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Social Comparison and Risk Taking Behavior*

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November 18, 2014

Abstract

This paper studies the effects of social comparison on risk taking behavior. In our framework, decision makers evaluate the consequences of their choices as changes with respect to both their own and their peers' conditions. We test experimentally whether different positions in the social ranking determine different risk attitudes. Subjects interact in a simulated workplace environment, where they receive possibly different wages as compensation for effort and then undertake a risky decision that may give them an extra gain. We find that social comparison matters for risk attitudes. In addition, risk aversion decreases with the size of social gains. As a consequence, subjects are less risk averse in social loss than in small social gain, whereas their risk attitudes do not differ between social loss and large social gain.

Keywords: Social comparison, risk aversion, interdependent preferences, reference point.
JEL classification: C91, D03, D81.

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1 Introduction

Imprudent risk-taking by investment bankers is often recognized as one of the main causes of the current world-wide financial crisis. In line with this view, financial regulation authorities in Europe and the United States have established, among other measures, caps on the variable component of bank managers' pay.[1] The effectiveness of such policies, however, depends not only on agents' sensitivity to monetary incentives, but also on the factors that determine risk attitudes, such as relative pay comparisons with other employees. In this paper we provide new evidence on the relevance of social comparison for risk taking in the workplace. We study the effects of relative pay comparisons on risk attitudes in an experimental labor relation setting, showing that pay inequalities enhance risk loving behavior.

Research in economics and other disciplines has acknowledged that social comparison is an important determinant of human behavior, since agents care not only about their own absolute income and consumption levels, but also their relative position with respect to others.[2] In social psychology, Social Comparison Theory suggests that people evaluate their own opinions and abilities in comparison with the opinions and abilities of others (Festinger, 1954). In the economic literature, Veblen (1899) introduced the idea that individuals care about comparisons with other members of the same community, and conspicuous consumption is a way to signal social status. Duesenberry (1949) emphasized the relevance of social comparison for consumption behavior. More recently, the economic literature has shown that positional concerns play a key role for labor market performance (Charness and Kuhn, 2007; Clark et al., 2010; Cohn et al., 2011; Gächter and Thöni, 2010; Ockenfels et al., 2010),[3] job satisfaction (Card et al., 2012; Clark and Oswald, 1996), and subjective well-being (Ferrer-i-Carbonell, 2005; Vendrik and Woltjer, 2007).

Following the seminal work by Kahneman and Tversky (1979), it is widely acknowledged that individuals may have different risk attitudes depending on whether they face positive or negative changes with respect to an internal reference point (e.g., status quo, aspirations, etc.).[4] Similarly, in a social environment, individuals may have different risk attitudes depending on whether the outcomes of a risky choice fall above or below the outcome of an external reference point (e.g., colleagues, neighbors, relatives, etc.). Therefore, a number of studies have tested whether standard models of social preferences (Bolton and Ockenfels, 2000; Charness and Rabin, 2002; Fehr and Schmidt, 1999) can

[1] See Committee of European Banking Supervisors (2010) and Office of the Comptroller of the Currency et al. (2010).

[2] See for example Abel (1990) and Galí (1994).

[3] For an analysis of the effects that *perceived* inequalities among agents have on their effort levels see Gill and Stone (2010).

[4] Models of reference-dependent preferences that differ from Prospect Theory are proposed, for example, in Koszegi and Rabin (2006, 2007), Masatlioglu and Ok (2005) and Munro and Sugden (2003).

be extended to decision problems with uncertain outcomes (Bolton and Ockenfels, 2010; Friedl et al., 2014; Lahno and Serra-Garcia, 2014; Rohde and Rohde, 2011).

A small number of recent studies have focused more specifically on the effects of social comparison *per se* on risk-taking behavior. Linde and Sonnemans (2012) study the effects of different social reference points on risk attitudes, in a setting where participants choose between two lotteries while a referent faces a fixed payoff. Their results indicate that, contrary to the predictions of Prospect Theory with a social reference point, participants are more risk averse in social loss (i.e., they can earn at most as much as their referent) than in social gain (i.e., they will earn at least as much as their referent).[5] Schwerter (2013) studies experimentally how risk attitudes change when the outcomes of risky decisions can reverse the social ranking. The results indicate that subjects are less risk-averse in social loss, consistently with the hypothesis of social loss aversion. A distinguishing feature of these studies is that, in the experimental design, only the social reference point is manipulated exogenously.

In this paper, we study experimentally whether and how social comparison affects risk taking behavior, by exogenously manipulating both the social and the private reference point. We reproduce a social environment, whereby randomly paired subjects interact in a real effort task. If the task is completed, workers earn a fixed wage, which can be either low or high and may coincide with, or differ from, the wage assigned to their co-worker. At the end of the task, subjects are informed of both their own and their co-worker's wage. Then, they face a risky decision through which they can gain an extra bonus on top of their wage. Within each pair the bonus is paid only to one worker, randomly selected after the risky decisions have been made. Thus, when making the decision, agents who have a concern for relative payoffs consider their co-worker's wage as their social reference point and their own wage as their private reference point. Different allocations of wages across pairs determine different conditions. Workers' total earnings (wage plus bonus) are either below the social reference point (social loss) or above the social reference point (social gain), while they are always above the private reference point (private gain). This allows us to exogenously manipulate the size of the social gain, while keeping constant the sign and size of the private gain.

We obtain the predictions for our experiment within a very general framework that displays interdependent preferences and assumes that the monetary outcome of a social referent enters the utility function of the decision maker. As in Maccheroni et al. (2012), we assume a utility function that is additive in a private and a social component. While the private component represents the intrinsic utility that the decision maker derives from his own outcome, the social

[5]In a closely related study, Linde and Sonnemans (2014) show that, in a setting where agents' choices only affect their own earnings, the presence of a social reference point does not affect risk-taking behavior, in contrast with the predictions of standard social preference models.

component represents the decision maker's concern for relative outcomes. We focus on the implications of a social component that displays the usual Prospect Theory properties, i.e., concavity (*social risk aversion*) in the social gain domain and convexity (*social risk love*) in the social loss domain.

We find that the decision maker's social condition affects risk taking behavior. While risk aversion is observed overall in every condition, subjects are more risk averse in small social gain than in social loss. In addition, risk aversion is stronger in small than in large social gain. Our interpretation is the following. First, subjects are risk averse in every treatment because, irrespective of their social condition, they face positive changes relative to their own wage. Second, changes in risk attitudes across social conditions are determined by two effects. On the one hand, decision makers are willing to take more risk when facing social loss than when facing social gain, as in the former case they are driven by the incentive to catch up with their peer (*keeping up with the winners effect*).[6] On the other hand, social risk aversion is decreasing in social gain: the further a decision maker is above his social referent, the richer he feels and the less risk averse he becomes (*perceived wealth effect*). The combination of these two effects implies that the relation between risk attitudes in social loss and in social gain is ambiguous, as it generally depends on the size of the social gain.

The paper is structured as follows. Section 2 provides the theoretical framework. Section 3 describes the experimental design and the hypotheses. Section 4 presents the results. Section 5 discusses the experimental findings. Section 6 concludes.

2 Theoretical Framework

The existing literature on social comparison and decision making under risk provides no empirical support in favor of a specific functional form for agents' value function. The theoretical approach commonly adopted by the literature is based on a standard reference-dependent utility function that can be represented in its general form as follows:

$$v(x, s) = u(x) + g(x - s) \tag{1}$$

where $u(x)$ describes the agent's intrinsic utility from the monetary outcome x and $g(x - s)$ describes the utility (or disutility) derived from the comparison of x with the outcome of a social referent s. An axiomatization of this utility function is provided by Maccheroni et al. (2012).[7] We assume that both

[6]The *keeping up with the winners* effect finds support in Fafchamps et al. (2013). Among other findings, their multi-round experiment on asset integration indicates that subjects who are asked to invest an initial endowment that is relatively smaller than the endowment received by the other subjects are more willing to take risks.

[7]Notice that the representation in equation (1) encompasses as special cases many functional forms that have been adopted to study, for example, relative income concerns in the macroeconomic literature (e.g., Abel, 1990) and in the empirical literature (e.g., Ferrer-i-

components are increasing in x.

Within this general framework, we want to study how changes in social condition, i.e., changes in $(x - s)$, impact the decision maker's risk attitudes. We focus on the social component of the value function, to investigate whether it displays Prospect Theory features, i.e., convexity in social loss and concavity in social gain. We also take into account that the private component may play an important role, as the satisfaction (or disappointment) of getting more (or less) than one's peers might not be the only determinant of risk taking behavior in a social context. Decision makers who dislike the risk associated with their absolute outcomes may display risk averse behavior regardless of their concern for relative outcomes. Hence, the decision maker's risk attitudes are determined by both his *private risk aversion*, i.e., the decision maker's aversion to risks associated with deviations from his private reference point, and his *social risk aversion*, i.e., the decision maker's aversion to risks related to his standing with respect to his peer's outcome.[8] Private and social risk aversion are related to the curvature of the two components of the utility function $u(\cdot)$ and $g(\cdot)$, respectively.

An application of Prospect Theory to the social reference point, disregarding the effect of the private utility component, would predict that risk attitudes are determined by social risk aversion, implying risk loving behavior in social loss and risk aversion in social gain.[9] However, the experimental evidence by Linde and Sonnemans (2012) suggests that Prospect Theory predictions do not apply to social comparison in a simple way. In their experiment, subjects display risk aversion in every social condition and, in particular, more risk aversion in social loss than in social gain.

In order to consider the role played by private risk aversion for overall risk attitudes in a social context, we need to generalize $u(\cdot)$ to be non-linear. In this case, the behavioral implications ultimately depend on the relation between private and social risk aversion. For example, a decision maker who is risk-averse in private gains ($u(\cdot)$ concave) and risk-loving in social loss (i.e., $g(\cdot)$ is convex when $x < s$) may not be risk lover overall. The private utility component may however depend on how subjects perceive outcome x in relation to some intrinsic reference point other than s. That is, private risk aversion, similarly to social risk aversion, may be reference-dependent. If this is the case, decision makers evaluate outcomes in relation with two reference points, a private and a social one.[10]

Carbonell, 2005). We find different specifications of equation (1) in Clark and Oswald (1998), Fehr and Schmidt (1999), and in recent experimental studies as Lahno and Serra-Garcia (2014) and Schwerter (2013).

[8]We borrow the term *social risk aversion* from Maccheroni et al. (2012).

[9]Notice that the same behavior is predicted by a utility function as in equation (1) if the private component is *linear* and the social component has Prospect Theory features, i.e., concave for social gain and convex for social loss.

[10]A recent strand of literature on behavioral decision making considers that decision makers' attitudes may be influenced by the presence of *multiple* individual reference points (see, for example, Wang and Johnson, 2012, and March and Shapira, 1992). For experimental evidence see Sullivan and Kida, 1995, Ordóñez et al., 2000, Koop and Johnson, 2010.

We thus assume $v(x;r,s) = u(x-r) + g(x-s)$, where both $u(\cdot)$ and $g(\cdot)$ are increasing in x and $g(\cdot)$ is concave in social gain ($x > s$) and convex in social loss ($x < s$). Let

$$RA^u(x-r) = -\tfrac{u''(x-r)}{u'(x-r)}, \quad RA^g(x-s) = -\tfrac{g''(x-s)}{g'(x-s)} \tag{2}$$

be the coefficients of private and social risk aversion respectively. The overall coefficient of risk aversion $RA(x;r,s)$ can be written as

$$\begin{aligned} RA(x;r,s) = & \frac{u'(x-r)}{u'(x-r)+g'(x-s)} RA^u(x-r) \\ & + \frac{g'(x-s)}{u'(x-r)+g'(x-s)} RA^g(x-s), \end{aligned} \tag{3}$$

so that overall risk aversion can be expressed as a convex combination of private and social risk aversion.

The following proposition shows, however, that risk attitudes in social gain and in social loss can be ranked only under specific conditions.

Proposition 1 *Consider x, r, $\bar{s}$ and $\hat{s} \in \mathbb{R}$ such that $\bar{s} < x < \hat{s}$. Then $RA(x;r,\bar{s}) > RA(x;r,\hat{s})$ if either of the following conditions apply:*

(i) $RA^g(x-\hat{s}) < RA^u(x-r) < RA^g(x-\bar{s})$;

(ii) $RA^u(x-r) \geq 0$ *and* $g'(x-\bar{s}) \leq g'(x-\hat{s})$.

Proof. For simplicity let $u' = u'(x-r)$, $\bar{g}' = g'(x-\bar{s})$, $\hat{g}' = g'(x-\hat{s})$. Let also $\widehat{RA}^g = RA^g(x-\hat{s})$ and $\overline{RA}^g = RA^g(x-\bar{s})$, and define similarly RA^u, $\widehat{RA}$ and $\overline{RA}$. First notice that, given the assumptions on $g(\cdot)$, $\widehat{RA}^g < 0 < \overline{RA}^g$. We can equivalently rewrite $\overline{RA} - \widehat{RA}$ as follows:

(i)

$$\begin{aligned} \overline{RA} - \widehat{RA} = & \frac{1}{(u'+\hat{g}')(u'+\bar{g}')} \left[u' \left((RA^u - \widehat{RA}^g)\hat{g}' + (\overline{RA}^g - RA^u)\bar{g}' \right) \right. \\ & \left. + (\overline{RA}^g - \widehat{RA}^g)\hat{g}'\bar{g}' \right]. \end{aligned} \tag{4}$$

From equation (4) it is easy to see that $RA^g(x-\hat{s}) < RA^u(x-r) < RA^g(x-\bar{s})$ is a sufficient condition for the difference to be positive.

(ii)

$$\overline{RA} - \widehat{RA} = \frac{1}{(u' + \hat{g}')(u' + \bar{g}')} \Big[u'(\hat{g}' - \bar{g}')RA^u + \hat{g}'\bar{g}'(\overline{RA}^g - \widehat{RA}^g) + u'(\overline{RA}^g \bar{g}' - \widehat{RA}^g \hat{g}') \Big]. \quad (5)$$

From equation (5) it is easy to see that $RA^u(x - r) \geq 0$ and $g^{'}(x - \bar{s}) \leq g^{'}(x - \hat{s})$ are sufficient conditions for the difference to be positive.

■

Proposition 1 implies that the relation between social risk attitudes in social loss and in social gain is reflected by the overall risk attitudes of the decision maker when either the risk attitudes of the social component are more extreme than the private risk attitudes ($RA^g(x - \hat{s}) < RA^u(x - r) < RA^g(x - \bar{s})$), or the decision maker has a private component that displays risk aversion ($RA^u(x-r) \geq 0$) and a social component that is steeper in social loss than in social gain.

3 The Experiment

We study the effect of social comparison on risk-taking behavior by reproducing a workplace environment in the lab, where subjects perform an effort task in pairs, receive (possibly) different wages and then face a risky decision that can generate a bonus on top of their wage. This experimental setting reproduces the economic context we have in mind, a financial institution where risk takers receive a pay which is given by a fixed part, the wage, and a variable part, the bonus, which depends on the success of their investment decisions.

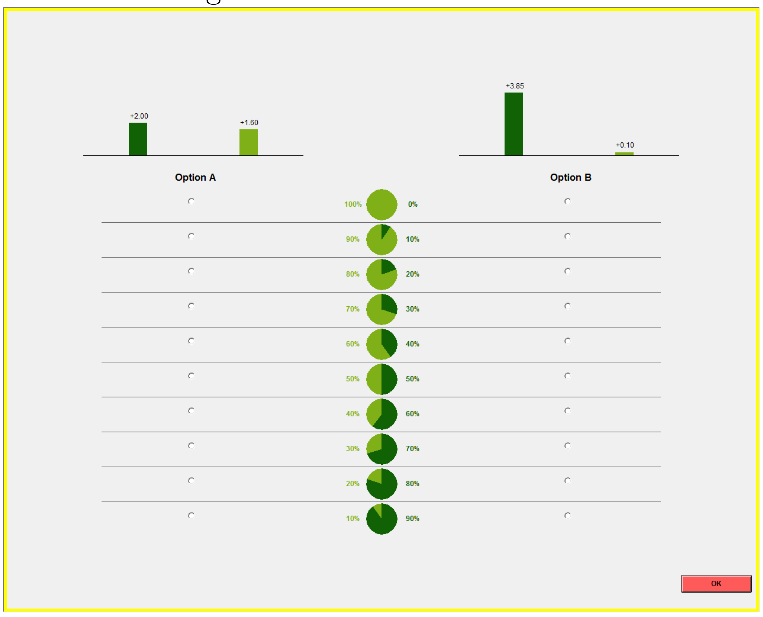
3.1 Task

The experimental task consists of two parts (experimental instructions are provided in Appendix). The first part is a *risk elicitation task* implemented in the absence of a social environment, which we used to classify participants' risk attitudes. The task was structured with a Multiple Price List (MPL) format (Holt and Laury, 2002; Laury and Holt, 2005). We modified the MPL format by making the components of the decision problems as visually salient as possible. Subjects faced a menu of ten choices between two lotteries (A and B), where each lottery had two possible monetary outcomes, and lottery A was safer than lottery B. Earnings were expressed in Experimental Currency Units (ECU), where 1 ECU = 1 euro. Lottery A paid either 2.00 ECU or 1.60 ECU, while lottery B paid either 3.85 ECU or 0.10 ECU.[11] The ten choices in the task differed in

[11]These are the same stakes as in Holt and Laury (2002). We also kept the same payment structure: if the risk task was paid out, the computer randomly drew one row out of ten and played the lottery chosen by the subject in that row.

the probability distribution over monetary outcomes, where the probability of the unfavorable outcome was 1 in the first row and decreased, in each of the subsequent choices, down to 0.1 in the last choice. Outcomes and probabilities were such that a rational decision maker would choose lottery A in the first-row, and a risk neutral decision maker would choose A for the first five rows and B for the remaining five. Figure 1 displays the screenshot of the risk task.

Figure 1: Risk elicitation task

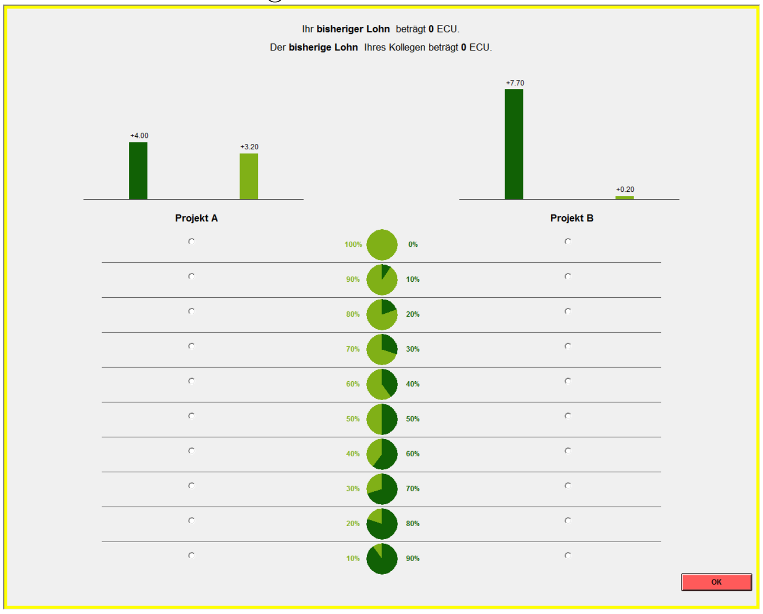


In the second and main part of the experiment every subject was randomly paired with a co-worker. Each pair undertook an effort task (*work task*) that determined the workers' wages. Thereafter, each worker faced a risky decision that could generate a bonus (*bonus task*).

In the work task, we assigned each participant one of two contracts (E and F). Each contract paid the worker, upon completion of the task, either 2 ECU or 10 ECU, depending on the realization of a computerized coin toss. In particular, contract E (F) paid the high wage of 10 ECU when head (tail) was tossed. Regardless of their contracts and the realization of the coin toss, workers received 0 ECU in case they could not finish the task within a certain time limit.[12] At this stage, participants were only informed about their own contract, not about their co-worker's one. At the end of the work task, a coin was tossed (once for all subjects in a session) and participants who completed both parts of this task were told the result of the coin toss, their own wage and the co-worker's wage.

[12]In every session, we allocated contracts in such a way that, in principle, half of the subjects could obtain a wage of 2 ECU and half a wage of 10 ECU by completing the task (subjects received this information in the instructions). Note that this contract allocation scheme ensured a procedurally fair wage distribution across all participants in a session and across co-workers in every pair. Obviously, *exactly* half of the subjects actually received 10 ECU and the other half 2 ECU only when everybody in the session completed the task.

Figure 2: Bonus task



Then, workers faced the bonus task, that was designed with a MPL format similar to the one administered in the first part of the experiment, but with different stakes[13] and some additional information (worker's and co-worker's wages) displayed on the top of the screen. The two lotteries were presented as projects that could generate additional earnings for the worker and outcomes were presented as positive changes with respect to the wage earned in the work task. Figure 2 displays the screenshot of the bonus task.

3.2 Treatments

We induced an explicit individual reference point r, which is the wage a worker obtains in the work task. Moreover, we expressed outcomes of the risky decision of the bonus task as positive changes with respect to the wage. Hence, every possible outcome that the decision maker faces is a gain with respect to the individual reference point. We kept $(x - r)$ constant across social comparison situations, for every possible outcome x of the two lotteries. This procedure allowed us to identify the effect of social comparison, since the changes in risk attitudes that we observe can only be produced by changes in social risk aversion.

We induced the social reference point in an unambiguous way. We implemented a payment scheme such that, in every pair, both workers received the fixed part of their final earnings (i.e., the wage), but only one of them (ran-

[13]In the bonus task, Lottery A paid now either 4.00 ECU or 3.20 ECU, while lottery B paid either 7.70 ECU or 0.20 ECU. These are the same stakes as in Laury and Holt (2005). As in the first part of the experiment, lottery A was safer than lottery B, the first choice assigns probability 1 to the unfavorable outcome, a rational decision maker would prefer lottery A in the first choice and a risk neutral individual would switch exactly after the 5^{th} row.

domly determined) was paid the relative part of his final earnings (i.e., the bonus). Thus, subjects were aware that, if they received the bonus, their co-worker would not receive it, so that his final earnings would be simply his wage.[14] Hence, from the subject's perspective, while his own *wage* represents the private reference point r, the *co-worker's wage* represents the social reference point s. Note that the social reference point is fixed: it does not depend on the worker's investment decision or the realization of the investment.

We implemented four treatments between subjects, corresponding to different pair-wise social comparison situations, characterized by the profile (r, s). A subject can face either *social gain*, when his final earnings are above his social reference point, or *social loss*, when his final earnings are below his social reference point. The payoff structure of the bonus task is such that subjects cannot reverse the (pair-wise) social ranking with their investment decisions. Indeed, if a worker has the low wage of 2 ECU and the co-worker has the high wage of 10 ECU, the bonus is not sufficient to make him earn more than his co-worker.[15] To sum up, our social conditions are such that subjects in treatment $(2, 10)$ face social losses with respect to their peers' final earnings, while subjects in treatments $(2, 2)$, $(10, 2)$ and $(10, 10)$ face social gains of different size (small in $(2, 2)$ and $(10, 10)$, large in $(10, 2)$).

3.3 Hypotheses

We start by testing the hypothesis that the size of the reference points does not affect risk attitudes. More specifically, we expect to observe the same risk attitudes in treatments $(2, 2)$ and $(10, 10)$, since subjects face the same variations with respect to both s and r.

> **H1 - Reference points do not affect risk attitudes**: Risk-attitudes do not differ in treatments $(2, 2)$ and $(10, 10)$.

The purpose of this hypothesis is twofold. On the one hand, it sheds light on the form of the utility function and, in particular, on the role played by private risk aversion. On the other hand, it is a preliminary step before making comparisons across different social conditions. Rejection of this hypothesis would

[14]The randomly selected worker within every pair was called the *team leader*. The fact that the identity of the leader was unknown during the bonus task induced both workers to focus on the investment decision as if they were the leader and their decision had economic consequences. This procedure allowed us pinpoint the social reference as the co-worker's wage.

[15]Obviously, if a worker has either the same wage as his co-worker or the highest wage in the pair, his final earnings including the bonus would be certainly larger than his co-worker's final earnings. We agree that to reverse the social ranking could be a driving force for risky behavior. For instance, decision makers could attribute high value to being the first and this would constitute a plausible incentive to choose a risky investment in the bonus task. However, our concern in this paper is to study how the relative position in the social ranking *per se* affects the risk attitudes of the decision maker.

imply that risk attitudes are sensitive to absolute outcomes.[16] If this were the case, we would not be able to compare in a meaningful way risk taking behavior of subjects who face different social conditions (i.e., different $x - s$) and, at the same time, different individual reference points r. For example, we could not conclude that differences in risk attitudes across treatments $(2, 10)$ and $(10, 10)$, or $(2, 10)$ and $(10, 2)$, are caused by relative outcome concerns, as they may be caused by the private utility being non-linear in own outcomes.

Given our general framework, we can formulate some predictions on how risk attitudes differ across social conditions. The first prediction regards risk attitudes in social gain conditions. We assume that social risk aversion decreases in social gain. This assumption is rather plausible, as it is the counterpart, in a social context, of the assumption that risk aversion is decreasing in *absolute* wealth, which is well supported by the experimental evidence (see, e.g., Holt and Laury, 2002). Indeed, if individuals are less averse to risks regarding their absolute wealth as they become richer, it is also plausible that individuals are less averse to risks that regard their relative wealth as they *perceive* to be richer, i.e., when they are further away from their social reference point. Under this assumption, Theorem 5 in Pratt (1964) implies that overall risk aversion is decreasing in social gain.[17] Hence, we expect to observe that decision makers with higher relative standing are less risk averse. We can state this hypothesis as:

> **H2 - Risk aversion decreases with size of social gain**: Subjects are less risk averse in large social gain (treatment $(10, 2)$) than in small social gain (treatments $(10, 10)$ or $(2, 2)$).

Next, we compare risk attitudes in social loss and in social gain. Predicting differences in risk taking behavior between these conditions is not trivial. In particular, it is not obvious that, overall, risk aversion is higher in social gain than in social loss, as Prospect Theory would predict. Even if we assume that the social component has Prospect Theory features, i.e., convexity in social loss and concavity in social gain, the relation that occurs between social risk aversion in social gain and loss does not always result in the same relation between overall risk aversion in the two domains. Indeed, such relation also depends on private risk aversion. As shown in Section 2, under plausible assumptions on the shape of $u(\cdot)$ and of $g(\cdot)$ less risk aversion is expected in social loss than in social gain. We can thus state the following hypothesis:

[16] This hypothesis implies that either we can represent the argument of the private utility as $(x - r)$ or that private utility is $u(x)$ but it displays constant risk aversion. In both cases, private risk aversion does not vary across treatments, hence we can focus on social risk aversion.

[17] Note that Theorem 5 in Pratt (1964) applies to our framework since our utility function is additive in its two components and both components are increasing in own outcomes. Essentially, the theorem states that the sum of two functions that are constantly or decreasingly risk averse is decreasingly risk averse. We assumed that the social component is decreasingly risk averse; the private component is constant across social conditions since, by design, its argument $(x - r)$ is constant.

H3 - Social Reflection Effect: Subjects are less risk averse in social loss (treatment $(2, 10)$) than in social gain (treatments $(2, 2)$, $(10, 10)$ or $(10, 2)$).

Note that, if it holds true that risk aversion decreases in social gain (as stated in H2), it might be the case that the relation predicted by H3 holds true when we compare social loss and small social gain, but not when we compare social loss and large social gain.

3.4 Procedures

We ran the experimental sessions in March and July 2013 at the lab of the Max Planck Institute of Economics in Jena. We recruited 436 participants from various disciplines at the local university using the ORSEE software (Greiner, 2004). We ran 14 sessions of about one hour each. The experiment was implemented with the software Z-tree (Fischbacher, 2007).

Upon arrival, subjects were randomly assigned to computer terminals. Each computer terminal was in a cubicle that prevented communication or visual interaction among the participants.[18] Paper-based instructions for each part of the experiment were distributed separately, participants were given time to read them privately and were allowed to ask for clarifications. At the beginning of each part, after reading the instructions, participants answered some control questions (displayed on the screen).

The work task consisted of two similar parts, each lasting a maximum of four minutes. Subjects had to complete both parts in order to receive their wage. In each part, subjects had to write 20 combinations of two letters, out of a given set of 10 letters (a, b, c, d, e, f, g, h, i, j, in the first part; k, l, m, n, o, p, q, r, s, t, in the second part). Participants were not allowed to write the same combination twice, or to write combinations already validated to their co-worker. When either of these two situations occurred, the participant received an error message. This procedure created a link between co-workers: by encountering each other during the work task (when they wrote a combination already validated by the co-worker) - or by knowing that there was such possibility - they experienced the existence of the other.[19]

At the end of the experiment, participants filled in a computer-based questionnaire, then received their payments. Subjects were paid in private in cash. The average monetary payoff in the experiment was 10.2 euros, including a 2.50 euro participation fee.

[18] Subjects had to complete both parts, but they were paid only for one of them, randomly drawn by the computer at the end of the experiment. The probability that the first part was paid was 10%.

[19] Note that a more competitive interaction would have generated emotions with an impact on the bonus task that would have been out of our control.

4 Results

We start by presenting a preliminary analysis of the risk preferences of the participants, as elicited in the first part of the experiment in the absence of the social reference point. Our visual application of the risk elicitation task by Holt and Laury (2002) and Laury and Holt (2005) is effective in producing consistent behavior. In particular, only 12 out of 436 subjects displayed inconsistencies such as choosing the dominated lottery in the first row or switching multiple times in either lottery task.[20] We focus only on the behavior of subjects who displayed none of these inconsistencies. Moreover, four subjects did not complete the work task, thus receiving a zero wage. We dropped these subjects and also their co-workers from the sample, as we believe that different incentives and mechanisms of social comparison may operate when wage inequalities arise from a failure of one of the two co-workers.[21] Hence, we analyze the behavior of the 417 subjects who received a positive wage, started from lottery A in the first row and switched to B only once.

In order to evaluate the risk attitudes of subjects in both risk tasks, we use the number of consecutive safe choices as a measure of their degree of risk aversion. As discussed in Section 2, a risk neutral subject would switch exactly at the fifth row in each task, a risk averse subject would switch after the fifth row, and a risk lover would switch before it. Table 1 provides the distribution of risk types, classified according to the number of consecutive safe choices (SCI) in the individual risk elicitation task. The individual risk elicitation task allows us to control for intrinsic disposition toward risk when we analyze the effect of social comparison on risk taking behavior. This is particularly helpful because we perform a between subjects analysis. By exploiting a measure of individual risk aversion we can isolate the social component in a more precise way.

Table 2 reports the average number of consecutive safe choices made in the bonus task (SCB) by treatment. Note that treatments where both subjects receive the same wage display a higher number of consecutive safe choices. Differences in means across treatments are relatively small. However, it should be noted that the MPL format has a tendency to induce a large concentration of switches around 5 or 6.[22]

We perform a between-subjects analysis to study whether and how social comparison affects risk attitudes. We estimate by OLS the parameters of the following specification:

[20] The largest number of mistakes was made in the first task, where 11 subjects made multiple switches between the lotteries, and one of them also started from the dominated lottery in the first row. In the bonus task only 6 subjects switched multiple times (5 of which also showed inconsistencies in the first task), while nobody started from the dominated lottery. Therefore, only 12 subjects displayed one or more of these inconsistencies, and were dropped from the sample. This finding is particularly interesting if one considers for example that Laury and Holt (2005) have 44 subjects out of 157 who present multiple switches.

[21] Overall, only 19 subjects were dropped, since one of the subjects with zero wage also was in the group of subjects with inconsistencies in the first risk task.

[22] See Harrison et al. (2005) for a discussion of the MPL format.

Table 1: Classification of subjects by risk attitude

Risk Attitudes	Frequency	Percentage
Risk averse	262	62.83
Risk neutral	85	20.38
Risk lover	70	16.79
Total	417	100.00

Notes: Classification of the subjects into risk types according to the number of consecutive choices in the individual risk task (SCI): Risk averse (SCI<5), Risk neutral (SCI$=5$), Risk lover (SCI>5).

Table 2: Aggregate behavior in the bonus task by treatment

Treatment	Mean	Std. Err.	Observations
(2, 2)	6.14	0.15	101
(2, 10)	5.90	0.15	107
(10, 2)	5.96	0.15	106
(10, 10)	6.26	0.14	103

Notes: Summary statistics across treatments of the variable SCB, defined as the number of consecutive safe choices in the bonus task.

$$SCB_i = \alpha + \beta SCI_i + \gamma_1 D(2,2) + \gamma_2 D(2,10) + \gamma_3 D(10,2) + \delta Z_i + \varepsilon_i, \qquad (6)$$

where SCB is the number of consecutive safe choices made in the bonus task, SCI is the number of consecutive safe choices made in the individual risk elicitation task, $D(r,s)$ is a set of dummy variables that identifies subjects in treatment (r,s), with $(10,10)$ as the base category, and Z_i represents individual controls based on the final questionnaire (age, gender and height).[23]

Table 3 reports estimation results. According to hypothesis H1, risk attitudes should not differ across treatments $(2,2)$ and $(10,10)$, i.e., $\gamma_2 = 0$. Table 3 indicates that γ_2 is not significantly different from zero. In treatments $(2,2)$ and $(10,10)$ subjects face final earnings that imply the same difference $(x-s)$ with respect to the social reference point. Social risk aversion should therefore have the same impact on their risk attitudes. As discussed in Section 2, differences between these two treatments, if any, should be attributed to the private component of the utility function, as these subjects only differ with respect to their own wages. The evidence that there are no significant differences across the two treatments implies that private risk aversion does not change with own absolute outcomes x when we keep $(x-r)$ fixed. Therefore, we can meaningfully compare subjects in treatments characterized by different own wages.

[23]In the questionnaire, we also asked subjects to report their weekly budget. However, since we inferred from their implausible answers that they did not understand the question, we do not consider this variable as a meaningful individual control. If included, the variable budget is significant with coefficient 0.0002, but none of the other results change.

Table 3: Effects of social comparison on risk taking

	(1)	(2)
SCI	0.534***	0.536***
	(14.47)	(14.44)
D(2,2)	-0.155	-0.143
	(0.89)	(0.81)
D(2,10)	-0.420**	-0.411**
	(2.45)	(2.37)
D(10,2)	-0.491***	-0.484***
	(2.85)	(2.78)
Age		-0.001
		(0.06)
Gender		-0.042
		(0.24)
Height		0.005
		(0.55)
Constant	3.063***	2.283
	(12.12)	(1.34)
R^2	0.34	0.34
N	417	417

Notes: Dependent variable: SCB (number of consecutive safe choices in the bonus task); SCI is the number of consecutive safe choices in the individual risk task; dummy variables D(r,s) identify subjects with wage r and a co-worker with wage s; Age is measured in years; Gender=0 is female; Height is measured in cm. The base category is treatment $(10, 10)$. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

In order to test whether risk aversion decreases with the size of social gain (H2), we compare the behavior of subjects in either $(10, 10)$ or $(2, 2)$ with $(10, 2)$, as less risk aversion expected in the latter. The results in Table 3 indicate that this is indeed the case, as $\gamma_3 < 0$ is negative and strongly significant. Similarly, γ_3 is lower than γ_1, i.e., the difference between $(10, 2)$ and $(2, 2)$ is negative and marginally significant ($p = 0.053$ (0.050) without (with) individual controls). Overall, the results provide support to the hypothesis that risk aversion is decreasing with the size of social gain.

Let us now consider the key hypothesis (H3), by comparing risk attitudes in social loss and social gain. Table 3 indicates that risk aversion is *less* strong in social loss than in small social gain: the difference between treatments $(2, 10)$ and $(10, 10)$ is negative and strongly significant; the difference between treatments $(2, 2)$ and $(2, 10)$ is also negative, although only marginally significant ($p = 0.113$ (0.112) without (with) individual controls). On the other hand, the difference between treatments $(2, 10)$ and $(10, 2)$ is small and not significant ($p = 0.675$ (0.671) without (with) individual controls). Overall, these results suggest that risk aversion is less strong in social loss than in small social gain, whereas risk attitudes do not differ when comparing social loss with large social gain.

In order to assess the robustness of the results, we ran two additional sets of regressions. First, we aggregated treatments $(2, 2)$ and $(10, 10)$ into a single group and estimated the specification in (6) using this broader group of small social gain as the base category. The results, reported in Table 4 indicate that the coefficient of $D(2, 10)$ is negative and significant. Hence, risk aversion is less strong in social loss than in small social gain. As above, the difference between social loss $(2, 10)$ and large social gain $(10, 2)$ is not significant ($p = 0.676(0.671)$ without (with) individual controls).

Table 4: Effects of social comparison on risk taking, alternative specifications

	(1)	(2)
SCI	0.534***	0.537***
	(14.46)	(14.45)
D(2,10)	-0.343**	-0.340**
	(2.32)	(2.28)
D(10,2)	-0.415***	-0.413***
	(2.78)	(2.76)
R^2	0.34	0.34
N	417	417

Notes: Dependent variable: SCB (number of consecutive safe choices in the bonus task); SCI is the number of consecutive safe choices in the individual risk task; dummy variables D(r,s) identify subjects with wage r and a co-worker with wage s. Specification (2) includes the same set of individual controls as in Table 3. The base category is the aggregate category that includes all subjects with a wage equal to the co-worker's wage, i.e., subjects in treatments $(2, 2)$ and $(10, 10)$. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Second, we replicated the analysis by restricting the attention on the subsample of subjects who displayed a risk averse or neutral behavior in the individual risk elicitation task. This is because our theoretical results on the comparison of risk attitudes between social loss and social gain are derived either under the assumption that there is private risk aversion or neutrality (Proposition 1.ii), or under parametric conditions that also depend on the type of concavity of the individual component (Proposition 1.i). Table 5 presents the results. When focusing only on subjects who are risk averse or neutral in the individual task, the comparison across regions is unaffected. Overall, the evidence supports the hypothesis that risk aversion is lower in social loss than in small social gain, but there is no significant difference when comparing social loss with large social gain.

As shown above, the risk attitudes displayed in the social risk task (SCB) and the individual risk task (SCI) are strongly correlated. Although the two tasks are not directly comparable,[24] it is interesting to consider how risk attitudes vary from the individual to the social environment across treatments. To

[24]The direct comparison may not be meaningful as the two risk tasks differ in terms of stakes and framing; moreover the order in which subjects face the two tasks is fixed.

Table 5: Effect of social comparison on risk taking, risk averse individuals

	base category D(10,10)		base category D(r=s)	
	(1)	(2)	(3)	(4)
SCI	0.583***	0.585***	0.585***	0.587***
	(11.36)	(11.35)	(11.41)	(11.40)
D(2,10)	-0.443**	-0.432**	-0.353**	-0.353**
	(2.38)	(2.30)	(2.21)	(2.20)
D(10,2)	-0.547***	-0.538***	-0.458***	-0.459***
	(2.92)	(2.86)	(2.84)	(2.84)
D(2,2)	-0.175	-0.153		
	(0.94)	(0.81)		
R^2	0.28	0.29	0.28	0.28
N	347	347	347	347

Notes: SCB is the number of consecutive safe choices in the bonus task; SCI is the number of consecutive safe choices in the individual risk task; dummy variables D(r,s) identify subjects with wage r and a co-worker with wage s; dummy variable D(r=s) identifies all subjects with a wage equal to the co-worker's wage. Specification (2) includes the same set of individual controls as in Table 3. The estimation sample is restricted to risk averse subjects (SCI$\geq$ 5). * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

this purpose, we created the variable $\Delta SC = SCB - SCI$. Table 6 reports the confidence intervals of the mean of ΔSC in the four treatments. A clear pattern can be observed: risk aversion increases in small gains, while it decreases in social loss and in large social gain.

Table 6: Difference in safe choices between individual and social risk tasks

Treatment	Mean	Std. Err.	Observations
(2, 2)	0.09	0.13	101
(2, 10)	-0.20	0.13	107
(10, 2)	-0.39	0.17	106
(10, 10)	0.27	0.13	103

Notes: Summary statistics by treatment of the variable ΔSC=SCB-SCI defined as the difference between the number of consecutive safe choices in the bonus task and the number of consecutive choices in the individual tasks.

5 Discussion

Our key findings are that risk aversion is less strong in social loss than in small social gain, while it does not differ in social loss and large social gain, and that risk aversion is decreasing in the size of social gain. Can these results be explained by inequity aversion?

The traditional functional form of inequity averse preferences introduced by Fehr and Schmidt (1999), adapted to our context with two reference points, can be written as follows:

$$v(x, r, s) = u(x - r) - \alpha \max\{s - x, 0\} - \beta \max\{x - s, 0\}$$

where $\beta \leq \alpha$ and $\beta \in [0, 1)$. This specific model of inequity aversion, commonly used to interpret experimental data, cannot explain our results, as the component that incorporates social comparison is linear, and therefore it does not influence the risk attitudes of individuals. Applications and extensions of Fehr and Schmidt (1999) to risky environments have been introduced in Brock et al. (2013), Fudenberg and Levine (2012) and Saito (2013). However, none of these models can explain our experimental results. In particular, they all predict that risk aversion should be constant across social gain conditions.[25]

How do our results compare to the existing experimental literature? Two features that differentiate our study from existing works are that decision makers cannot change their social status or influence the social reference point, as both their social condition and their co-worker's wage are *exogenously determined*. In particular, Schwerter (2013) studies experimentally risk taking under social comparison in a setting where the outcomes of risky decisions can reverse the social ranking. In our experiment, the social ranking is pre-determined by the wages assignment and decision makers can only influence their distance from the social reference point, so that any social loss aversion consideration is ruled out. Our studies are complementary: within a theoretical framework of reference-dependent utility, Schwerter (2013) focuses on the slope of the social component, while we focus on its curvature.

The fact that the social reference point is certain and exogenously given allows us to rule out social concerns that the decision maker might have in the case he is responsible also for the payoff or the risk faced by his peer. This aspect distinguishes our study from other experiments where the decision maker's choice determines the peer's payoff and (or) the distribution of the peer's payoffs (Bolton and Ockenfels, 2010; Rohde and Rohde, 2011; Lahno and Serra-Garcia, 2014). For example, in Bolton and Ockenfels (2010) subjects face dictator choice problems with uncertain payoffs allocation. The authors study how advantageous or disadvantageous inequality in the payoff allocations of either the safe or the risky option affect the decision maker's risk attitude. Rohde and Rohde (2011) study decision making under uncertainty in a social context and show that risk taking is affected by the risks faced by other persons.

The experimental work that is closest to ours is the one by Linde and Sonnemans (2012). Importantly, their experiment demonstrates that a straightforward

[25] For example, Saito (2013) axiomatizes the *expected inequality-averse* model, which, applied to our social reference point s, can be rewritten as follows:

$$V(x, s) = \delta U\left(\mathbb{E}(x), \mathbb{E}(s)\right) + (1 - \delta)\mathbb{E}\left(U(x, s)\right),$$

where $U(x, s) = x - \alpha \max\{s - x, 0\} - \beta \max\{x - s, 0\}$. If we limit our attention to social gain we can rewrite the above equation as $U(x, s) = x - \beta(x - s)$ which is linear. Hence $U\left(\mathbb{E}(x), \mathbb{E}(s)\right) = \mathbb{E}\left(U(x, s)\right)$; moreover $V(x, s)$ becomes linear and cannot explain the finding that risk attitudes vary across the social gain domain.

application of Prospect Theory to social comparison fails to explain risk taking behavior in a social environment. In Section 2 we discussed how this calls for an analysis that takes into account both private and social risk attitudes. We designed our experiment so as to isolate the effect of social conditions, keeping fixed private risk attitudes, while framing the choice problems as positive changes from a given wage (individual gain) in every social condition. Focusing on the results, Linde and Sonnemans (2012) find that subjects are less risk averse in social loss than in social gain.[26] We find, instead, that subjects are less risk averse social loss than in small social gain, whereas their risk attitudes do not differ between social loss and large social gain. How can we interpret these differences?

First, our theoretical analysis (and experimental results) show that there are no clear-cut predictions in the comparison between social loss and social gain, due to the simultaneous presence of private and social risk attitudes. As we induce a salient individual reference point, and we compare choices in which social conditions differ while the distance from the individual reference point is the same, we intentionally control for variations of the private component. This may explain why our results are closer to Prospect Theory predictions. Second, the larger number of choices that subjects face in the experiment by Linde and Sonnemans (2012), based on a within-subjects design where subjects alternate conditions of social gain and social loss, and tasks with exogenous or endogenous peer's outcome, may introduce confounding factors that are absent in our work. More generally, the two studies may be considered part of the same research program. Linde and Sonnemans (2012) suggest that Prospect Theory does not apply trivially to a social context; we propose a model which modifies Prospect Theory and proves to be compatible with risk taking in a workplace environment. In particular, our model suggests that an analysis of the effects of social comparison on risk taking should take explicitly into account the role played by the individual reference point.

6 Conclusions

We studied how social comparison affects risk attitudes. The main contribution of our paper is twofold. At the empirical level, we find new evidence that subjects are less risk averse in social loss than in small social gain, whereas risk attitudes do not differ in social loss and large social gain. These findings cannot be explained by a straightforward application of Prospect Theory or by inequity aversion models applied to uncertain environments (Brock et al., 2013; Fudenberg and Levine, 2012; Saito, 2013). We also find that, within the social gain domain, risk aversion is decreasing in the size of social gain, a finding that cannot be explained by inequity aversion models that predict

[26] Their paper also provides results on the neutral condition. However, such condition differs from gains and losses as the decision maker chooses which lottery will be played not only for himself but also for the other person.

constant risk attitudes in such domain. At the theoretical level, we show that our experimental results are compatible with a reference-dependent model where overall risk attitudes are determined by the interplay of a private and a social component, and the latter displays risk love in social loss and decreasing risk aversion in social gain.

A better understanding of the mechanisms through which social comparison affects risk attitudes will be a fruitful avenue for future research, as risk-taking behavior can have a relevant economic impact. Our experimental work emphasizes that social comparison may play a significant role for risk-taking behavior in a workplace environment, as large differences in workers' earnings can produce more risk-loving behavior. Indeed, for different reasons, workers who are below and far above their social reference point will take more risks than workers who are close to it. While the former take more risk in order to catch up with the social referent, the latter do so as they feel far more rich.

An important implication of our findings is that, in order to discourage imprudent risk taking, acting only through monetary incentives (e.g., the ratio between the fixed and the variable component of bankers' pay) may not be sufficient, especially when there exist structural differences in bankers' fixed pay components. More importantly, our analysis suggests that social comparison may provide an additional channel to moderate bankers' risk taking behavior. Compensation schemes should limit not only the variable component of bankers' pay, but also the (overall) pay inequality between them.

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