

Incentives and Relative-Wealth Concerns: Theory and Evidence

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Abstract

In this paper I show that if risk-averse agents prefer both to be richer in absolute terms and to be richer than their peers (relative-wealth concerns), then 1) they will prefer positive correlation between their payoffs and the payoffs of other agents, and 2) they will be averse to negative correlation between payoffs. I test these theoretical predictions in a laboratory experiment. I find that subjects prefer positively correlated payoffs over risk-free and negatively correlated payoffs. Furthermore, subjects who by observing other participants' payoffs signal stronger relative-wealth concerns, also show stronger aversion to negatively correlated payoffs. Finally, women appear to be concerned about other agents' payoffs more than men. This novel evidence has implications that help explain why firms apparently use profit-sharing and broad-based incentives contracts too extensively, and why Relative Performance Evaluation (RPE) contracts are scarcely used in common compensation practice.

1 Introduction

Two puzzles have been put forth by several studies in the compensation literature: the extensive use by firms of broad-based incentive plans for low-level employees and the paucity of Relative Performance Evaluation (RPE) contracts, where agents are compensated for the performance they achieve measured relative to the performance of their peers. In this paper I offer and then test in a laboratory experiment a preference-based hypothesis that contributes to the solution of both puzzles. I assume that agents prefer to be both wealthier in absolute terms and wealthier than their peers. Moreover, I assume agents to be risk-averse in both absolute and relative wealth. I define an agent for whom these two assumptions hold true as relative-wealth concerned. I then show theoretically that relative-wealth concerned agents prefer positive correlation between their payoffs as, for example, in the case of firm-wide stock option plans. Also, under these assumptions I show that agents are averse to negative correlation between their compensations, as in the case of RPE contracts where an agent's remuneration is reduced as his colleagues earn more. The experimental results provide evidence in support of the relative-wealth concerns hypothesis. In addition, I find that women appear to be concerned about other agents' payoffs more than men.

The first puzzle is that firms routinely tie compensation to the overall firm performance for employees who cannot possibly influence such performance, even when their individual outputs are observable and contractible. This practice conflicts with the well-known results of Holmstrom (1979), who shows that performance-linked contracts should be used only when the performance measure conveys a signal about the effort exerted by employees. If employees cannot affect the performance measure, the firm cannot gain any knowledge about their effort. Moreover, risk-averse employees require a risk premium as a consequence of the volatility of their performance-linked payoff. As a result, compensation schedules based on uninformative performance measures are more costly than a fixed wage and do not provide employees with any incentive. There is no conclusive evidence of the reasons behind this puzzle. Oyer (2004) and Oyer and

Schaefer (2005) suggest that the firm-wide use of “incentive” contracts¹ is motivated by the opportunity to tie worker wages to the fluctuation of their reservation utilities, which avoids costly wage renegotiation. Core and Guay (2001) hypothesize that stock option plans are a channel through which the company can be financed by its own employees.² Kedia and Rajgopal (2008) find that social forces justify the geographical clustering of stock option plans.

The second puzzle is the scarce use of RPE contracts in compensation practice, which appears surprising in the light of the results of Holmstrom (1982). If employees’ outputs are affected by common random shocks, then paying based on relative performance nets out the common noise source and provides the firm with a more precise signal of the effort exerted by each employee. Despite this argument, RPE contracts are rarely used in practice. The literature has provided relatively little evidence on the reasons behind the paucity of RPE use as a compensation instrument (Murphy(1999)). Murphy and Hall (2003) suggest that accounting rules may drive compensation practice away from RPE instruments like market or industry indexed options.³ Aggarwal and Samwik (1999) justify the lack of use of RPE contracts as a consequence of strategic interaction between competing firms. Bandiera et al (2005) find that the enforcement of collusive agreements between employees justifies the scarce resort to RPE contracts within a firm.

In this paper I offer and test a preference-based hypothesis that reconciles economic theory with observed practice. Suppose that individuals’ utility increases in both their absolute wealth *and* their wealth measured relative to their peers. Suppose further that, in addition to being risk averse in their absolute wealth, agents are also risk averse in their relative wealth. If both assumptions hold true for a group of agents, I define them as relative-wealth concerned. Since positive correlation between payoffs

¹By “incentive” contracts the authors mean compensation contracts that link the employee payoff to the overall firm performance.

²This argument does not provide an exhaustive explanation of why a company in need of financial resources would resort to such an expensive source given the high risk premium required by risk averse and undiversified agents (see Hall and Murphy (2003)).

³Although more recent accounting rules eliminated the disadvantage in the use of these instruments, in practice their use did not increase.

reduces the volatility of relative wealth, while negative correlation increases it, the relative-wealth concerned agent will prefer positively correlated payoffs to negatively correlated ones. I also show that relative-wealth concerned agents prefer a moderately volatile payoff over a risk-free payoff of comparable value, as long as the volatile payoff is positively correlated with the payoffs of their peers. In a companion paper (Miglietta (2009)) I derive the optimal linear contract that a principal offers to a body of relative-wealth concerned agents: they are compensated on the basis of both their individual performance and the overall firm performance. In the same paper I show that, in the presence of relative-wealth concerns, the informational advantages of RPE contracts may be outweighed by the additional compensation cost induced by agents' aversion to negative correlation.⁴

The above theoretical results are a direct consequence of agents being relative-wealth concerned. Hence, any attempt to validate the theory must first find evidence of relative-wealth concerns in agents' preferences. Since archival data provide extremely noisy information on agents' preferences, a laboratory experiment is the most promising way to investigate this subject fruitfully. I run seven experimental sessions with college students as participants. In the first three sessions, half of the participants receive a random payoff and they can choose a level of costly "effort"⁵ in order to modify the probability distribution of their payoffs. The other half of the participants can choose between a risk-free payoff and a risky payoff but they do not choose a level of effort. In the second part of the session, their payoff choices are different; they can choose between three possible payoffs: a risk-free payoff and either one of two risky payoffs, one positively correlated and the other negatively correlated with the payoff of another agent. Along with this change in the payoff choices, participants are given the possibility

⁴The optimal compensation in the presence of other-concerned preferences is studied by Frank (1984a, 1984b). The author shows that if agents are concerned about their relative wage, then the wage distribution among workers is less dispersed than the distribution of their marginal productivity. More recently, Fershtman et al (2003) study the impact of relative-wealth concerns on the optimal contract offered to an agent, in a multi-principal/one-agent context. Bartling (2008) and Englmaier and Wambach (2006) derive the optimal compensation contracts in the presence of inequity aversion (Feher and Schmidt (1999)).

⁵Participants by spending different amounts of money can induce different probability distributions over their payoff. This is a simple way to replicate effort exertion in a laboratory environment.

to observe other subjects' payoffs. The objective of these initial sessions is to ascertain whether subjects modify their choices once they move from a non-social context, where no correlation and no observation is allowed, to a social one, where correlation between payoffs and observation of other agents' payoffs are allowed.

Should participants choose differently in a social context, I further need to test whether this modification in their choices is indeed driven by relative-wealth concerns. For this reason, I run four additional experimental sessions. In these last sessions, I try to separate participants that are relative-wealth concerned from those who are not, and verify that the first behave consistently with my theoretical predictions. The key to achieving this goal is to track whether subjects observe their peers' payoffs. In fact, the experimental design is such that the observation of other subjects' payoffs should not convey economically relevant information. Hence, by observing other subjects' payoffs a participant signals that she is concerned about her relative payoff.

The experimental results show that in the social context agents choose a risky payoff more frequently than in the non-social context. In particular their most frequent choice is the positively correlated payoff. Most importantly, participants who observe the payoffs of other subjects, signaling in this way stronger relative-wealth concerns, show a significantly stronger aversion to negatively correlated payoffs, consistent with the relative-wealth hypothesis. Also, I find no significant impact of relative-wealth concerns on agents' effort choices.

The experimental approach has been frequently used in the analysis of behavioral theories in labor economics and compensation. Fehr et al (1996) run a laboratory experiment and argue that fairness concerns induce employers to offer employees rents above their reservation utility (see also Akerlof and Yellen (1990)). Charness and Kuhn (2007) study experimentally how the effort exerted by an agent is influenced by relative compensation, finding no significant impact. My results also contribute to this literature by adding evidence about agents' correlation preferences.

Another aspect I examine is whether women's effort and payoff correlation choices

differ from the choices made by men.⁶ My results suggest that women are more concerned about other agents' payoffs than men. In fact women have stronger preferences for positively correlated payoffs than men. Furthermore, women choose a higher level of effort when they move from a non-social context to a social one, while male participants do not show any significant change in their effort choices.

