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An experimental study of the impact of competition for Other People's Money: the portfolio manager market

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Abstract In this paper we experimentally investigate the impact that competing for funds has on the risk-taking behavior of laboratory portfolio managers compensated through an option-like scheme according to which the manager receives (most of) the compensation only for returns in excess of pre-specified strike price. We find that such a competitive environment and contractual arrangement lead, both in theory and in the lab, to inefficient risk taking behavior on the part of portfolio managers. We then study various policy interventions, obtained by manipulating various aspects of the competitive environment and the contractual arrangement, e.g., the Transparency of the contracts offered, the Risk Sharing component in the contract linking portfolio managers to investors, etc. While all these interventions would induce portfolio managers, at equilibrium, to efficiently invest funds in safe assets, we find that, in the lab, Transparency is most effective in incentivising managers to do so. Finally, we document a behavioral "Other People's Money" effect in the lab, where portfolio managers tend to invest the funds of their investors in a more risky manner than their Own Money, even when it is not in either the investors' or the managers' interest to do so.

Keywords Contracts · Experiments · Competition for funds

JEL Classification D86 · D92

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1 Introduction

"I love money. I love money more than the things it can buy. There's only one thing I love more than money. You know what that is? Other People's money"— Lawrence "the Liquidator" Garfield played by Danny DeVito in the 1991 Norman Jewison's movie, Other People's Money.

One issue of prominence these days is what many consider to be an excessive amount of risk taking in financial markets. What distinguishes these markets from others is the fact that in these markets portfolio managers must compete for the right to invest other peoples' money. In this paper we experimentally investigate the impact that competing for funds has on the risk-taking behavior of laboratory portfolio managers. We construct a simple laboratory market for capital among portfolio managers with the following properties: the investor is not well-diversified across funds, the portfolio manager's investment strategy is opaque, and the managerial contract is characterized by option-like compensation feature according to which the manager receives (most of) the compensation for returns in excess of pre-specified strike price (the details of this contract are described in Sect. 2.4). These properties are designed to represent, in an admittedly stylized manner, actual markets for funds.

In the simple model underlying our experiment, both managers and investors are risk-neutral and maximize they monetary payoffs. Nonetheless, the contracts they face render them responsive to risk. Most importantly, excessive risk taking is a feature of the equilibrium: it is the interaction between the competition for funds and the option-like contract for the manager which leads to an inefficient equilibrium outcome. Different policy interventions aimed at limiting risk taking on the part of managers do, in theory, rectify this result. We investigate several of these, which modify independently the competitive environment of fund managers and their contractual arrangements. More specifically, in one intervention (the Transparency treatment) we manipulate the competitive environment of fund managers by imposing Transparency on their investment strategy; that is, by forcing the manager to announce (and commit to) the risk level of its intended investment before the investor invests. In a second intervention (the Risk Sharing treatment), we modify the managerial compensation scheme to require complete Risk Sharing between the manager and the investor. Finally, in a third intervention (the Cap on Watermark treatment), we also change the managers' contractual arrangement by capping the strike price or promised return which managers can offer investors to limit how much competition could unravel.

In all these environments, at equilibrium, portfolio managers should efficiently invest funds in safe assets. Indeed, all of these interventions prove to substantially reduce risk taking in the experimental data. However, while we find that the most efficient intervention in this respect is the Transparency treatment, none of these interventions succeed in reducing risk taking completely or as thoroughly as predicted by the theory.

One possible explanation for the failure of our policy interventions to completely eradicate excessive risk taking is behavioral: in our experiment, managers are not investing their Own Money and this may lead them to a greater tendency to invest in risky projects. To investigate this hypothesis, we ran an "Own Money" treatment, which is identical to the Risk Sharing treatment except that, in the Own Money treatment, the manager is investing his own funds while in the Risk Sharing he is investing other people's money that he competed for. Interestingly, we find that managers tend to invest other people's money in riskier assets than they invest their own.[1] We interpret this difference as a manifestation of an effect which might have a component of a framing effect, which we call the *Other People's money effect*. Indeed, while managers invested their own funds in the risky project only about 11 % or 21.5 % of the time (depending on the treatment), they invested other people's money in such projects 39 % of the time in the Risk Sharing treatment. The *Other Peoples' money* effect, therefore, represents a quantitatively significant behavioral inefficiency induced by competition for funds in our capital market laboratory. In other words, the excessive risk taking we observe in this paper may stem from two sources. The first is the natural result of competition in which excessive risk raking is a feature of the equilibrium. The second may be an *Other People's money* effect where subjects behave in an excessively risky way because they are not investing their Own Money.

Our paper, adds to the literature in a number of ways. To begin with, we are one of the very few papers that look at an environment where different contractual arrangements interact with various aspects of competition in a financial market. In this respect the closest paper to ours is Asparouhova et al. (2011) which also studies theoretically and experimentally competition in portfolio management. In that paper, however, the contractual environment is fixed and managers are paid a constant fraction of the funds they collect, independently of performance. On the other hand, others have investigated the impact of contracts on the behavior of agents in financial markets; see, e.g., Levitt and Syverson (2008), who look at contracts in real estate markets; and Ou-Yang (2003), Palomino and Prat (2003), He and Xiong (2010), and Ellison and Chevalier (1999), who investigate contracts for portfolio managers. None of these papers however integrate competition into their models, studying instead one person contracting environments.

A few related papers study experimentally the attitudes of subjects towards other people's money. Specifically, Brennan et al. (2008) and Chakravarty et al. (2011) examine both attitudes of laboratory subjects towards their own payoffs as well as the payoffs of other subjects, finding a weaker dependence from the risk of the other subjects' payoffs than their own. Eriksen and Kvaloy (2010), with a similar experimental design, find an opposite effect: agents handling other peoples' money behave in a more loss-averse manner and take less risks for their clients. The focus of the analysis of these papers is the social preferences of their subjects: in their experimental design the decision makers who make decisions for others are not incentivized to do so. We study, instead, the behavior of subjects who compete for funds and then invest them, fully incentivized to do so to maximize payoffs. In our paper, therefore,

[1] In our experiments, managers face the choice between the safe and the risky investment. These investment opportunities are constructed in such a way that both risk neutral and risk averse individuals unambiguously prefer the safe investment since it has a higher expected return and a lower variance. Thus, even though we do not measure directly investors' risk preferences or managers' beliefs about investors' risk preferences, one would have to assume that investors are risk loving or managers' mistakenly believe that they are in order to interpret our experimental results differently.

the *Other Peoples' money* effect is a behavioral phenomenon, which could be interpreted as a specific form of framing, rather than a consequence of a specific form of social preferences.

The paper proceeds as follows. In Sect. 2, we present a simple model of a market for capital and we prove some simple results about the equilibria of such markets. We then introduce, in Sect. 3, our experimental design, mapping the model into a simple laboratory market. In Sect. 4 we present the results of our experiment. Finally, Sect. 5 concludes.

2 The market for capital

We are interested in markets in which portfolio managers compete for capital. A stylized representation of those markets include the following:[2]

(i) the size of the investment per investor is fixed, say \$1 (\$million, typically);
(ii) the portfolio manager receives a share, β, of all profits made above a "high-water mark"/strike price, w;[3] if the funds are lost, manager is not liable, that is, he/she only shares the upside risk in the contract and not any downside.
(iii) the portfolio manager is under no requirement to offer the investor any specific information about her investment strategy.

More precisely, when β, and w are as described above and R is the return earned by the fund in any given year, the cash flow accruing, respectively, to the investor (Π^{investor}) and the portfolio manager (Π^{manager}) can be written as follows:

$$\Pi^{\text{manager}} = \beta \max(0, R - w)$$
$$\Pi^{\text{investor}} = \min(R, w) + (1 - \beta) \max(0, R - w)$$

We assume in the theoretical analysis that both the manager and the investors are risk neutral and hence that their choices maximize Π^{manager} and Π^{investor} respectively. It is immediate to see that, nonetheless, the manager's payoff is convex, and the invertors' concave, in the return on the fund R, for given w. This is due to the contract they face and allows us to discuss equilibrium outcomes in terms of the associated risk the agents face.[4]

2.1 Contractual environments

Consider a world with two portfolio managers and one investor. The investor possesses a $\$x$-chip to be invested, which the managers compete for. The manager who

[2]We shall argue at the end of this section that this is a reasonable representation of the contractual environment which is found in hedge fund markets.

[3]We abstract from small fixed fees, which possibly have little effect on risk taking in practice.

[4]Risk neutrality is therefore assumed just for simplicity and because our theoretical analysis is meant to guide the experimental analysis, which has relatively small stakes. On the other hand, all our results are qualitatively unchanged allowing for some risk aversion; more specifically, as long as the manager's objective remains convex.

is successful in attracting the chip can invest it in one of two projects, called *safe* and *risky*.

The return on the safe project is a dichotomous random variable paying $R_s > 0$ with probability $0 < p_s < 1$, and 0 otherwise. The return on the risky project is also a dichotomous random variable paying $R_r > R_s > 0$ with probability $0 < p_r < p_s < 1$, and 0 otherwise. Note that the risky project, has a higher return when successful with respect to the safe asset; but the probability of success is higher for the safe asset. We assume however that the safe payoff has a higher expected return,

$$p_s R_s > p_r R_r$$

This assumption is called for, because we want to study the case in which investing in the risky asset is a dominated choice, absent the moral hazard implicit in the portfolio manager's intermediation of funds.

We consider several alternative contractual environments (interventions) in which the portfolio managers compete for the investor's funds. Each environment will serve as a treatment in our experiment. To avoid considering a multi-dimensional competition problem, we consider the following extreme cases.

1. *Baseline contract*. In this contract β is fixed $= 1$ and the managers compete for funds by choosing the water mark, w.
2. *Risk Sharing contract*. In this contract, in contrast to the baseline contract above, w is fixed $= 0$ and managers compete by offering different shares β of the proceeds of their investments.
3. *Transparency contract*. This contract is identical to the baseline contract ($\beta = 1$ and managers compete by setting w), except that when competing for funds, the manager is required to publicly commit to the project the funds will be invested in. Hence, an offer in this treatment is a pair (w, safe) or (w, risky). (This implicitly assumes the investment is verifiable.)

Finally, we also study a contractual environment in which a legally binding condition restricts the portfolio managers' offers,

4. *Cap on Watermark contract.* This contract is again identical to the baseline contract ($\beta = 1$ and managers compete by setting w) except for the fact that we place an upper bound, $\bar{x}$, on the w's that can be offered and hence require $w \leq \bar{x}$.

In any of the contractual environments described, after observing either w or β, depending on the contractual environment, the investor decides which manager to invest his funds ($\$x$) with. The manager, before knowing if she will receive the funds decides which project, safe or risky, to invest them into. The manager who has received the funds will then go ahead and invest them as decided. After all investment decisions are made, the cash flow is realized and payoffs determined.

We specify these various contracts because we will be interested in how they affect the performance of the market for other people's money. As the propositions below indicate, these contracts can have a significant impact on the risk taking of managers and the subsequent welfare of our agents.

2.2 Equilibria

We now study equilibria in the different contractual environments.[5] We concentrate first on the baseline contract, our baseline.

Result 1 *In the Baseline contract, there exist a cutoff* w^* *such that, if* $w \geq w^*$ *each manager has an incentive to invest the funds in the risky project (strictly so, if* $w > w^*$*).*

In fact, w^* is such that each manager is indifferent with respect to her investment, and it satisfies

$$w^* = \frac{p_s R_s - p_r R_r}{p_s - p_r} > 0$$

Result 2 *In the Baseline contract, if one manager offers* w_1 *and another manager offers* w_2 *such that* $w_1 \leq w^* \leq w_2$ *and* $\frac{w_2}{w_1} > \frac{p_s}{p_r}$*, then the investor will give his chip to the manager who offered* w_2*. Likewise, in the Transparency contract, if one manager offers* $(w_1, safe)$ *while the other manager offers* $(w_2, risky)$ *and* $\frac{w_2}{w_1} > \frac{p_s}{p_r}$*, then the investor will give his chip to the manager who chose the risky project.*

These results state that if one manager chooses the safe project, the other manager has an incentive to offer a high enough w *and* choose the risky project. That is, there exists a risk premium ($\frac{p_s}{p_r}$) such that a rational investor will be willing to leave the safe project for the risky one. In the Transparency contract an investor is able to observe the contract in which his funds will be invested. Thus, an investor demands a compensation of at least $w_2 \geq w_1 \cdot \frac{p_s}{p_r}$ for high risk. In the baseline contract, if $w_1 \leq w^* \leq w_2$ then the investor can infer that a manager that offered w_1 will invest in the safe project and a manager that offered w_2 will invest in the risky project (see Result 1). Since $\frac{p_s}{p_r} w^* < R_r$ a deviation on the part of a manager to the risky project is always feasible. This is the case under a regularity condition bounding the relative return of the safe project, a condition satisfied by the parametrization of the game we take to the lab.

It is now straightforward to show, by a Bertrand competition argument, that

Proposition 1 *In the Baseline contract, at equilibrium, both portfolio managers offer* $w = R_r$ *and invest the funds in the risky project.*[6]

Proposition 2 *In the Transparency contract, at equilibrium, both portfolio managers offer* $w = R_s$ *and invest the funds in the safe project.*

[5] See Matutes and Vives (2000) for a model of bank competition which resembles, along several dimensions, our laboratory capital market.

[6] This result holds true more generally, when managers in capital markets compete by choosing both the share, β, of all profits made above a "high-water mark"/strike price, w, and the "high-water mark"/strike price, w itself (see Online Appendix for the formal proof).

Table 1 Equilibrium predictions

Contract	Investment	β	ω
Baseline	Risky	NA	10
Risk sharing	Safe	0	NA
Transparency	Safe	NA	7
Cap on Watermark	Safe	NA	$\bar{x} \leq 3.25$

Proposition 3 *In the Cap on Watermark contract, with $\bar{x} \leq w^*$, at equilibrium both portfolio managers offer $w = \bar{x}$ and invest the funds in the safe project.*

Proposition 4 *In a Risk Sharing contract, at equilibrium both portfolio fund managers offer $\beta = 0$ and invest the funds in the safe project.*

Note that these contracts lead to different results in the market. For example, under the Baseline contract, competition forces w up to the level of R_r and all funds are invested in the risky project. In all the other contracts, however, at the equilibrium, the funds are invested in the safe project with different equilibrium w's in the Transparency and Cap on Watermark contracts and β in the Risk Sharing contract. For example, in the Risk sharing contracts where managers compete by offering $1 - \beta$ and where $w = 0$, the only equilibrium is one involving both investors investing in the safe project and $\beta = 0$. In this contract the incentives of the investors and managers are perfectly aligned so that the managers should invest the investor's chip as if he was investing his Own Money. In the Cap on Watermark contract funds should be invested in the safe project since we restrict $\bar{x} \leq w^*$.

2.3 Parametrization

In our experiments we investigate one particular parametrization of this model. In this parametrization the safe project has a cash flow of 7 tokens if successful, with probability 0.9, ($R_s = 7$, $p_s = 0.9$) while the risky project has a cash flow of 10 tokens if successful, with probability 0.5, $R_r = 10$, $p_r = 0.5$. Without loss of generality, if we restrict w to be in [0, 10] it is easy to show that, in this parametrization, $w^* = 3.25$ and all our assumptions are satisfied, i.e., $6.3 = p_s R_s > p_r R_r = 5$ and $\frac{p_s}{p_r} w^* = 5.85 < R_r = 10$. Given this parametrization we have the following equilibrium predictions for our different contracts (see Table 1).

2.4 Hedge fund markets

Our objective in the paper is to study stylized capital markets in the laboratory. To put our analysis in its proper context, then, we introduce here briefly some relevant institutional aspects which characterize capital markets in the real world, and in particular, hedge funds.

Hedge funds are largely unregulated investment funds which, in the last twenty years have become increasing important in the capital markets. At its peak in the summer 2008, the hedge fund industry managed around $2.5 trillion, according to

Aima's Roadmap to Hedge Funds, Inechen and Silberstein (2008).[7] Hedge funds typically compete for institutional and wealthy investors, requiring a substantial minimal investment tranche to participate in the fund (thereby imposing substantial diversification costs to investors). Moreover, hedge funds are characterized by their investment strategies and by the incentive schemes their managers are compensated with.

The investment strategies and styles of hedge funds are generally opaque, and are not revealed to investors. In other words, fund managers compete for investors in this market by signaling skills through past performance and through their incentive compensation scheme. Manager compensation typically includes a small management fee (proportional to the investment tranche, of the order of 1–2 %) and a larger performance fee, of the order of 15–25 % of returns exceeding the "high-water mark" (the maximum share value in a pre-specified past horizon).[8] This incentive compensation scheme is equivalent to a call option with the "high-water mark" as strike price. Furthermore, the manager is subject only to limited liability, while it is relatively standard in the industry to require that a substantial fraction of the managers' private capital be heavily invested in their own fund. See Fung and Hsieh (1999) and Goetzmann et al. (2003) for rich institutional details on the hedge fund industry.

Option-like contracts, like those common in the hedge fund industry, are designed to signal managerial skills, but also induce managers to take high risks. More precisely, a rational portfolio manager facing a dynamic option-like contract will be lead to take extreme risk while the fund is below water (its return below the "high-water" mark), while he will invest more safely when just above water.[9] A large empirical literature has documented that, in fact, (1) hedge-funds returns contain a significant excess risk-adjusted return due to managerial skills (or "alpha"); see Edwards and Caglayan (2001); (2) hedge-fund returns are significantly riskier than other investment forms (e.g., mutual funds): even after accounting for survivor (and other related) bias, hedge funds paid (geometric) average returns 2 % in excess of mutual funds in the period 1996–2003; see Malkiel and Saha (2005), Tables 3–4, and Brown et al. (2001). In particular, even though hedge fund returns display a low correlation with stock market indices, they are characterized by exceptionally large cross-sectional range and variation. Consequently, the attrition rate of hedge funds in the market is very high: over 50 % in 5 years from the 90s; see Liang (2000) and Amin and Kat (2002).

3 Experimental design

Our experimental design attempts to implement the market for funds outlined above. The experiments were run at the experimental lab of the *Center for Experimental*

[7] The first hedge fund was apparently founded by A.W. Jones, a sociologist and financial journalist, in 1949. In the 1990's, however, the industry was managing about $50 billions; see Malkiel and Saha (2005).

[8] A norm in the market seems to be "2/20" contracts: 2 % management and 20 % performance fee.

[9] See e.g., Carpenter (2000), Goetzmann et al. (2003), and Jackwerth and Hodder (2006), Panageas and Westerfield (2009).

Social Science at New York University. Students were recruited from the general undergraduate population via E-mail solicitations. In total 311 students participated in the experiments, which lasted approximately 45 minutes and students earned on average \$20. Each different contractual environment represents a treatment in the experiment.

The *Baseline treatment* is the contract environment which we introduce first. The complete instructions for this treatment are presented in the Appendix. When subjects arrived at the lab they were divided into groups of three with two managers and one investor in each group. The experiment consisted of 20 identical decision rounds. In each round the investor was endowed with one "investment chip". Each round started by each manager simultaneously selecting a promised $w \in [0, 10]$. The managers also choose which project, safe or risky, they intend to invest in. The w's are announced to the investor in the market, but not the investment decision, which is kept private. After both managers choose their w's, the investor decides who to invest his chip with. The selected manager then has the right to make the investment that she decided on. The other manager can make no investment in this round. We ran our market with only one investor in order to maximize competition and with only two managers in an effort to minimize the number of subjects needed (and hence the amount of money required).

After the investment decisions were made the chosen project was played out and payoffs determined. A successful investment in the risky project paid $10 - w$ tokens to the manager and w to the investor. A successful investment in the safe project paid $\max\{0, 7 - w\}$ tokens to the manager and $\min\{7, w\}$ tokens to the investor (the manager is not liable for any loses imposed on the investor).

After each round, both managers observe the w chosen by the other and which manager received the chip. The manager receiving the chip was also informed as to which project the chip was invested in, the resulting cash flow, and whether or not she was able to pay the investor in this round. The investor was told whether or not he received his payment and his profit in this round, *but not* which project the chip was invested in. The experiment then moved into the next round where subjects were randomly matched into new groups of 3 while retaining their role in the experiment, so that if a subject was an investor (manager) in round 1 she retained that role over the entire 20 rounds. The identity of subjects was anonymous so subjects could not identify other subjects' roles. This eliminated the possibility of managers creating a reputation.

In addition to the Baseline treatment, we ran several other treatments each of which replicated one of the different contractual environments described above. The first such treatment was the *Cap on Watermark treatment*, for which we chose $\bar{x} = 3$. This treatment was run to check our hypothesis that it is competition, and the heightened promises of returns it encourages, that lead to risky behavior on the part of investors. Obviously, since $3 < 3.25 = w^*$, in this treatment we would expect all funds to be invested in the safe project. Otherwise, our hypothesis that risk taking is an artifact of market competition pushing promised returns above $w^* = 3.25$ would be easily disproved. In this treatment all procedures were identical to those of the hedge fund contract except for the restriction on w.

Our *Transparency treatment* is identical to the baseline contract except for the fact that, in the first move of the game, the managers not only choose w, but also commit on a project to invest in. In other words, they choose a pair $(w, \text{Project})$ where Project $\in$ {safe, risky} and each pair chosen by the managers is shown to the investor. The investor then chooses a manager to give his chip to and the rest of the round is played out as in the Hedge Fund treatment.

Our fourth treatment is the *Risk Sharing treatment*. In this treatment $w = 0$ and managers offer a share $1 - \beta$ to the investor indicating what fraction of the returns investors will receive if the project succeeds. If $\beta = 0$ then all the proceeds of the investments go to the investor, while if $\beta = 1$ then the manager keeps all the proceeds for himself. This treatment is conducted using private information (when making their choice investors observe only the shares both managers propose) in an effort to isolate the impact of the contract on behavioral and not confound it with Transparency considerations.

In all four treatments discussed above when the experiment was over we surprised the subjects by informing them that we wanted them to engage in one more decision. In this decision we gave each of them a chip and asked them to invest it for themselves in either the risky or the safe project. The chip was worth 10 times the value of the chip used in the previous 20 rounds so this decision was a more valuable one and should indicate how subjects would invest when investing their Own Money rather than that of others. This investment opportunity was given to both subjects who played the role of investors and managers in the experiment. We will refer to this part of the experiment as *Own Money (big stakes) treatment*.

The *Own Money (big stakes)* treatment is similar to the "surprise quiz" round used by Merlo and Schotter (1999). In this treatment subjects play for large stakes and do so only once after their multi-round participation in the experiment. The idea is that this one large-stakes decision should be a sufficient statistics for all they have learned during their participation in the experiment.[10]

Finally, we ran an additional Own Money treatment which we call the *Own Money (small stakes)* treatment. In this treatment, all subjects participating in the experiment performed the role of managers. In each round (20 rounds in total) the manager was endowed with his/her own chip and faced the same two investment projects: safe and risky. The task of the manager was to choose how to invest his/her own chip. After the investment decisions were made the chosen project was played out, payoffs determined and shown to the subjects. As before, a successful investment in the risky project paid 10 tokens and a successful investment in the safe project paid 7 tokens.

The Own Money (small stakes) treatment is designed to replicate as close as possible the main features of the Risk Sharing treatment with one modification: managers are investing their Own Money ("investment chip") as opposed to the other people's money (the chip received from the investor). Indeed, similar to the other treatments, in the Own Money (small stakes) treatment the game is repeated (20 decision rounds), the stakes are of the same magnitude and, finally, subjects have no prior experience with the game being played.

Given the projects available, at equilibrium, managers invest their own funds in the safe project. This is the case also, at equilibrium, for the Risk Sharing treatment,

[10]In this sense it is preferable to repeating the Own Money (small stakes) treatment 20 times since in that treatment repetition may lead to boredom and false diversification.

Table 2 Experimental design

Treatment	Competition	Information	N of sessions	N of subjects
Baseline	Unrestricted	Only w	4 sessions	72 subjects
Cap on Watermark	$w \leq 3$	Only w	4 sessions	63 subjects
Risk sharing	Unrestricted	Only $1 - \beta$	4 sessions	78 subjects
Transparency	Unrestricted	$(w,$ Project$)$	4 sessions	75 subjects
Own Money (small stakes)	None	NA	1 session	23 subjects
Own Money (big stakes)	None	NA	8 sessions	288 subjects

in which managers invest funds received from the investor, because the preferences of the manager and the investor are completely aligned. Any difference we might observe in manager's behavior when they invest their Own Money and investors' money, will be interpreted as a manifestation of the *Other Peoples' money* effect described in the Introduction.

Our complete experimental design is summarized in Table 2.

4 Results

We now ask whether the predictions of the model are borne out in the lab. Our emphasis however is not on the model's point predictions. Rather, as is true in many experiments, we are more interested in its qualitative comparative statics since it is those that have the major policy implications.

We will present the results of our experiments in the following order. First, we focus on the Baseline treatment and investigate whether the competition between managers leads the market to unravel inducing investment in a risky project when a safe project dominates in terms of expected returns. Second, we introduce three policy interventions (Cap on Watermark, Transparency and Risk-Sharing) and compare their performance in terms of how successful they are in reducing risky investments by the managers. Third, we investigate individual behavior of managers and investors in order to understand the main determinants of their decision-making process. Finally, we ask whether managers invest their own funds (as measured by the Own Money treatments) differently from the ones received from the investors.

Most of the statistical analysis will be performed using session averages in order to avoid the possibility that, given our re-matching procedure, observations may not be independent within sessions. To establish treatment effects we will use nonparametric Wilcoxon Ranksum test with 4 session averages per treatment.

4.1 Does the market unravel in the baseline treatment?

In the Baseline contract environment, at equilibrium, managers are expected to offer the highest return $w = 10$ and invest in the risky project. The key element in this result is that competition for funds will force w above 3.25 at which point investing in the risky project becomes rational for the manager.

Table 3 How often managers chose risky investment in the baseline treatment

	All managers	Managers that received chip
All rounds	58 %	66 %
Round 1	15 %	13 %
Rounds 2–5	47 %	60 %
Rounds 6–10	63 %	71 %
Rounds 11–15	64 %	71 %
Rounds 16–19	61 %	71 %
Round 20	67 %	79 %

Table 3 lists the fraction of times managers chose to invest in the risky project in the Baseline treatment. Interestingly, while managers start the game by choosing the safe project more than 85 % of the times in the first period, the market unravels quickly and by the end of the experiment the vast majority of chips received from investors (79 %) are invested in the risky project. Focusing on the last 5 periods of the game, we reject the hypothesis that managers that received the chip from the investor are equally likely to invest in the safe and in the risky project at 6 % significance level. Formally, this conclusion is reached by performing the Wilcoxon matched-pairs signed-ranks test on the session averages for the fraction of risky investments in the last 5 periods in the Baseline treatment ($z = 1.826$ and $p = 0.0679$).[11]

A second fundamental equilibrium prediction in the Baseline treatment is that risk taking on the part of managers is associated with high-return offers (high w's) to investors. In fact, in this environment the theory predicts that w will rise to $R_r = 10$. Qualitatively, all that matters in order to observe risky behavior is that the observed w in the market rise above $w^* = 3.25$ since such high promised returns are expected to lead to risky investments. This is once again the case in the lab data.

Note that managers promised consistently, on average, more than 3.25. In the first 5 rounds, we observe only 7 % of all offers below the cutoff of $w^* = 3.25$. As subjects gain experience with the game, this fraction vanishes and by the end of the experiment no managers offer watermarks below the cutoff value (0 % in the last 5 rounds). On the other hand, as subjects gain experience with the game more and more managers offer very high watermarks of 7 tokens and above (18 % among all managers and 23 % among managers that received the chip from the investor in the last 5 rounds). Naturally, the vast majority of managers that offer such high watermarks of $w \geq 7$ are also the ones who intended to invest in the risky project (93 % in the last 5 rounds), since promising more than 7 is a losing proposition for managers who intend to invest in the safe project.[12] All in all, evidence presented in Table 4 suggests that even

[11] The results of the test do not change if we take into account all the intended investments of manager and not just the ones who received the chip from the investor.

[12] Our data suggests that there is some resistance to offering an w much above 7. In fact the highest watermark offered in the last 5 rounds was 7.9 tokens. This may be explained by a number of reasons. For example, in the Baseline treatment there is a residual 37 % of subjects who intended to invest in the safe project in the last 5 rounds. Those subjects almost never promised more than 7 tokens. Hence, a manager

Table 4 Offered and accepted contracts in the baseline treatment

	All managers				Managers that received chip			
	Risky (frac)	Mean w (tokens)	$w \leq 3.25$ (frac)	$w \geq 7$ (frac)	Risky (frac)	Mean w (tokens)	$w \leq 3.25$ (frac)	$w \geq 7$ (frac)
All rounds	58 %	5.3	3 %	13 %	64 %	5.6	0 %	17 %
Rounds 1–5	41 %	4.8	7 %	9 %	51 %	5.2	2 %	15 %
Rounds 6–10	63 %	5.3	3 %	10 %	71 %	5.6	0 %	13 %
Rounds 11–15	64 %	5.5	1 %	15 %	71 %	5.7	0 %	18 %
Rounds 16–20	63 %	5.6	0 %	18 %	72 %	5.9	0 %	23 %

though our lab managers in the Baseline treatment did not push the promised return up to their limit of 10, as predicted, they did consistently push it above the threshold where risky behavior became rational.

In summary, on a qualitative level we find that, as predicted, competition between managers in the Baseline treatment leads to high fraction of risky investments (above 75 % in the last 5 rounds) which are also associated with the promised returns above predicted cutoff value of $w^* = 3.25$. In the next section we investigate how effective different policy interventions are in increasing market efficiency which is measured by the fraction of safe investments.

4.2 How effective are policy interventions?

From the equilibrium predictions of our theory we would expect that all three interventions (Cap on Watermark, Transparency and Risk Sharing contracts) would eliminate risky investment. This would be the case for different reasons, however. In the Cap on Watermark treatment, the exogenous upper bound on the promised returns is set low enough to ensure that the only equilibrium is the one in which both managers invest in the safe project which guarantees higher expected returns than the risky project. In the case of Risk Sharing, since $w = 0$, the incentives of the manager and the investor are aligned. Since the safe project has a higher expected return, it is in the interest of the manager to invest in it so all funds should be invested in the safe project. In the Transparency case it is competition that insures safe investment since the only equilibrium is one where both firms promise to invest safe and offer $w = 7$ and, at that return, there exists no promised return that can induce the investor to want his chip invested in the risky project. As a result, we would expect less risky investments in the Cap on Watermarks, Risk Sharing and Transparency treatments than in the Baseline treatment.

Figure 1 presents how often the chip received from the investor was invested in the risky project in each treatment, while Table 5 presents session-by-session averages.

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intending to invest in the risky project may have believed that it was not necessary to offer more than 7 since there was a good chance that he would be facing a safe investor who he believed would never offer more than 7.

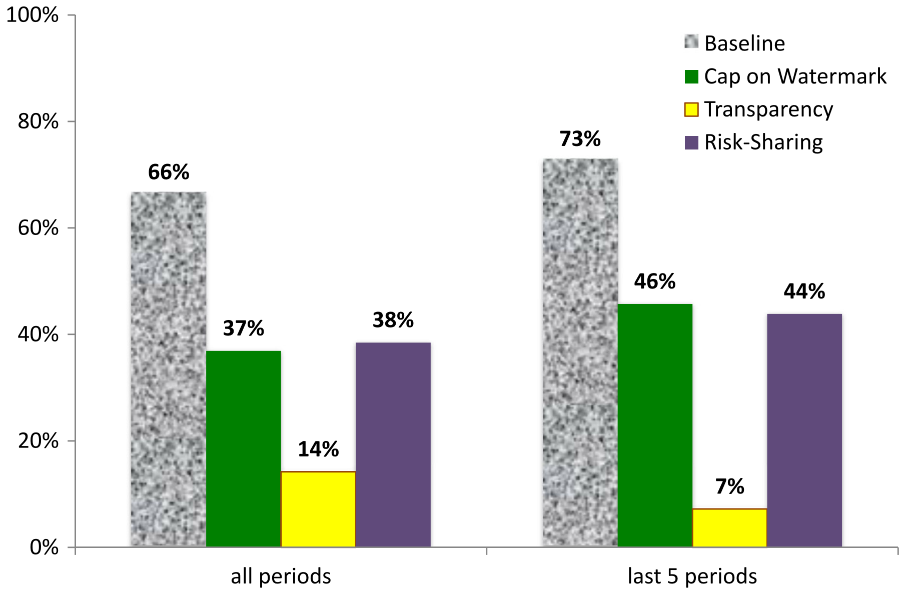

Fig. 1 Fraction of risky Investments, by treatment

Table 5 Fraction of risky investments, session-by-session data

	First round					All rounds					Last 5 rounds				
	All	s1	s2	s3	s4	All	s1	s2	s3	s4	All	s1	s2	s3	s4
Baseline	0.13	0.29	0.00	0.13	0.00	0.66	0.63	0.68	0.68	0.68	0.73	0.54	0.85	0.73	0.88
Cap on w	0.24	0.26	0.17	0.29	0.25	0.37	0.20	0.36	0.41	0.48	0.46	0.15	0.43	0.57	0.60
Risk sharing	0.23	0.38	0.14	0.14	0.25	0.39	0.33	0.49	0.31	0.44	0.44	0.38	0.51	0.34	0.60
Transparency	0.32	0.57	0.33	0.25	0.00	0.14	0.28	0.05	0.11	0.11	0.07	0.11	0.00	0.10	0.05

Both Fig. 1 and Table 5 indicate that our expectations are substantiated by experimental data. While subjects invested in the risky project 66 % of the time over the 20 periods of the Baseline treatment (73 % in the last 5 periods), they did so only 37 %, 38 % and 14 % of the time in the Cap on Watermark, Risk Sharing and Transparency treatments respectively (46 %, 44 % and 7 % in the last 5 periods respectively).

Statistical analysis reveals that the fraction of risky investments in the Baseline treatment is significantly higher than those documented in the Cap on Watermark, Risk Sharing and Transparency treatments both in all 20 periods ($p < 0.05$) and in the last 5 periods ($p < 0.05$).[13] Moreover, we observe far less risky investments in the Transparency treatment than in either the Cap on Watermark or the Risk Sharing

[13]With the exception being the Cap on Watermarks treatment in the last 5 periods, in which the fraction of risky investments is significantly smaller than the one documented in the Baseline treatment at 10 % (rather than 5 %) level of significance.

treatments ($p < 0.05$ in both all 20 periods of the experiment and in the last 5 periods). Finally, both the Risk Sharing and the Cap on Watermarks treatments lead to similar efficiency levels as measured by the fraction of risky investments made by the managers that received the chip from the investor ($p = 0.7728$ in all 20 periods of the experiment and $p = 0.8845$ in the last 5 periods).[14] Notice that in spite of some variation in the fraction of risky investments between sessions (as depicted in Table 5), the main results are not driven by one single session but rather stable across sessions. Put differently, while all policy interventions significantly reduce the proportion of risky investments compared with the Baseline treatment, the most effective intervention is the Transparency contract.

The dramatic impact of Transparency on the Baseline contract is noteworthy since it indicates that investors in the experiment prefer to have their funds invested in the safe project and that the excessive risk taking in the Baseline treatment might be ascribed to investors inability to control how their funds are being invested. Moreover, the complete alignment of the preferences between the managers and investors (as imposed by Risk Sharing contract) or limiting offered returns (as imposed by the Cap on Watermarks contract) might not be enough to reduce risk-taking behavior of the managers who face competition for funds.

Our Result 2 implies that if one manager proposes to invest in the safe project while the other proposes to invest in the risky project, as long as the promised return on the risky project is more than $\frac{p_s}{p_r}$ times the promised return on the safe project (1.8 in our parameterization), the investor should prefer to invest his money in the risky project. Perhaps one of the reasons why we see so much investment in the safe project in the Transparency treatment is that while there is a significant premium for risky investment in this treatment (see Table 6), it is not sufficiently large to induce investors to want to go risky. For example, note that in the Transparency treatment the mean w offered for investment in the safe project over all periods (last 5 periods) was 4.46 (4.86) tokens while the same w offered for investment in the risky project was 5.70 (6.15) tokens. While this premium is statistically significant ($p < 0.05$ in all 20 rounds and in the last 5 rounds of the experiment according to Wilcoxon Ranksum

Table 6 Average offers of managers, by treatment

Transparency	w in all rounds	w in last 5 rounds
Managers that chose risky project	5.70	6.15
Managers that chose safe project	4.46	4.86
Cap on Watermark	w in all rounds	w in last 5 rounds
Managers that chose risky project	2.95	3.00
Managers that chose safe project	2.92	2.99
Risk-Sharing	β in all rounds	β in last 5 rounds
Managers that chose risky project	62.6 %	70.4 %
Managers that chose safe project	62.0 %	71.8 %

[14] All the comparisons are made based on the results of the Wilcoxon Ranksum test for equality of medians using the fraction of risky investments averaged per session, which gives us 4 observations per treatment.

test performed on session averages), it is not, on average, as high as needed to be sufficient to make risky investment preferred by investors.[15]

In the Risk Sharing treatment, managers that intended to invest in the risky and in the safe projects offered very similar shares of the proceeds to the investor: about 62 % in all 20 rounds and about 71 % in the last 5 rounds (see Table 6). These shares are not statistically different ($p = 0.5637$ in all 20 rounds of the experiment and $p = 0.3865$ in the last 5 rounds). Same is true for the Cap on Watermark treatment: managers promised similar returns to the investor irrespectively of whether they intended to invest funds in the risky or safe project. Thus, the investors could not infer from the promises made by managers whether their funds will be allocated to the safe or to the risky project.

To summarize, all three policy interventions are effective in reducing the fraction of risky investments observed in the Baseline treatment with the Transparency treatment being the most effective.

4.3 Individual behavior of managers and investors

In this section we discuss individual behavior of managers and investors in order to detect learning that occurs during the course of the experiment. We summarize here the most interesting observations and refer the reader to the Online Appendix, where we conduct a regression analysis of how the decisions in a current round are affected by the experience of each party in the preceding round(s).

Recall that managers compete for the scarce investment opportunity by choosing two features of the contract: the investor's profits in case investment is successful, and the type of the project (safe or risky) in which funds will be invested. Table 7 summarizes how often managers choose the risky project conditional on (1) defaulting in the previous period and (2) being successful in the previous period. Interestingly,

Table 7 How often managers chose risky project in period t after defaulting and after successful investment in period $t-1$, by treatment

	Baseline		Transparency		Cap on Watermark		Risk-sharing	
	All periods	Last 5	All periods	Last 5	All periods	Last 5	All periods	Last 5
Defaulted in $t-1$ frac of risky in t (# obs.)	68 % (179)	84 % (49)	31 % (84)	24 % (17)	53 % (95)	58 % (26)	42 % (141)	54 % (35)
Success in $t-1$ frac of risky in t (# obs.)	58 % (733)	57 % (191)	21 % (866)	19 % (233)	34 % (703)	39 % (184)	39 % (847)	41 % (225)

[15] We note that managers who chose the safe project in the Transparency treatment offer on average strike price of 4.6 which is above theoretical threshold value of 3.25. One possible explanations for the inconsistency between offering strike price above the threshold and investing in the safe project might be the mistakes subjects make in calculations. In other words, subjects are able to internalize main trade-offs of the environment they face; however, they make small mistakes in calculations which lead them to believe that the threshold is higher than it actually is. Importantly, subjects that perform the role of managers realize that risky investments should be accompanied by the premium in returns, which is what we observe.

Table 8 How often investors allocated the chip to the manager that promises a higher profits in case of success, by treatment

Baseline		Transparency		Cap on Watermark		Risk-sharing	
All periods	Last 5	All periods	Last 5	All periods	Last 5	All periods	Last 5
82 % (433 obs)	82 % (144 obs)	74 % (441 obs)	70 % (110 obs)	91 % (65 obs)	100 % (2 obs)	88 % (461 obs)	86 % (117 obs)

comparing the fraction of risky investments in these two categories we find that managers choose risky project in (1) at least as often as they do in (2). This indicates that managers *do not* change their behavior after defaulting, which happens primarily if they chose risky in the previous period. In other words, high default rates associated with the risky investments in the past do not discourage managers to choose risky projects in the future.

Turning our attention to the behavior of investors, we note that in all four contractual environments, investors observe the returns promised by two competing managers before making their choice. Table 8 summarizes how often investors choose to allocate their investment chip to a manager that promised a higher return in case of success, in each treatment.

In all four treatments, investors primarily choose to allocate their funds to a manager who promises higher returns conditional on promises being different. This happens more than 80 % of the times in Baseline, Cap on Watermark and Risk-Sharing treatments as well as 70 % of the times in the Transparency treatment in the last 5 periods of the experiment.[16] The lowest percentages observed in the Transparency treatment are due to the fact that in this treatment investors also observe whether their funds will be invested in the safe or risky project and could use this information to partially control the level of risk they are willing to incur. Our data indicates that investors use this channel extensively, by allocating the funds to a manager that commits to the safe project 79 % in all periods and even more so by the end of the experiment (88 % in the last 5 periods). This, coupled with the observation about inability of managers to resist the competition and restrain from making risky investments, explains why we observe such a low level of risky investments in the Transparency treatment compared to the other ones.

4.4 Is there an other people's money effect?

We say that an *Other Peoples' money* effect occurs if managers tend to be more willing to take higher risks when investing other peoples' than their Own Money. To be precise, in our experimental set-up, we define the Other People's money effect as the difference in the risk taking behavior of managers in the Risk Sharing and Own Money treatments. In both treatments managers' incentives are completely aligned

[16] Such a small number of observations in Cap on Watermark treatment is due to the fact that in the last 5 periods of the game both managers proposed the same maximum possible watermark to investors, which is $\bar{w} = 3$.

Table 9 How often funds were invested in the risky project (all managers)

	Risk sharing	Own Money (small stakes)	Own Money (big stakes)
Rounds 1 to 5	35.4 %	23.5 %	
Rounds 6 to 10	36.9 %	21.7 %	
Rounds 11 to 15	41.9 %	19.1 %	
Rounds 16 to 19	42.8 %	16.3 %	
Round 20	42.3 %	43.5 %	
All 20 rounds	39.2 %	21.5 %	Managers 11 % Investors 10 %

with those of investors and theoretically, at equilibrium, we expect to see all funds invested in the safe project.[17]

Table 9 presents the percentage of times subjects made risky investment in the Risk sharing and the Own Money treatments, where we used the data from all the intended investments by managers in the Risk Sharing treatment. In the Own Money (big stakes) treatment only 11 % of managers and 10 % of investors chose to invest their own funds in the risky project,[18] while managers did so 39.2 % of the time in the Risk Sharing treatment. In other words, if subjects have learned anything over the course of the 20 rounds experiment it is that they want their chip to be invested in the safe project when it is worth a lot of money.

Similar conclusions can be drawn from comparing the Risk Sharing and the Own Money (small stakes) treatments. Except for the very last round, subjects are much more likely to make risky investments when they allocate other people's money (39.2 %) than their own (21.5 %). Using Wilcoxon Signrank test we reject the hypothesis that the fraction of risky investments in the Risk Sharing treatment over the course of the experiment (one observation per session) is statistically indistinguishable from 21.5 % which is the fraction of risky investments in the single session of Own Money (small stakes) treatment at 6 % significance level ($z = 1.826$).

Finally, results in Table 9 suggest that the fraction of risky investments monotonically decreases with experience in the Own Money (small stakes) treatment, while it is relatively constant in the Risk Sharing treatment. The last round of the Own Money (small stakes) treatment shows the end-game effect: in the last round 43.5 % of the

[17] We note that there is a difference in the stake size between Risk Sharing, Own Money (small stakes) and Own Money (big stakes) treatment. Indeed, in the Risk Sharing treatment managers on average 38 % of the profits and give the rest to the investor (see Table 6). In the Own Money (small stakes) managers enjoy 100 % of earned profits as they do not face the competition for funds and receive investment chip for free in every round. Finally, in the Own Money (big stakes) treatment the stakes are much higher than in both Own Money (small stakes) and Risk Sharing treatment. Despite these differences, we believe that the point we are trying to make in this section is not driven by the difference in stake sizes. The point being that managers make riskier investments when operating with the funds received from the investor than when they invest their own funds.

[18] Recall that the Own Money (big stakes) treatment was performed at the end of each session after another treatment. There is, however, no significant difference in the behavior of either managers or investors according to the different treatments they previously played ($p > 0.10$). Therefore, we pool together all the data from Own Money (big stakes) treatment and report them together.

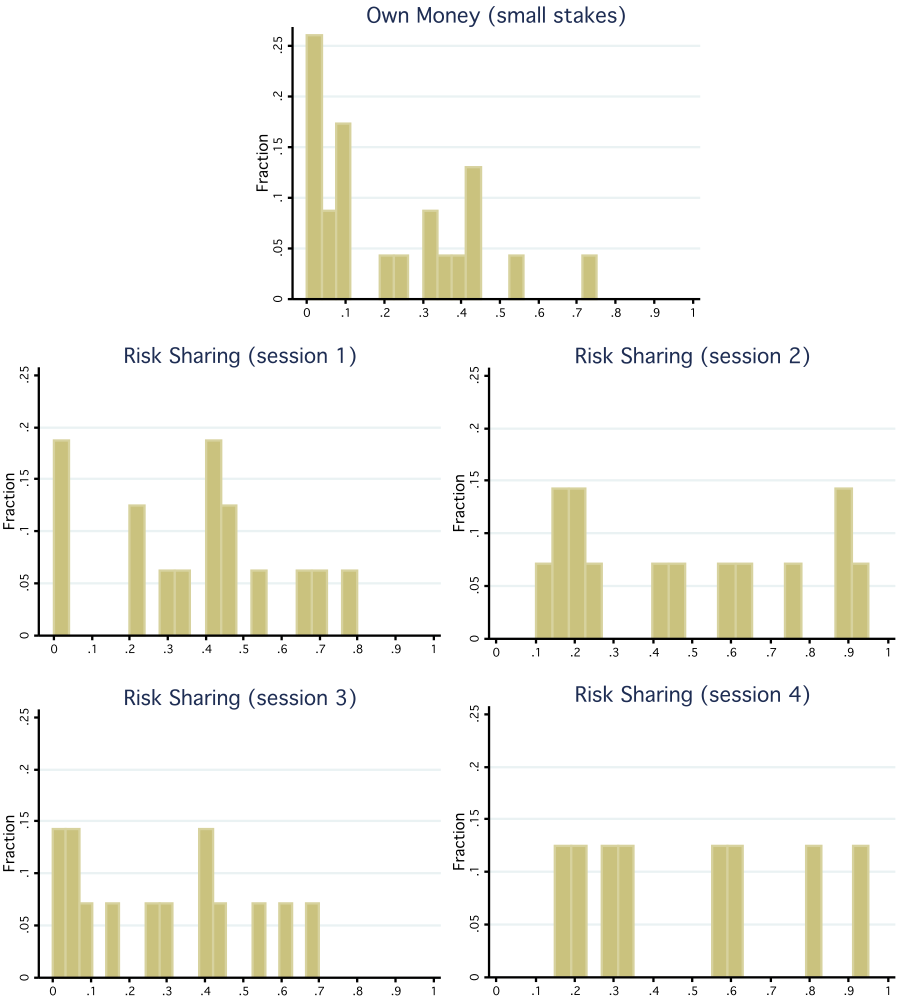

Fig. 2 Histogram of how often managers chose risky projects in Own Money (small stakes) and Risk Sharing treatments (by session)

managers chose the risky project, which is two times more than the percentage of risky investments in the first 19 rounds where average is about 20 %.[19]

Figure 2 depicts the histograms of the riskiness of the managers' investments in the Own Money (small stakes) and in the Risk Sharing treatments (by session). To create this figure we constructed one observation per manager, which indicates the

[19]The difference in managers' behavior in the last round resembles end-game effects which are often observed in the experiments on finitely repeated games, albeit that in our experiment managers behave significantly more risky in the very last round, while in the repeated games subjects tend to be more selfish in the very last round of the experiment (see Reuben and Suetens 2009 and the references mentioned there). