 2 we have to show that (a) and (b) above hold for common gambles. For (a), we have $u_{rr} = u_{sr} \iff p_r x_r(1-\sigma) = p_s x_s[1 - \rho + p_r(\rho - \sigma)]$, which in particular implies that $p_r x_r < p_s x_s$, since $1 - \sigma > 1 - \rho + p_r(\rho - \sigma)$ for $\rho > \sigma$. Thus, while being risk-neutral with independent gambles when the peer chooses the riskier lottery, a DM with convex distributional preferences is risk-loving with common gambles. For (a) to hold, note that $u_{rs} < u_{ss} \iff p_s x_s[1 - (1 - p_r)\sigma - p_r \rho] > p_r x_r(1 - \rho)$, which is true since the DM was shown to be risk-loving, i.e. $p_r x_r < p_s x_s$ and it was also shown that $1 - \sigma - p_r(\rho - \sigma) > 1 - \rho$. Finally, for (b) we have $u_{rs} = u_{ss} \iff p_r x_r(1-\rho) = p_s x_s[1-(1-p_r)\sigma - p_r\rho]$, which in particular implies that $p_r x_r > p_s x_s$, since $1 - \rho < 1 - \sigma - p_r(\rho - \sigma)$ for $\rho > \sigma$. The DM is then risk-averse in his choice between lotteries if the peer chooses the safer lottery, just as in the independent gambles case. To complete the argument for the case of convex distributional preferences, we note that condition $u_{rr} > u_{sr}$ is equivalent to $p_r x_r(1-\sigma) > p_s x_s[1-\rho+p_r(\rho-\sigma)]$, which is satisfied since $1-\sigma > 1-\rho+p_r(\rho-\sigma)$ for $\rho > \sigma$, and $p_r x_r > p_s x_s$ by risk aversion. The argument for the other two cases of Proposition 2 follows similar lines.

□

7.2 Appendix B: Proof of Proposition 3

Proof. To show that for $\rho > \sigma$ the difference in indifference probabilities $d(\rho, \sigma, v)$ is positive for each admissible value of v, we first take the derivative of $d(\rho, \sigma, v)$ with respect to v. We find the derivative to be

$$\frac{\partial d(\rho,\sigma,v)}{\partial v} = \frac{p_s}{x_r(1-\rho) + p_s x_s(1-\sigma)} - \frac{p_s}{\sqrt{4x_r(\sigma-\rho)(p_s\rho x_s - p_s v) + (x_r - \rho x_r - p_s\rho x_s + p_s\sigma x_s)^2}} \tag{22}$$

Setting this derivative equal to zero, we find a unique solution at $v = x_s$. Now we just need to evaluate $d(\rho, \sigma, v)$ at $v = x_s$. If its value is positive, we know that $d(\rho, \sigma, v)$ has a minimum at $v = x_s$, and thus $d(\rho, \sigma, v)$ is always positive. Evaluating $d(\rho, \sigma, v)$ at $v = x_s$, we get

$$d(\rho,\sigma,v=x_s) = \frac{2p_s^2\rho^2 x_r x_s - 4p_s^2\rho\sigma x_r x_s + 2p_s^2\sigma^2 x_r x_s - 2p_s^2\rho^2 x_s^2 + 4p_s^2\rho\sigma x_s^2 - 2p_s^2\sigma^2 x_s^2}{2x_r(\rho-\sigma)[x_r(1-\rho) + p_s x_s(\rho-\sigma)]} \tag{23}$$

Inspection of the numerator in the above equation shows that it can be rewritten as $2p_s^2 x_s(x_r - x_s)(\rho - \sigma)^2$, which is positive for any ρ, σ. Inspection of the denominator shows that if $\rho > \sigma$, then the expression in the denominator is positive. Thus, for $\rho > \sigma$, the term $d(\rho, \sigma, v)$ is positive. If, instead, $\rho < \sigma$, then the first term in the denominator is negative, and for the second term (in brackets) it must be that $\rho - \sigma < 1 - \sigma < 1 - \rho$ since $\rho < 1$. Then $x_r(1-\rho) > p_s x_s(\rho - \sigma)$, since $x_r > p_s x_s$ and $1 - \rho > \rho - \sigma$. In this case, the denominator is negative and thus, for $\rho < \sigma$, the term $d(\rho, \sigma, v)$ is negative.

□

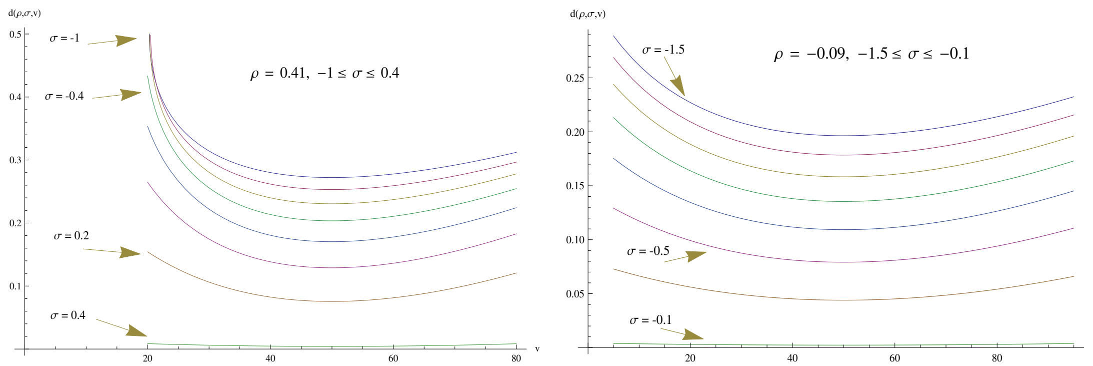


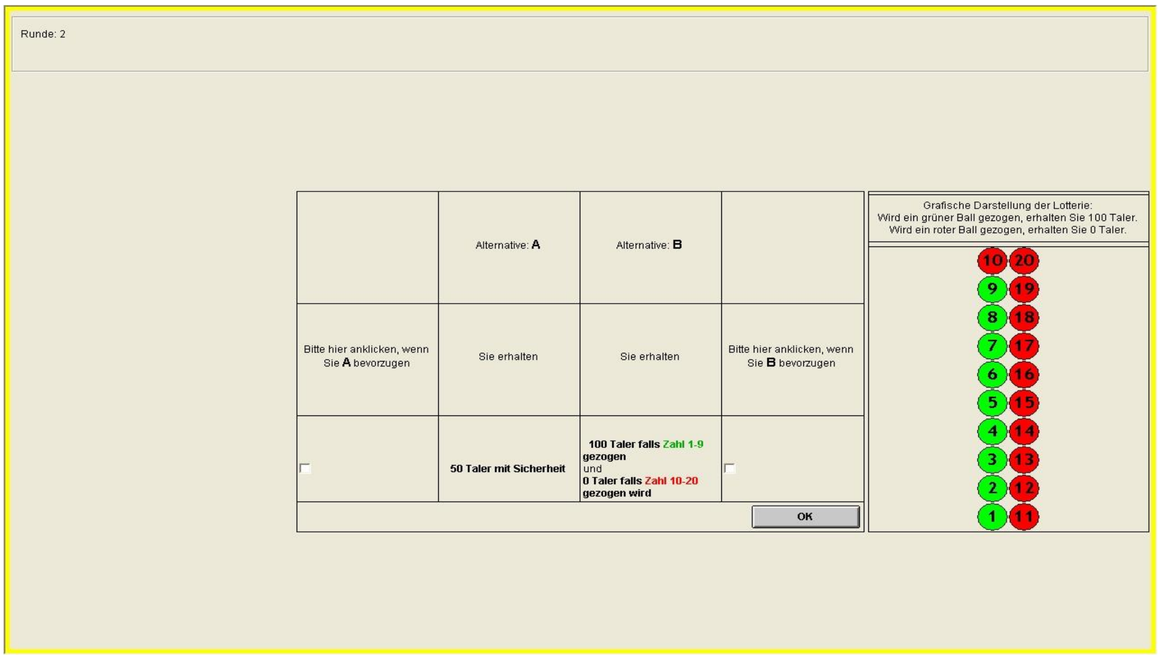
Figure 3: Difference in Indifference Probabilities of DM with Convex Distributional Preferences

Figure 3 illustrates the results for convex distributional preferences using the lottery parameters of the experiment.[25] Figure 3 displays the shape of $d(\rho, \sigma, v)$ for various types of convex distributional preferences. For each curve, ρ and σ are kept fixed and $d(\rho, \sigma, v)$ is plotted as a function of v, where we allow for arbitrary values of v within the admissible range. On the left graph of Figure 3, we fix ρ at some positive value and vary σ, allowing for positive values (such parameter combinations correspond to convex altruism) as well as negative values (such parameter combinations correspond to inequality aversion à la Fehr and Schmidt 1999). On the right graph we fix ρ at some negative value and vary σ, allowing only for values $\sigma < \rho$ to ensure convexity (such parameter combinations correspond to spiteful preferences). Each curve shows the change in the DM's indifference probability when the peer's decision moves from risky to safe. Note first that for all cases of convex distributional preferences, the level of the curve $d(\rho, \sigma, v)$ is positive, i.e. the DM's indifference probability is larger if the peer

[25]Remember that in the experiment subjects are exposed to choices where the safer lottery contains no risk at all. Here it is important to note that all our results hold in particular for $p_s = 1$, and we prefer to use a secure payoff in the experiment since it makes the decision less complex for subjects.

chooses the safe alternative, and smaller if the peer chooses the risky alternative. In other words, for a risky choice of the peer the DM requires a smaller probability for the favorable outcome x_r to occur in order to prefer the risky alternative. The DM thus follows the peer's behavior. Note further that, as stated in Proposition 3, the U-shaped curves all have their minimum for a risk-neutral DM, i.e. the social interaction effect is smallest here, while it is larger the more risk-averse or risk-loving a DM is.

7.3 Appendix C: Screenshot of Experiment



Translation:

	Alternative **A**	Alternative **B**		Graphical representation of the lottery: If a green ball is drawn, you receive 100 Taler; if a red ball is drawn, you receive 0 Taler.
Please click here, if you prefer **A**	You receive	You receive	Please click here, if you prefer **B**	
□	**50 Taler with certainty**	**100 Taler if number 1-9 is drawn** and **0 Taler if number 10-20 is drawn**	□	
			OK	

Figure 4: Presentation of a Decision Pair in Part 2 of the Experiment

Supplementary Material: Experimental Instructions

General Information

You are participating in two experiments on decision making. A research foundation has provided the funds for conducting the experiment. You can earn a considerable amount of money by participating. The text below describes exactly how your total earnings will be determined. For better comprehension only male pronouns are used; they should be understood as gender neutral.

Anonymity:
Your decisions remain anonymous. Neither the experimenters nor other subjects will be able to link you to any of your decisions. In order to keep your decisions private, please do not reveal your choices to any other participant. Each participant will only be informed about his own earnings, but not about the earnings of other participants.

Procedure:
First, Experiment 1 will be described and completed, and then we proceed to Experiment 2. At the beginning of each experiment you will receive precise instructions. We will read the instructions aloud and you will have time for questions. Please do not hesitate to ask questions if there is need for clarification. Upon completion of both experiments you will be paid out your total earnings.

Experimental Currency:
You earnings will be given in **Thalers** in both experiments. At the end of both experiments, Thalers will be converted into Euros, and you will be paid the Euro amount in cash. A Thaler corresponds to 10 Cents, that is

10 Thalers correspond to 1 Euro.

No Private Communication:
Please do not talk to other participants. If you have questions after reading the instructions or during the experiment, please raise your hand and one of the experimenters will come to clarify your question.

Experiment 1

In Experiment 1 another participant is assigned to you as your passive partner. **Your decisions** in this experiment have **consequences for you own earnings as well as for the earnings of your passive partner.** Your passive partner, however, cannot affect your earnings. A random decision of the computer will determine who your passive partner is, and you will not know his identity at any point in time. Your passive partner will also never be informed about your identity.

Decisions and Pairs of Alternatives: You will make a total of **10 decisions** in Experiment 1. Each of your decisions is a choice between alternative LEFT and alternative RIGHT. Each alternative is a distribution of Thalers between you and your passive partner.

Example: You may be asked whether you prefer alternative LEFT, in which you receive 15 Thalers and your passive partner receives 30 Thalers, or alternative RIGHT, in which you receive 20 Thalers and your passive partner also 20 Thalers. You have to make a choice between these two alternatives. This decision problem would be represented in the following way:

	Alternative: **LEFT**		Alternative: **RIGHT**		
Please click here if you prefer **LEFT**	*you receive*	*passive partner receives*	*you receive*	*passive partner receives*	*Please click here if you prefer* **RIGHT**
□	15 Thalers	30 Thalers	20 Thalers	20 Thalers	□

Your earnings from Experiment 1 will be determined in the following way:

Earnings as active participant: At the end of the experiment **one** of the 10 decision problems is selected by a random draw made separately for each participant, and the alternative chosen in this decision problem is paid out in real money. Each **random draw** is made publicly **from a bingo cage with ten numbered balls** (with numbers from 1-10). All numbers are equally likely to be drawn. The number on the ball drawn for you determines the decision problem from which you receive your payoff as active participant. This number is entered in the computer, and the computer assigns the corresponding payoff to you. For example, if the decision problem above were chosen for you, and if you had chosen alternative LEFT, then you would receive 15 Thalers as active participant, while your passive partner would receive 30 Thalers from his role as a passive partner.

Earnings as passive partner: Just like your passive partner receives money from your decision without doing anything, you receive money from another participant without doing anything, i.e. you are the passive partner of some other participant. The computer program ensures that you are not assigned the same person as active participant and passive partner. That is, if your decision determines the payoff of participant x, then the decision of participant x will not determine your payoff, but that of another participant.

To summarize: In Experiment 1 you will make 10 decisions, one of which will determine your actual payoff as active participant. At the time when you make your decisions, you will not know which of the 10 decisions will determine your payoff from the role of an active participant. All of your decisions are equally likely to be drawn for determining the payoff. In addition to your earnings in the role of an active participant you will also receive earnings from the role of a passive partner. You cannot affect the amount of your earnings in the role of a passive partner; it depends exclusively on the decisions of another participant. **The computer program ensures that you are assigned different partners in both roles.**

The draws for determining the earnings from Experiment 1 will be made after Experiment 2 is completed.

Experiment 2

Your decisions in Experiment 2 have **consequences for your own earnings only; they do not affect the earnings of other participants**. This is also true for all other participants: they can only affect their own payoffs but not the payoffs of any other participant.

Decision rounds and pairs of alternatives: Experiment 2 consists of 30 decision rounds. In each round, you will see a pair of alternatives on the screen. All participants see the same pair of alternatives in each round. Each pair of alternatives consists of Alternative A and Alternative B. **Alternative A is always a sure payoff, Alternative B is always a lottery**.

Active and passive role: In some rounds, you will see pairs of alternatives which you have already seen in previous rounds. In such rounds, some participants have an active role, and others have a passive role. Participants in an active role have to make a new decision. Participants in a passive role do not make a new decision; the computer automatically implements the decision they made the first time they saw this pair of alternatives. In rounds with active and passive roles you will be informed at the beginning of a round which role is assigned to you.

Information: When you see a pair of alternatives for which you have already made a decision in a previous round, the screen will display which decision you made the first time you saw this pair of alternatives. If you are in an active role, you will also be informed about the decision some other participant made the first time he saw this pair of alternatives. This information will be displayed on your screen. The other participant is now in the passive role, that is, the computer automatically implements the same decision that he made the first time he saw this pair of alternatives. Thus, **you know precisely how this other participant decides in the current round**. This other participant remains anonymous for you, that is, you will not get to know his identity at any point in time. As mentioned above, your earnings in Experiment 2 do not depend on the decisions of other participants, but only on your own decisions.

Your task in a decision round: If you are in an active role in a given round, you will be asked to make a decision between the two alternatives. You may change your decision as long as you have not clicked the "confirm" button. If you click "confirm", you will go to the next round with a new pair of alternatives. If you are in a passive role in a given round, the computer will implement your previous decision for this pair of alternatives. You are only asked to click "confirm" in order to get to the next round.

Your earnings from Experiment 2 will be determined at the end by using the following two-stage procedure:

Stage 1: From a **bingo cage with 30 numbered balls** (numbers from 1-30) **a ball will be drawn**, visible to anyone in this room. All balls are equally likely to be drawn. The number on the drawn ball determines the round that will be paid out. Therefore**, the round that determines earnings from Experiment 2 is the same for all participants.**

Stage 2: A separate random draw follows for each participant. The bingo cage now contains 20 numbered balls (numbers from 1-20) for each draw. Again, all balls are equally likely to be drawn. The number on the ball is the **personal lucky number** of the respective participant. If this participant has chosen Alternative A in the round that is determined to be paid out (in Stage 1), then he receives the corresponding sure payoff independent of his personal lucky number (since Alternative A is always a sure payoff). If, instead, the participant has chosen Alternative B in that round, then his personal lucky number determines his payoff as shown in the following example:

Example: Suppose that in Stage 1 the number 7 is drawn. This means that for all participants round 7 will be paid out. Suppose that in this round the following pair of alternatives was presented:

	Alternative **A**	Alternative: B	
Please click here if you prefer **A**	*you receive*	*you receive*	*Please click here if you prefer* **B**
□	**50 Thalers**	**100 Thalers if number 1-6 drawn**, and **0 Thalers if number 7-20 drawn**	□

Your earnings from Experiment 2 depend on how you decided in this round. If you chose **Alternative A**, then you receive a total of 50 Thalers from Experiment 2 independent of your personal lucky number. If you chose **Alternative B**, then your earnings from Experiment 2 depend on your personal lucky number. Suppose that in Stage 2 the number 3 was drawn as your personal lucky number. In this case you receive 100 Thalers if you chose Alternative B, since your personal lucky number is between 1 and 6. Suppose another participant also chose Alternative B in this round, but the number 8 was drawn as his personal lucky number. Then he receives 0 Thalers.