The paper proceeds as follows: in Section 2 I derive the theoretical predictions that will allow me to test the presence of relative-wealth concerns in a laboratory setting. Section 3 describes the experimental approach adopted. Section 4 develops the explicit hypothesis I test within the experimental framework, and Section 5 analyzes the results of the experiment. Section 6 concludes the paper.

2 Preferences with Relative Wealth Concerns

Throughout this work I contrast two alternative assumptions for agents' preferences. The first one is the that agents are self concerned, that is, they are only interested in their wealth. Therefore, the preferences of a generic agent i are represented by:

$$U_i(t_i) = E[u(t_i) - c(e_i)] \quad (1)$$

In this case, agent i 's utility function is additively separable in monetary payments t_i and effort e_i . The function $u(\cdot)$ is increasing and concave.

The second hypothesis is that agents are relative-wealth concerned. Under this hypothesis, the preferences of the generic agent i are represented by the following expected utility function:

$$U_i(t_i) = E[u(t_i) + \beta_i g(t_i - t_j) - c(e_i)] \quad (2)$$

In this case, agent i 's utility function is additively separable in monetary payments

⁶The differences between men and women in their attitudes toward other agents is the subject of a number of experimental studies. Eckel and Grossman (1998) find that women are more generous (selfless) than men. On the other hand, Bolton and Katok (1995), do not find any gender-related difference in the behavior of participants. Andreoni and Vesterlund (2001), find that women tend to be more "equalitarian" in their choices (that is, they tend to equally share), while men seem to polarize around either a completely selfless or selfish behavior.

t_i , effort e_i and, assuming that agent i is assigned to a group of two people, his relative payoff $(t_i - t_j)$ (where j indicates the individual agent i is matched with). The function $u(\cdot)$ is increasing and concave. Function $g(\cdot)$ is increasing ($g' > 0$) and concave ($g'' < 0$) as well. These assumptions indicate that agents are risk averse not only in their absolute wealth but also in their relative wealth.⁷ The coefficient $\beta_i \geq 0$ measures how concerned an agent is about his wealth measured relative to his peer's. Finally, notice that (1) is a particular case of (2), when $\beta_i = 0$. I will indicate agents whose utility is given by (2) and with $\beta_i > 0$ as relative-wealth concerned. The wider class of preferences that are impacted by the choices or the payoff of other agents, even without any impact on the agent's wealth, will be indicated as other-looking or other-concerned preferences.

The objective of this study is to investigate how relative-wealth concerns might induce risk-averse agents to prefer volatile payoffs, and to understand the impact of relative-wealth concerns on the effort exerted by agents. For this reason I will consider two types of agents. The first type of agents receives incentives, in the sense that by exerting more or less effort they can induce a different probability distribution over their payoff outcomes. Since they can induce a different probability *Distribution* over their payoff, the first type of agents will be indicated as Agent D. Agents of the second type do not receive any incentive and they can just choose to exert a fixed effort. Also, they can choose whether to receive a fixed payment or a payment that is positively or negatively correlated with the payment of agent D. Since the agents of the second type can choose the *Correlation* of their payoffs they will be indicated as agents C. Within this simplified framework, I will derive some testable implications of the presence of relative-wealth concerns and contrast them with the implications of the alternative preferences hypothesis, namely, the self-concerned preferences.

Assume that all agents are assigned to a group of two people where every agent C is matched with one agent D. Also, assume that each agent D makes his effort decision

⁷A similar concept is inequity aversion, in this case, though g' can be both positive or negative. Also, in the formulation of the model by Fehr and Schmidt (1999), if an agent will always be richer or poorer than his peers, then he will be risk neutral both in his absolute wealth and his relative wealth. In this case, agents C should not display any particular preference for positive or negative correlation. The hypothesis of risk aversion in relative wealth and inequity aversion can be joined by considering $g''' < 0$.

and that the agent C rationally expects it. Given the effort agent D exerted, he can receive a random monetary transfer t_D

$$t_D = \begin{cases} t_D^H & \text{with probability } p \\ t_D^L & \text{with probability } (1 - p) \end{cases} \quad (3)$$

where $t_D^L < t_D^H$.

Then we have the following:

Proposition 1. *If agent C's preferences are represented by (2), she is risk averse in her relative wealth, and she is matched with an agent D whose payoff is given by (3), then*

1. *It will be always optimal to introduce a moderate volatility in agent C's payoff as long as it is correlated with agent D's payoff.*
2. *Agent C will be more averse than a self-concerned agent to moderate volatile payoffs that are negatively correlated with agent D's payoff.*
3. *There exists a unique random payoff $t_C^* = \{t_C^H, t_C^L\}$, positively correlated with the payoff of agent D, that minimizes the expected value of agent C's payoff and does not violate her participation constraint. Moreover, t_C^* is such that*

$$\frac{u'(t_C^H) - u'(t_C^L)}{[g'(t_C^L - t_D^L) - g'(t_C^H - t_D^H)]} = \beta_C \quad (4)$$

Proof of Proposition 1 . See Appendix ■

Proposition 1 tells us that, if agent C is relative-wealth concerned, she will always prefer a slightly volatile payoff that is correlated with the payoff of her D counterpart rather than a risk-free payoff with the same expected value. Point 2 of Proposition 1 follows from the fact that the concavity of function $g(\cdot)$ amplifies the aversion of agent C beyond the risk aversion implied by the concavity of $u(\cdot)$. Finally, the last point of the proposition, tells us that if agent D is receiving a specific random payoff, a

hypothetical principal has a unique payoff to offer agent C, and the payoffs of the two agents will be positively correlated. The rationale behind this result is fairly simple: when agent C receives a risk-free payoff and her D counterpart receives a risky one, this will induce volatility in her relative wealth. Given the concavity of agent C's utility function in her relative wealth, she will be willing to pay a premium in order to reduce the volatility of her relative wealth. Of course, by stabilizing agent C's relative payoff a principal induces volatility in her absolute wealth. Hence in order not to introduce too much volatility in agent C's absolute wealth her payoff will be moderately volatile. The optimality condition in (4) implies that as β_C increases the agent will be less concerned about the volatility introduced in her absolute payoff and more concerned about stabilizing her relative wealth. Last, notice that the optimality condition in (4), includes the self-concerned solution. By setting $\beta_C = 0$, the optimality condition would imply $u'(t_C^H) - u'(t_C^L) = 0$, that is $t_C^H = t_C^L$, consistent with the assumption of risk aversion of agent C in her absolute wealth.

Turning the attention to agent D, his effort choice is driven by two motivations, the first one is to increment the expected utility originating from his absolute wealth and the second is to increment the expected utility originating from his relative wealth. Therefore if agent D moves from a stand-alone status (where he is not matched with any other agent) to a matched status (where he is matched with another agent), his effort decision might change given his concerns about relative wealth. In addition, the correlation choice of his C counterpart in the matched status may impact on the incentives originating from relative-wealth concerns. For this reason, different payoff correlation choices by agents C may induce agents D to exert different levels of effort. This argument is formalized in the following:

Proposition 2. *Assume that agent D is relative-wealth concerned and risk averse as in (2). Also, he can exert a level of effort chosen from the finite set $\{e_i\}_{i=1,2,\dots,N}$ where $e_i < e_j$ if $i < j$. Assume further that the effort choice e_i induces a cost equal to c_i , such that $c_i < c_j$ if $i < j$. Finally, the effort choice e_i induces a probability p_i to receive the high payoff t_D^H , and $0 < p_i < p_j < 1$ if $i < j$. Then,*

1. *Moving from a stand-alone status to a matched status, if $t_D^H - t_C^H > t_D^L - t_C^L$, the effort exerted by agent D increases or stays the same.*
2. *In the matched status, when his C counterpart chooses a risk free payoff \bar{t} , the effort exerted by agent D is the same or higher than the effort exerted by D when his C counterpart chooses a positively correlated payoff $t_C = \{t_C^H, t_C^L\}$, where $t_C^H > \bar{t} > t_C^L$.*
3. *In the matched status, when his C counterpart chooses a risk free payoff \bar{t} , the effort exerted by agent D is the same or lower than the effort exerted by D when his C counterpart chooses a negatively correlated payoff $t_C = \{t_C^H, t_C^L\}$, where $t_C^H > \bar{t} > t_C^L$.*

Proof of Proposition 2 . See Appendix ■

Point 1 of Proposition 2 tells us that moving from a stand-alone case to a matched case, the incentives to exert effort are strengthened by the fact that agent now can also become richer than their peers. Point 2, tells us that when in a matched status agents C choose positively correlated payoffs, the incentives for agent D to exert effort in order to become richer than his peers become weaker. If they become weak enough, then he might choose to exert a lower effort than in the case of uncorrelated payoffs. Point 3, just inverts the logic of Point 2.

The empirical implications of Proposition 2 are somehow more ambiguous than the implications of Proposition 1. In fact agents D will change their effort decision only if the changes in the incentives originating from relative-wealth motivations are large enough. If the IC conditions were slack to begin with (having a finite number of effort choices) the change in the relative-wealth motivations might not be large enough to induce a different effort choice. Therefore, in the empirical test of this theory, we must expect to observe stronger results in the case of agents C than in the case of agents D.

3 The Experiment

The experimental results presented in this paper are obtained from seven experimental sessions. The first three sessions aim at verifying the existence of other-looking preferences, while the objective of the last four is to understand whether there are relative-wealth concerns in agents' preferences. I will indicate the first three sessions as the "First Treatment" and the last four sessions as the "Second Treatment".

3.1 The First Treatment

Each session of the First Treatments is divided in two parts, each formed by seven decision rounds. Hence, participants took part in 14 decision rounds. Before starting the first round, agents were assigned to one of two possible roles: D or C and were endowed with 500 Points. Participants assigned to role D will realize either 1000 Points or 500 Points and can modify the probability distribution of their payoff by investing more of their endowment.⁸ In the table below, it is indicated how the outcome probability, the expected value and the standard deviation of the net payoff for a subject D vary as a consequence of his expenditure decision.

<i>D Expenditure</i>	250	300	500
Pr[1000]	0.3	0.5	0.7
Pr[500]	0.7	0.5	0.3
Expected Payoff D	400	450	350
Std Dev Payoff D	230	250	230

The investment that maximizes the expected payoff is 300 Points (yielding an expected net payout of 450 Points), while the investment with the lowest expected payoff is 500 Points (yielding an expected net payout of 350). Investing the lowest amount (250 points) yields an expected payout of 400 points). In terms of the "riskiness" of the

⁸In the experimental context effort exertion is mimicked by a Point expenditure.

payouts, the standard deviation from the lowest and highest investments are 230, while the standard deviation from the 300-Point investment (yielding the highest expected net payout) is 250. Therefore, a risk-neutral agent concerned only about his own wealth will invest 300, while a risk-averse agent concerned only about the expected utility of his own wealth will invest either 250 or 300, but should not invest 500.

Participants assigned to role C can take part to a decision round by spending 100 Points. If a participant C decides to participate to the round, she can choose between two different payoffs: the first is a fixed payment of 475 Points, the second is a random payoff. The random payoff consists of a payment of 500 points with probability 0.5 and a payment of 450 with probability 0.5. Therefore, the random payoff has the same expected value as the risk-free payment (475 Points) and a volatility of 25 Points. So a risk-averse participant should choose the risk-free payment while risk-neutral participants should be indifferent between the two payoffs. The sequence of actions in a given round is the following:

1. Participants C make their payoff choice: receive a risk-free payoff or a risky payoff.
2. Participants D make their expenditure choice.
3. Payoffs are realized

After the first seven decision rounds, agents were randomly re-assigned to role C or D.⁹ Once participants are assigned to their new roles, they will take part to seven additional decision rounds. At the beginning of each round agents are randomly assigned to a group of two people, where one has role D and one has role C. The random re-assignment is such that participants were never matched with the same counterpart more than once. The expenditure decisions and the probability distribution of the payoff received by participants D are the same. On the other hand, participants assigned to role C can now decide to receive three alternative payoff: a risk-free payment of 475 Points, a random

⁹The random re-assignment to role C or D, serves the purpose to avoid the use of heuristic decision rules. If agents are assigned to the same role, even if a variation is introduced in the experiment, they will repeat their choices mainly guided by the decisions taken in the first part of the experiment, without considering the new setting.

payoff positively correlated with the payoff of the participant D they were matched with, or a random payoff negatively correlated with the payoff of the participant D they were matched with. The expected value and the volatility of the payoff received by a participant C in a given round are reported in the following table:¹⁰

Expected Payoff C				Std Dev Payoff C			
<i>D Expenditure</i>	250	300	500	<i>D Expenditure</i>	250	300	500
<i>Fixed</i>	375	375	375	<i>Fixed</i>	-	-	-
<i>Positive Corr.</i>	365	375	385	<i>Positive Corr.</i>	23	25	23
<i>Negative Corr.</i>	385	375	365	<i>Negative Corr.</i>	23	25	23

Suppose that C chooses to be positively correlated with participant D, then if participant D receives a payoff of 500 Points at the end of the round, C will receive a payoff of 450 Points, or if agent D receives a payoff 1000 Points at the end of the round, C will receive a payoff of 450 Points. If C chooses the risk-free payoff, she will receive 475 Points at the end of the round, independently on participant D's payoff.

Finally, in the second part of the treatment I introduce an observation option for both participants in a given group: participants D can decide to observe whether their C counterpart chose an uncorrelated, positively correlated or negatively correlated payoff, before they make their expenditure decisions. Agents C, at the end of the round, can decide whether to observe the payoff received by their D counterpart. Hence the sequence of choices in a given round for the second part of the experiment is the following:

1. Participants are randomly assigned to a group of two people.
2. Participants C make their payoff choice: a payoff uncorrelated (risk-free), positively or negatively correlated with their D counterpart's payoff.
3. Participants D decide to observe or not the choice of their C counterparts.

¹⁰Of course, the expected value depends on the expenditure choice made by the D counterpart.

4. Participants D make their expenditure choice.
5. Payoffs are realized.
6. Participants C decide to observe or not the payoff of their D counterparts.

3.2 The Second Treatment

In the second treatment participants are still assigned to one of two possible roles: C or D. Each experimental session, as in the previous treatment, is divided in two parts, and each parts is, in turn, divided into seven decision rounds. In the first part of the experiment, agents are randomly assigned to a group of two people: one with role C and one with role D. The expenditure and payoff choices are the same as in the second part of the first treatment. The only difference is that participants can not observe anything about their counterpart, therefore the sequence of actions is the following:

1. Participants are randomly assigned to a group of two people.
2. Participants C make their payoff choice: a payoff uncorrelated, positively or negatively correlated with their D counterpart's payoff.
3. Participants D make their expenditure choice.
4. Payoffs are realized

The last seven decision rounds of the Second Treatment, are the same as the last seven decision rounds of the First Treatment:

1. Participants are randomly assigned to a group of two people.
2. Participants C make their payoff choice: a payoff uncorrelated (risk-free), positively or negatively correlated with their D counterpart's payoff.
3. Participants D decide to observe or not the choice of their C counterparts.
4. Participants D make their expenditure choice.

5. Payoffs are realized.
6. Participants C decide to observe or not the payoff of their D counterparts.

3.3 The Experimental Design

The experimental sessions were run at the California Social Science Experimental Laboratory (CASSEL) at UCLA. Participants are UCLA students of age 18 or older. Participants were recruited through email and postings on the CASSEL website. No subject took part to more than one session. The interactions in a session were computerized, using the open-source software package Multistage Games. The number of participants to a given experimental session ranged from 14 to 18 subjects. At the beginning of each session participants were given an endowment of \$1.25 (500 Points, each Point being valued \$0.0025). Participants' earnings typically range from \$18 to \$28 for each session.

At the beginning of each session, instructions were read from a stage to participants. The instructions covered the rules of the game and described the functioning of the computer Graphic User Interface (GUI). A sample copy of the instructions is in the online appendix.¹¹ After the instructions were read, participants played one practice round for which they received no payment. After the first seven decision rounds, another set of instructions was read to the participants, and then subjects completed the last seven decision rounds.

Three sessions of the First Treatment and four sessions of the Second Treatment were run. The number of subjects participating in the First Treatment sessions was 50 (30 men and 20 women), and 68 subjects (39 men and 29 women) took part in the Second Treatment sessions, for a total of 118 subjects.

4 The Hypothesis

The main objectives of the experiment are: 1) test if agents are concerned about the wealth of their peers, 2) if they are, whether relative-wealth concerns induce agents'

¹¹<http://www-scf.usc.edu/~migliett/research.html>

preferences for positive correlation and an aversion for negative correlation between payoffs, 3) observe what impact relative-wealth concerns might have on the incentives of agents to exert effort, and 4) examine the existence of gender-related differences in relative-wealth concerns.

The First Treatment aims at detecting whether agents change their behavior when they move from a stand-alone status to a matched status. In particular, it is important to observe if changes in agents' choices are consistent with concerns regarding other agents. Considering separately agents C and agents D, if there are other-looking concerns, I should be able to refute the following:

Hypothesis 1

- If agents D are self concerned they will spend 300 Points (or 250 Points if they are risk-averse) and will not change their expenditure decision moving from the first part of the experiment (where participants are in a stand-alone situation) to the second (where participants are matched in groups of two).
- If agents C are self concerned, in the first part of the session their choice should be driven by risk-aversion in absolute wealth, and the same should be true for the second part. That is the ratio between agents choosing the risk-free payoff and the risky payoff should be left unchanged between the two parts.

Considering the First Treatment, in order for the agents' choices to be consistent with relative-wealth concerns I should observe a higher frequency of choice of positive correlated payoffs by agents C (point 1 Proposition 1), and agents D either maintaining their previous expenditure choice or increasing it (point 1 Proposition 2). Nevertheless, even if the results from the First Treatment are consistent with the presence of relative-wealth concerns, they are susceptible to multiple alternative interpretations. In fact, moving from the first to the second part of the session, agents might change their actions for an altruistic reasons or biased belief about other agents type. In fact, agents may decide to invest more Points assuming that following a positive correlation choice by their C counterparts (altruism). On the other hand, participants C may choose

the positively correlated payoff because they expect their counterpart to invest 500 Points, therefore the driving force behind agents C choice might be a profit maximizing motivation rather than the presence of relative-wealth concerns.

Hence, I further need to test whether the other-looking preferences originates from relative-wealth concerns as opposed to other behavioral reasons. The purpose of the Second Treatment is to address this issue, in particular, following from the first point in Proposition 1 and the last two points of Proposition 2, I will test the following hypothesis:

Hypothesis 2

- If agents D are relative-wealth concerned, and in the second part of the session they observe the choice of positive correlation by agent C, their investment should be either the same or lower (point 2, Proposition 1). If they observe the choice of negative correlation, their investment should be either the same or higher (point 3, Proposition 1).
- If agents C are relative-wealth concerned, then they will prefer a payoff positively correlated over a payoff that is fixed or negatively correlated with their peers (point 1 Proposition 1). In particular, if participants C observe the payoff received by their counterparts, they should show a higher propensity towards positive correlation (point 1 Proposition 1) and a stronger aversion towards negative correlation (point 2 Proposition 1).

Agents C may be heterogeneous in their relative wealth concerns: some of them may be interested in the relative wealth of their peers ($\beta_C > 0$) some other may be self concerned ($\beta_C = 0$). The fact that an agent C observes her counterpart's payoff signals that she is relative-wealth concerned. In fact the Second Treatment is designed so that the observation does not convey any economically-relevant information. Hence, I assume that the agents C who observe have $\beta_C > 0$. For this reason the expected utility of an "observing" agent increases when her payoff is moderately variable and positively correlated with the payoffs of her D counterpart. Also, compared to a self-concerned

agents, she experiences a sharper decrease in her expected utility when her payoff is negatively correlated with the payoffs of her D counterparts.¹²

Finally, I also study the impact of gender on relative wealth concerns. In the experimental literature there are indications of women being more selfless than men (Eckel and Grossman (1998)) or of women having a more pronounced tendency to share than men (Andreoni and Vesterlund (2001)). For this reason, it is an interesting extension of this work to examine whether women differ in their effort and payoff choices from men, and if this difference can be traced back to stronger relative-wealth concerns.

5 Experimental Results

In this section I separately analyze the results from the two treatments. For each treatment, I will first study the distribution of frequencies over the possible choices made by subjects. The choice frequencies, though, are susceptible to be driven by the behavior of a small group of participants rather than representing the behavior of the population. Therefore, it is important to conduct an analysis of the results that controls for individual effects. In this work I will control for individual random effects.¹³ In order to evaluate how individual and choice characteristics influence the likelihood of a participant to make a choice, I estimate a linear-probability model. In particular, I will regress the indicator function of agents making a particular choice on

¹²To see this more formally, assume that agent D can receive t_D^H or t_D^L both with probability $\frac{1}{2}$, and $t_D^H > t_D^L$. Assume that agent C can receive either a non random payoff \bar{t} or a random payoff where she receives $\bar{t} + \frac{\epsilon}{2}$ if agent D receives t_D^H or $\bar{t} - \frac{\epsilon}{2}$ if agent D receives t_D^L . Hence, if $\epsilon > 0$, agent C's random payoff is positively correlated with agent D's payoff, if $\epsilon < 0$, agent C's random payoff is negatively correlated with agent D. It can be shown (see proof of Proposition 1) that the first order approximation of the difference between the expected utility of agent C when she receives a random payoff and the expected utility when she receive a risk-free payoff is given by $U_{Random} - U_{Risk Free} \approx \beta_C [g'(\bar{t} - t_D^H) - g'(\bar{t} - t_D^L)] \epsilon$. Therefore the larger β_C , the stronger the incentive for a relative wealth concerned agent C to choose a positively correlated (and moderately variable) payoff ($\epsilon > 0$) and to refuse a negatively correlated payoff ($\epsilon < 0$).

¹³The choice to rely on random effects rather than fixed effect, is due to the fact that the high number of dummy variables the matrix of the observations of the independent variables becomes nearly singular. Random effects, allow me to overcome this problem by assuming a normal distribution of the random effects, which requires the estimation of two parameters of the distribution rather than the estimation of N individual fixed effects. Also, I test for the presence of fixed effects and I can reject this hypothesis in favor of the presence of random effect at 1% significance, through a Lagrange multiplier test.

a number of independent variables.¹⁴ I also ran a logit regression with random effects (unreported) and the results are consistent with the linear-probability regressions. The main drawback of the linear approach is that the coefficients might be such that the “fitted” probability can become negative or bigger than 1, for a subset of values taken by the independent variables. Nevertheless, in the linear probability model the magnitude of the estimated coefficient gives a more intuitive understanding of the impact of the regressors on the probability of the agent making a specific choice.

5.1 First Treatment

The First Treatment directly addresses Hypothesis 1. The main objective of the treatment is to verify if agents have other-looking preferences, that is, if agents modify their behavior moving from a stand-alone status (where they are not matched with any other participant), to a matched status (where they are matched with another participant). In fact, in this treatment if participants D are self-concerned, they have no reason to change their investment decision moving from the first to the second part, since there is no change in the way they can affect their payoffs through their investments.

Result 1.

Moving from the stand-alone status to the matched status, male participants assigned to role D do not change their investment choice, while female participants increase their investment.

The results for agents D in the First Treatment are summarized in Table 1. The most frequent choice is the 300-Point investment. This is not surprising since the 300-Point investment is the choice that guarantees the highest expected net payoff. What is not in line with the expected payoff maximizing behavior is that agents seem to

¹⁴I will run unrelated regressions. Nonetheless, the probability of an agent making a given choice should be consistent with the probabilities of making the other, since the sequence of choices by an agent could be thought as a trinomial distribution. Hence, the unrelated regression will not account for this consistency. On the other hand, the linear probability model, allows me to jointly control for individual random effect and errors clustered at an individual level.

prefer the 500-Point investment choice over the 250-Point investment, although the lower investment offers a higher expected payoff at the same risk. The bias towards the 500-Points investment may be justified by behavioral aspects such as optimism of the agents when they evaluate their expected payoff or a probability weighting that overweights the likelihood of positive outcomes. The fact that participants choose to invest 500 Point rather than 250 Point seems not to depend on other-looking preferences: in Panel A of Table 1, even if the frequency of the 250 investment in the first part is twice the frequency in the second part, the chi-square and F-exact test statistics show that the difference between the choice frequencies in the two parts is not significant. Nevertheless, Panel B and Panel C of Table 1 show that moving from a stand-alone to a matched status introduces a significant change in participants' choices once the results are separated by gender, while the frequency distributions over investments are not significantly different for men and women in the first part of the session (stand-alone), they diverge the second part (matched). In particular, the frequency with which women choose the 500-Point investment increases by more than 20% in the matched case, and it is accompanied by a decrease of around 15% in the 300-Point investment. The change in female participants' choices are inconsistent with the hypothesis of self-concerned preferences: women choose the investment option with the worst expected net payoff (500 Points) and they do so by reducing the frequency with which they choose the option with the highest expected net payoff (300 Points). Overall, by this first analysis, we can draw a first conclusion that female participants, when assigned to role D, seem to be more other-concerned than male participants, who, in turn, appear to act more in accordance with self-concerned preferences.

Considering the linear probability model in the case of subjects D, the explanatory variables of interest are:

- Gender of the participant: female (0) male (1).
- The fact that the choice is made in the first part (0) or the second part (1) of the session.

- Whether the participant D observed a positively correlated choice by his C counterpart (1) or not (0).
- Whether the participant D observed a negatively correlated choice by his C counterpart (1) or not (0).
- Whether the participant was assigned to role D in both parts of the session(1) or not (0).

Panel A of Table 2 reports the estimate of three regressions estimating the impact of the above variables on the probability of choosing one investment level over the other two. The gender of participants stands out as an explanatory variable, in particular female subjects are significantly more likely to choose a 500 Point investment and less likely to choose a 300 Point investment. Panel B and Panel C of Table 2 reports how the likelihood to choose the 500-Point investment or the 250-Point investment over the 300-Point investment is impacted by the above independent variables. In particular, Panel B reports the results obtained with observations from both parts of the sessions, while Panel C reports the results obtained with observations from the second part of the sessions. The regressions show that women are more likely to choose the 500 Points investment and less likely to choose the 300-Point investment. Moreover, it appears that this gender-driven effect is mostly due to choices made in the second part of the session.

Result 2.

Moving from a stand-alone status to a matched status, participants assigned to role C change their payoff choice. More participants choose a variable payoff instead of a risk-free payoff. Also, female participants choose a positively correlated payoff more frequently than male participants.

The results for agents C in the First Treatment hint in a stronger way to the existence of other-looking preferences. Panel A of Table 3 shows that in the first part of the sessions 38.29% of the participants choose the risk-free payoff while 61.71% choose the

risky payoff. Moving from the first part of the session to the second part, where agents C have the possibility to decide to be correlated, the percentage of participants choosing the volatile payoff increases by 20%. Panel B and Panel C of Table 3 shows that male and female participants C appear to behave similarly both in the first and the second part of the session, if we just consider the choice between a fixed payoff or a variable payoff. Panel C of Table 3, though, show that women choose the positively correlated payoff more frequently than men (72.86% for women and 48.57% for men).

Considering now the choices of participants C, I regress the indicator function of them choosing a risk-free or risky payoff on the following variables:¹⁵

- Gender of the participant: female (0) male (1).
- The fact that the choice is made in the first part (0) or the second part (1) of the session.
- The fact that the participant observes the payoff received by her D counterpart (1) or not (0).
- Whether the participant was assigned to role C in both parts of the session (1) or not (0).

The second regression in Table 4¹⁶, shows that moving from the first to the second part of the sessions, increases the frequency of the choice of variable payoffs.

Overall, the strongest evidence of the existence of other-looking preferences comes from the observation of agents C choices. This results is expected if the changes in behavior originate from relative-wealth concerns. In fact, from Proposition 1 it follows that whenever agent C is relative-wealth concerned, she should *always* choose a positively correlated payoff with her counterpart. On the other hand, given the results of Proposition 2, agents D might not change their actions once they are matched to another agent even if they are relative-wealth concerned.

¹⁵In this case the logit approach model can not be used give the violation of the independence of irrelevant alternatives condition.

¹⁶In the second regression the Observation variable is dropped due to collinearity with the variable indicating the second part of the treatment. In fact, by dropping the observation variable the significance of the coefficient increases, without inducing a significant change in the R squared.

5.2 Second Treatment

The First Treatment, in particular in the case of participants C, provides us with evidence that participants are not self-concerned. Nonetheless, it does not allow us to discern whether this results follow from relative-wealth concerns as in (2) or other behavioral features of preferences.

The design of the Second Treatment is such that the payoff structure is the same in the first part of the session (the first seven decision rounds) and the second part of the session (the last seven decision rounds). The difference between the two parts is that, while in the first seven decision rounds participants can not observe anything about their counterparts, in the last seven decision rounds: 1) participants D can observe the payoff correlation choice made by the agent C they are matched with, and 2) participants C can observe the payoff received by their D counterpart, after the payoffs are realized. Notice that the observation of their counterpart's payoff by participants C, should not convey any relevant information for two reasons: 1) the payoff have been already realized and 2) participants C will not be matched with the same participant D more than once. From the discussion of Hypothesis 2, if by observing participants signal their (higher) relative wealth concerns, then we can expect that agents who observe choose positive correlated payoffs more frequently. Also, they should be more averse to negatively correlated payoffs. As before, I start by analyzing the results for participants D and conclude with the analysis of the results for participants C.

Result 3.

The introduction of observability does not induce any statistically significant difference in the overall frequency distribution of the investment choices for participants D. Nonetheless, considering only female participants, they choose the 500-Point investment more frequently than male participants. The results in Table 5 show that about 60% of the participants chose the 300-Point investment, that is, the expected payoff maximizing choice. Nonetheless, the frequency of the 500-Point investment is almost 10% higher than the frequency of the 250-Point investment, showing a slight bias towards

over-investment as in the First Treatment. The introduction of observability has no significant impact on the overall investment choices made by participants as it is shown in Panel A of Table 5. Nevertheless, Panel C of Table 5 shows that female participants choose the 500 Point investment more frequently than male participants, but only in the second part of the sessions. This result is similar to the one observed in the First Treatment. Finally the regression analysis in Table 6 confirms the effect of gender on the probability for a participant to choose the 500 Point investment.¹⁷ Nevertheless, participants D do not change their investment decisions upon observing a positively or negatively correlation choice by their C counterparts. This circumstance suggests that the increase in the Point investment by female participants is due to other looking features in their preferences, other than relative wealth concerns¹⁸, such as altruism.

Result 4.

If a participant C observes the payoff of her D counterpart, the likelihood that she chose the negatively correlated payoff decrease. Also, female participants are more likely than male participants to choose a random payoff as opposed to the risk-free payoff. In particular, women choose more frequently the positively correlated payoff.

From an inspection of Panel A of Table 7, it seems that there is no significant difference in agents' choices between the first and the second part of the session. Once I break down the frequencies by gender in Panel C of Table 7, it is apparent that female participants change their behavior in the second part of the session, abandoning the risk-free payoff choice and incrementing their choice of positively and negatively correlated payoff, being the positively correlated payoff the one they choose more frequently (56%). Male participant do not to change their behavior between the two parts of the session. Once again, it seems that there is a strong gender effect and that female participants have more other-concerned preferences. Once again, though there is the concern of a

¹⁷I do not include the regression for the 300 and 250 choices, since there is no significant effect of the independent variables I consider on the investment choice.

¹⁸In fact if the effect was induced by relative wealth concerns, then the interaction between the observation of either positive or negative correlation choices by agent C with the gender variable (unreported) should have some explanatory power. This is not the case.

small group of individuals driving the results, therefore a complete analysis requires to control for individual effects. The most relevant result is reported in Table 8. First, male participants choose a risk-free choice more frequently than women, which is consistent with men being more self-concerned. Moreover, women choose the positively correlated payoff more frequently than man, showing a higher degree of other looking concerns than men. Somehow surprising is the fact that women also choose the negatively correlated payoff more frequently than male participants. Nonetheless, the most frequent payoff choice made by women is by far the positively correlated payoff.

The most interesting result of this work comes from the consideration of the “observation” activity of participants C. Panel A of table 8 shows that the observation of the payoff by agents C impacts on their probability to choose a positively correlated payoff (which significantly increases if they observe), and the probability of participants C to choose the negatively correlated one (which significantly decreases if they observe). A further analysis shows that the result is mainly driven by the aversion of “observing” participants to negatively correlated payoffs. In particular Panel C of Table 8 shows that the likelihood of the choice of a negative correlation payoff is decreased by the fact that the agent observes the payoff of their counterparts. The fact that an agent observes her counterpart payoff seems not to explain why she prefers a positive correlated payoff over a risk-free payoff. One possible explanation is that for a relative wealth concerned agent, the worst choice is the negatively correlated payoff, therefore this is the choice agents will avoid more strongly. An alternative explanation is a risk-aversion argument: by selecting a positively correlated payoff, relative wealth concerned participants C increase their expected utility on the one hand, but on the other they increase the volatility of their payoff. Hence these two effects may offset each other and make the estimator of the coefficient more noisy. The negatively correlated payoff, though, decreases the expected utility of a relative-wealth concerned agent in a more sharply than in the case of a simply risk-averse agent (point 2 of Proposition 1), therefore a relative wealth-concerned agent will be more averse to negative correlation than an agent who is simply risk averse.

Once again, we should not be surprised that the results are stronger for participants C than in the case of participants D. In fact a relative wealth concerned agent C, and more precisely an agent who is risk averse in his relative wealth, is *always* better off by being positively correlated with his peer's payoff. Agents D, on the other hand, might not be responsive to correlation choice even though they are relative wealth concerned, if their incentive compatibility condition is not binding or near-binding.

6 Conclusions

In this paper I investigate the impact of relative-wealth concerns on the preferences of agents for positive correlation and aversion to negative correlation between agents' payoffs. In particular, I assume that agents' utility functions are increasing in their absolute wealth as well as in their relative wealth. In addition I assume that agents are risk averse in both absolute and relative wealth. Under these assumptions I show that agents prefer positive correlation between payoffs and are averse to negative correlation between payoffs. I then test this prediction in a laboratory experiment and find that agents indeed prefer positively correlated payoffs. Moreover, agents who observe their peers' payoff, showing concerns for their relative payoff, are significantly less likely to choose negatively correlated payoffs. These findings support the hypothesis that relative-wealth concerns play a significant role in explaining why firms use extensively profit-sharing and broad-based incentives (since they induce positive correlation between payoffs) and rarely employ Relative Performance Evaluation contracts (which induce negative correlation between payoffs).

This work also contributes to the experimental literature on compensation by directly addressing the question of agents' preferences for correlation between payoffs. Previous works mainly focus on how fairness concerns and reciprocity shape the relationship between a principal and an agent: Feher and Falk (1998) find that agents reciprocate a generous offer by a principal by exerting a higher than minimal effort. Feher et al (1996) show that employees may refuse wages higher than their reservation

utility if they deem the offer to be unfair. Charness (2004), addresses the question of whether agents attitude towards a given payoff may be influenced by the fact that it is offered by a person rather than by a random process. The author finds that agents reciprocate more an offer received by an individual rather than an offer received by an external process. More related to this work is Charness and Kuhn (2007) that studies the impact of social forces between employees rather than a vertical relation between employees and employers. In this paper the authors find that relative compensation has no impact on the level of effort exerted by agents. These contributions are based on theoretical grounds similar to the hypothesis relative-wealth concerns, nevertheless they do not directly test preferences of agents for correlation between their payoffs and the payoffs of their peers.

The experimental approach also allows me to overcome a problem that compensation studies encountered when addressing the subject of RPE compensation. The fact that RPE contracts are scarcely used in practice, strongly limits the possibility to investigate this issue through archival data. In an experimental setting, though, I can exogenously offer negatively correlated payoffs to the agents and study under what conditions they will refuse them.

One more aspect I investigate is how gender influences agents' preferences for payoff correlation and their effort exertion. I find that women change their behavior more sharply than men when they move from a non-social context to a social one. In particular they increase their effort and choose more frequently a volatile payoff, in particular if positively correlated with the payoffs of their peers. These results suggest that in organizations where the presence of women is higher, we should observe a wider use of firm-wide incentive contracts and a higher level of effort exerted. These predictions have interesting analogies with the findings of Adams and Ferreira (2008) about gender-diverse boards of directors. The authors find that women have higher attendance rates to board meetings than men, and they are more involved in committee activities than their male colleagues. Moreover, the authors find that "the proportion of female directors is associated with more equity-based pay for directors". This evidence, far from

being conclusive, opens promising perspectives for the study of the relation between gender and compensation policies.

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Appendix

Proof of Proposition 1.

I will first show that if agent C preferences are represented by (2) and if she is matched with an agent D who can receive a payoff as in (3), then C will prefer to receive a payoff that is positively correlated with agent D's payoff rather than receive a riskless payment with same expected value. Without loss of generality, assume that the participation for the agent has no cost. If agent C receives a risk free payoff equal to \bar{t} , then her expected utility will be:

$$U_C(\bar{t}) = u_C(\bar{t}) + p\beta_{CG}(\bar{t} - t_D^H) + (1-p)\beta_{CG}(\bar{t} - t_D^L)$$

Consider now an alternative payment t_C such that

$$t_C = \begin{cases} \bar{t} + \frac{\epsilon}{p} & \text{if } D \text{ receives } t_D^H \\ \bar{t} - \frac{\epsilon}{1-p} & \text{if } D \text{ receives } t_D^L \end{cases}$$

where $\epsilon > 0$ and $1 > p > 0$.

The expected utility for agent C is now

$$U_C(t_C) = pu_C\left(\bar{t} + \frac{\epsilon}{p}\right) + (1-p)u_C\left(\bar{t} - \frac{\epsilon}{1-p}\right) + p\beta_{CG}\left(\bar{t} + \frac{\epsilon}{p} - t_D^H\right) + (1-p)\beta_{CG}\left(\bar{t} - \frac{\epsilon}{1-p} - t_D^L\right)$$

Consider now the difference between the expected utility under \bar{t} and t_C :

$$\begin{aligned} \Delta U &= U_C(t_C) - U_C(\bar{t}) = \\ & p \left[u_C\left(\bar{t} + \frac{\epsilon}{p}\right) + \beta_{CG}\left(\bar{t} + \frac{\epsilon}{p} - t_D^H\right) - \beta_{CG}(\bar{t} - t_D^H) \right] + \\ & + (1-p) \left[u_C\left(\bar{t} - \frac{\epsilon}{1-p}\right) + \beta_{CG}\left(\bar{t} - \frac{\epsilon}{1-p} - t_D^L\right) - \beta_{CG}(\bar{t} - t_D^L) \right] - u_C(\bar{t}) \end{aligned}$$

approximating the above expression, for small values of ϵ

$$\Delta U \approx \beta_C [g'(\bar{t} - t_D^H) - g'(\bar{t} - t_D^L)] \epsilon > 0$$

which follows from the concavity of $g(\cdot)$.

The proof for point 2 can be obtained by following the same steps as in the proof of point 1, and by choosing $\epsilon < 0$. In this case the first-order approximation of difference in the expected utility, moving from a risk free payoff to a moderately random payoff that is negatively correlated with the payoff of agent D is given by

$$\Delta U \approx \beta_C [g'(\bar{t} - t_D^H) - g'(\bar{t} - t_D^L)] \epsilon < 0.$$

While the first order effect for a self-concerned agent would be just 0.

The uniqueness of the agent payoff that minimizes the expense for a hypothetical risk neutral and self concerned principal, follows from the solution of the following problem

$$\begin{cases} \min & pt_C^H + (1-p)t_C^L \\ \text{s. t.} & \\ & p[u(t_C^H) + \beta_C g(t_C^H - t_D^H)] + (1-p)[u(t_C^L) + \beta_C g(t_C^L - t_D^L)] \geq \bar{U} \end{cases}$$

where \bar{U} is the reservation utility of the agent. First of all, notice that the participation constraint has to be binding otherwise for the principal is always possible to reduce t_C^H or t_C^L and make the participation constrain bind. Given the binding condition, we can compute the following implicit derivative:

$$\frac{dt_C^H}{dt_C^L} = -\frac{1-p}{p} \frac{u'(t_C^L) + \beta_C g'(t_C^L - t_D^L)}{u'(t_C^H) + \beta_C g'(t_C^H - t_D^H)} \quad (5)$$

Applying the chain rule we also have

$$\begin{aligned} \frac{d^2 t_C^H}{dt_C^L{}^2} &= -\frac{1-p}{p} \frac{\partial}{\partial t_C^L} \left[(u'(t_C^L) + \beta_C g'(t_C^L - t_D^L)) \frac{1}{u'(t_C^H) + \beta_C g'(t_C^H - t_D^H)} \right] = \\ &= -\frac{1-p}{p} \left[\frac{u''(t_C^L) + \beta_C g''(t_C^L - t_D^L)}{u'(t_C^H) + \beta_C g'(t_C^H - t_D^H)} + (u'(t_C^L) + \beta_C g'(t_C^L - t_D^L)) \frac{\partial}{\partial t_C^L} \left(\frac{1}{u'(t_C^H) + \beta_C g'(t_C^H - t_D^H)} \right) \right] \end{aligned}$$

Substituting (5) into the above, we finally obtain

$$\frac{d^2 t_C^H}{dt_C^L{}^2} = -\frac{1-p}{p} \left[\frac{u''(t_C^L) + \beta_C g''(t_C^L - t_D^L)}{u'(t_C^H) + \beta_C g'(t_C^H - t_D^H)} + \left[\frac{(u'(t_C^L) + \beta_C g'(t_C^L - t_D^L))^2}{u'(t_C^H) + \beta_C g'(t_C^H - t_D^H)} \frac{u''(t_C^H) + \beta_C g''(t_C^H - t_D^H)}{(u'(t_C^H) + \beta_C g'(t_C^H - t_D^H))^2} \frac{1-p}{p} \right] \right] > 0$$

so $\frac{dt_C^H}{dt_C^L}$ is monotone.

Notice that as long as $\frac{dt_C^H}{dt_C^L} > -\frac{1-p}{p}$ it is convenient for the principal to decrease t_C^L and increase t_C^H . While if $\frac{dt_C^H}{dt_C^L} < -\frac{1-p}{p}$, it is convenient for the principal to decrease t_C^H and increase t_C^L . The optimal payoff t_C^* for the principal, given the payoff for agent D, will be reached when $\frac{dt_C^H}{dt_C^L} = -\frac{1-p}{p}$. The uniqueness of t_C^* follows from $\frac{d^2 t_C^H}{dt_C^L{}^2} > 0$.

From the condition $\frac{dt_C^H}{dt_C^L} = -\frac{1-p}{p}$, follows that

$$-\frac{1-p}{p} \frac{u'(t_C^L) + \beta_C g'(t_C^L - t_D^L)}{u'(t_C^H) + \beta_C g'(t_C^H - t_D^H)} = -\frac{1-p}{p}$$

that is

$$\frac{u'(t_C^L) + \beta_C g'(t_C^L - t_D^L)}{u'(t_C^H) + \beta_C g'(t_C^H - t_D^H)} = 1$$

rearranging:

$$\frac{u'(t_C^H) - u'(t_C^L)}{[g'(t_C^L - t_D^L) - g'(t_C^H - t_D^H)]} = \beta_C \blacksquare$$

Proof of Proposition 2.

Point 1. can be proved by considering the stand-alone IC condition. Agent D will choose to exert effort e_i if

$$\begin{cases} u(t_D^H) - u(t_D^L) \geq \frac{c_i - c_j}{p_i - p_j} \quad \forall j \neq i \text{ if } p_i > p_j \\ u(t_D^H) - u(t_D^L) \leq \frac{c_i - c_j}{p_i - p_j} \quad \forall j \neq i \text{ if } p_i < p_j \end{cases} \quad (6)$$

When agent D is matched with an agent C, the incentive compatibility condition becomes:

$$\begin{cases} u(t_D^H) - u(t_D^L) + \beta_D [g(t_D^H - t_C^H) - g(t_D^L - t_C^L)] \geq \frac{c_i - c_j}{p_i - p_j} \quad \forall j \neq i \text{ if } p_i > p_j \\ u(t_D^H) - u(t_D^L) + \beta_D [g(t_D^H - t_C^H) - g(t_D^L - t_C^L)] \leq \frac{c_i - c_j}{p_i - p_j} \quad \forall j \neq i \text{ if } p_i < p_j \end{cases} \quad (7)$$

Since $t_D^H - t_C^H > t_D^L - t_C^L$, $g(t_D^H - \bar{t}) - g(t_D^L - \bar{t}) > 0$. Therefore, while the IC conditions in the first inequality of (6) will be still holding in the first inequality of (7), some of the IC condition represented in the second inequality of (6), might be violated. This last circumstance would induce the choice of a higher effort.

Point 2. can be proved in a similar fashion, assume that agent C receives a risk-free payoff \bar{t} , then an agent D will choose an effort level e_i if the IC conditions in (7) are respected once we set $t_C^H = t_C^L = \bar{t}$, that is

$$\begin{cases} u(t_D^H) - u(t_D^L) + \beta_D [g(t_D^H - \bar{t}) - g(t_D^L - \bar{t})] \geq \frac{c_i - c_j}{p_i - p_j} \quad \forall j \neq i \text{ if } p_i > p_j \\ u(t_D^H) - u(t_D^L) + \beta_D [g(t_D^H - \bar{t}) - g(t_D^L - \bar{t})] \leq \frac{c_i - c_j}{p_i - p_j} \quad \forall j \neq i \text{ if } p_i < p_j \end{cases} \quad (8)$$

Assume now that agent C chooses a payoff $t_C = \{t_C^H, t_C^L\}$ positively correlated with agent D's payoff, such that $t_C^H > \bar{t} > t_C^L$, then

$$g(t_D^H - \bar{t}) - g(t_D^L - \bar{t}) > g(t_D^H - t_C^H) - g(t_D^L - t_C^L) \quad (9)$$

Given (9), the set of conditions represented by the last inequality in (8) will still hold. On the other hand if the left-hand side of (9) is larger enough than the right-hand side, than some of the conditions in the set of conditions represented by the first inequality in (8) can be violated. This circumstance would imply the choice of a lower level of effort.

The proof of Point 3. is obtained in following the same steps■

Table 1

First Treatment - Agent D Frequencies. This table reports the relative (absolute) frequencies with which Participants D choose an investment of 250, 300, 500 points in the First Treatment. Panel A reports the investment choices for the first and second part of the session. Panel B reports the investment choices broken down by gender in the first part of the session. Panel C reports the investment choices broken down by gender in the second part of the session. The Chi-square and the F exact statistics P-values are reported.

investment	Tot	Panel A		Panel B First Part		Panel C Second Part	
		First Part	Second Part	Female	Male	Female	Male
250	10.00% (35)	13.14% (23)	6.86% (12)	13.10% (11)	13.19% (12)	7.14% (5)	6.67% (7)
300	53.71% (188)	53.14% (93)	54.29% (95)	52.38% (44)	53.85% (49)	37.14% (26)	65.71% (69)
500	36.29% (127)	33.71% (59)	38.86% (68)	34.52% (29)	32.97% (30)	55.71% (39)	27.62% (29)
Total	100% (350)	100% (175)	100% (175)	100% (84)	100% (91)	100% (70)	100% (105)
		χ^2 Pr = 0.13 Exact Pr = 0.13		χ^2 Pr = 0.97 Exact Pr = 0.97		χ^2 Pr < 0.01*** Exact Pr < 0.01***	

Table 2

First Treatment - Agent D Regression Analysis. Panel A reports three separate linear probability regressions. The first one reports the impact of gender (Male=1 Female=0), the fact that participants were playing the first 7 or the last 7 rounds (First Part=0 Second Part=1), the fact that a participant observed the payoff choice of her counterpart (Positive or Negative), and the fact that they were assigned to role D for both parts of the session (Same Role) on the probability of D choosing a 500 Point investment decision. The second regression reports the impact of the same variables on the probability of D choosing a 300 Point investment decision, while the third regression reports the impact of the same variables on the probability of D choosing a 250 Point investment decision. Panel B reports two linear probability regressions estimates of the impact of the independent variables on the probability of participants choosing the 500 Point investment over the 300 Point investment, and on the probability of participants choosing the 250 Point investment over the 300 Point investment. Panel C reports the same estimates as in Panel B, using observations for the second part of the sessions. T-statistics are reported in parenthesis.

$$\Pr(\text{Expenditure}) = \alpha_i + \beta_1 * \text{Male} + \beta_2 * \text{Second} + \beta_3 * \text{Obs Pos} + \beta_4 * \text{Obs Neg} + \beta_5 * \text{Same Role}$$

	<i>Panel A</i>			<i>Panel B</i>		<i>Panel C</i> <i>Second Part</i>	
	500 vs. Rest	300 vs. Rest	250 vs. Rest	500 vs. 300	250 vs. 300	500 vs. 300	250 vs. 300
<i>Male</i>	-0.181** (-1.96)	0.165* (1.95)	0.014 (0.30)	-0.182* (-1.93)	-0.030 (-0.44)	-0.295** (-2.27)	-0.044 (-0.50)
<i>Second Part</i>	0.028 (0.36)	0.014 (0.19)	-0.056* (-1.80)	0.016 (0.21)	-0.074 (-1.43)		
<i>Obs Positive</i>	0.010 (0.13)	0.004 (0.05)	0.005 (0.16)	0.008 (0.10)	-0.010 (-0.18)	0.001 (0.01)	-0.003 (-0.04)
<i>Obs Negative</i>	0.078 (0.78)	-0.156* (-1.71)	0.093 (1.34)	0.118 (1.12)	0.162 (1.52)	0.097 (0.98)	0.156 (1.51)
<i>Same Role</i>	-0.126 (-1.31)	0.175* (1.87)	-0.050 (-1.13)	-0.145 (-1.46)	-0.098 (-1.50)	-0.175 (-1.35)	-0.024 (-0.28)
<i>Individual RE</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Clustered Errors</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>R-sq</i>	3.89%	5.36%	3.00%	5.04%	5.05%	11.97%	4.39%

Table 3

First Treatment - Agent C Frequencies. This table reports the relative (absolute) frequencies of agents C choosing riskless or volatile payoff in the First Treatment. Panel A reports the payoff choices for the first and second part of the session. Panel B reports the investment choices broken down by gender in the first part of the session. Panel C reports the investment choices broken down by gender in the second part of the session, also the choices are further broken down in positive or negative correlation choices. The Chi-square and the F exact statistics P-values are reported.

Payoff	Tot	Panel A		Panel B First Part		Panel C Second Part	
		First Part	Second Part	Female	Male	Female	Male
Fixed	28.57% (100)	38.29% (67)	18.86% (33)	30.36% (17)	42.02% (50)	15.71% (11)	20.95% (22)
Variable	71.43% (250)	61.71% (108)	81.14% (142)	69.64% (39)	57.98% (69)	84.29% (59)	79.05% (83)
Corr. +						72.86% (51)	48.57% (51)
Corr. -						11.43% (8)	30.48% (32)
Total	100% (350)	100% (175)	100% (175)	100% (56)	100% (119)	100% (70)	100% (105)
		χ^2 Exact	$Pr < 0.01^{***}$ $Pr < 0.01^{***}$	χ^2 Exact	$Pr = 0.13$ $Pr = 0.18$	χ^2 Exact	$Pr = 0.38$ $Pr = 0.44$

Table 4

First Treatment - Agent C Regression Analysis. This table reports two linear probability regressions. The regression estimates the impact of gender (Male=1 Female=0), the fact that participants were playing the first 7 or the last 7 rounds (First=0 Second=1), the fact that a participant observed the payoff of their counterpart (Observation=1 No-Observation=0), and the fact that they were assigned to role C for both parts of the session (Same Role) on the probability of C choosing a variable payoff over a risk-free one. T-statistics are reported in parenthesis.

$$\Pr(\text{Payoff}) = \alpha_i + \beta_1 * \text{Male} + \beta_2 * \text{Second} + \beta_3 * \text{Observation} + \beta_4 * \text{Same Role}$$

Variable vs Fix		
<i>Male</i>	-0.073 (-0.88)	-0.074 (-0.90)
<i>Second Part</i>	0.192* (1.93)	0.204*** (2.83)
<i>Observation</i>	0.016 (0.20)	
<i>Same Role</i>	-0.027 (-0.29)	-0.028 (-0.29)
<i>Individual RE</i>	Yes	Yes
<i>Clustered Errors</i>	Yes	Yes
<i>R-sq</i>	5.43%	5.47%

Table 5

Second Treatment - Agent D Frequencies. This table reports the relative (absolute) frequencies with which Participants D choose an investment of 250, 300, 500 points in the Second Treatment. Panel A reports the investment choices for the first and second part of the session. Panel B reports the investment choices broken down by gender in the first part of the session. Panel C reports the investment choices broken down by gender in the second part of the session. The Chi-square and the F exact statistics P-values are reported.

investment	Tot	Panel A		Panel B First Part		Panel C Second Part	
		First Part	Second Part	Female	Male	Female	Male
250	15.13% (72)	16.39% (39)	13.87% (33)	12.24% (12)	19.29% (27)	7.14% (6)	17.53% (27)
300	60.50% (288)	61.76% (147)	59.24% (141)	63.27% (62)	60.71% (85)	52.38% (44)	62.99% (97)
500	24.37% (116)	21.85% (52)	26.89% (64)	24.49% (24)	20.00% (28)	40.48% (34)	19.48% (30)
Total	100% (476)	100% (238)	100% (238)	100% (98)	100% (140)	100% (84)	100% (154)
		χ^2 $Pr = 0.39$ <i>Exact</i> $Pr = 0.39$		χ^2 $Pr = 0.31$ <i>Exact</i> $Pr = 0.30$		χ^2 $Pr < 0.01^{***}$ <i>Exact</i> $Pr < 0.01^{***}$	

Table 6

Second Treatment - Agent D Regression Analysis. This table reports three linear probability regressions relating to session of the Second Treatment. The first regressions estimates the impact of gender (Male=1 Female=0), the fact that participants were playing the first 7 or the last 7 rounds (First Part=0 Second Part=1), the fact that a participant observed the payoff choice of his counterpart (Positive or Negative correlation), and the fact that they were assigned to role D for both parts of the session (Same Role) on the probability of D choosing a 500 Point investment decision. T-statistics are reported in parenthesis.

500 vs. Rest	
<i>Male</i>	-0.146* (-1.87)
<i>Second Part</i>	0.028 (0.36)
<i>Obs Positive</i>	0.010 (0.13)
<i>Obs Negative</i>	0.078 (0.78)
Same Role	-0.126 (-1.31)
<i>Individual RE</i>	Yes
<i>Clustered Errors</i>	Yes
<i>R-sq</i>	3.30%

Table 7

Second Treatment - Agent C Frequencies. This table reports the relative (absolute) frequencies of agents C choosing a riskless payoff or a payoff positively or negatively correlated with his D counterpart, in the Second Treatment. Panel A reports the payoff choices for the first and second part of the session. Panel B reports the payoff choices broken down by gender in the first part of the session. Panel C reports the payoff choices broken down by gender in the second part of the session. The Chi-square and the F exact statistics P-values are reported.

Payoff	Tot	Panel A		Panel B First Part		Panel C Second Part	
		First Part	Second Part	Female	Male	Female	Male
Fixed	26.00% (123)	27.97% (66)	24.05% (57)	21.90% (23)	32.82% (43)	12.71% (15)	35.29% (42)
Corr. +	45.24% (214)	41.95% (99)	48.52% (115)	44.76% (47)	39.69% (52)	55.93% (66)	41.18% (49)
Corr. -	28.75% (136)	30.08% (71)	27.43% (65)	33.33% (35)	27.48% (36)	31.36% (37)	23.53% (28)
Total	100% (473)	100% (236)	100% (237)	100% (105)	100% (131)	100% (118)	100% (119)
		χ^2 <i>Exact</i>	$Pr = 0.35$ <i>Pr = 0.35</i>	χ^2 <i>Exact</i>	$Pr = 0.17$ <i>Pr = 0.18</i>	χ^2 <i>Exact</i>	$Pr < 0.01^{***}$ <i>Pr < 0.01^{***}</i>

Table 8

Second Treatment - Agent C Regression Analysis. Panel A reports three separate linear probability regressions. The first one reports the impact of gender (Male=1 Female=0), the fact that participants were playing the first 7 or the last 7 rounds (First=0 Second=1), and the fact that a participant observed the payoff of his counterpart (Non observation= 0 Observation=1), on the probability of C choosing a positively correlated payoff vs. the other payoffs. The second regression reports the impact of the same independent variables on the probability of C choosing a negatively correlated payoff vs. all others, while the third regression reports the impact of the same independent variables on the probability of C choosing a fixed payoff vs. all others. Panel B reports two linear probability regressions. The first regression reports the impact of the same independent variables on the probability of C choosing a negatively correlated payoff vs. a fixed payoff, the second regression reports the impact of the same independent variables on the probability of C choosing a positively correlated payoff vs. a fixed payoff. Panel C reports two linear probability regressions considering observation from the second part of each experimental session. The first regression reports the impact of the same three variables on the probability of C choosing a negatively correlated payoff vs. a fixed payoff, the second regression reports the impact of the same three variables on the probability of C choosing a positively correlated payoff vs. a fixed payoff. T-statistics are reported in parenthesis.

	<i>Panel A</i>			<i>Panel B</i>		<i>Panel C</i> <i>Second Part</i>	
	Negative	Positive vs.	Fix vs.	Negative	Positive vs.	Negative	Positive vs.
	vs. Rest	Rest	Rest	vs. Fix	Fix	vs. Fix	Fix
<i>Male</i>	-0.089 (-1.50)	-0.070 (-0.93)	0.160* (1.75)	-0.345 (-1.59)	-0.151 (-1.52)	-0.740*** (-2.84)	-0.301** (-2.44)
<i>Second Part</i>	0.153* (1.89)	-0.110 (-1.11)	-0.017 (-0.42)	0.162 (1.42)	-0.020 (0.09)		
<i>Observation</i>	-0.257*** (-4.03)	0.174** (2.36)	0.070 (1.46)	-0.383** (-2.47)	0.005 (2.36)	-0.462*** (-2.68)	0.008 (0.20)
<i>Same Role</i>	0.092 (1.43)	-0.054 (-0.75)	-0.037 (-0.39)	0.187 (0.89)	0.012 (0.12)	0.082 (0.33)	-0.148 (-1.19)
<i>Individual RE</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Clustered Errors</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>R-sq</i>	5.04%	2.04%	4.15%	10.26%	4.01%	21.16%	10.65%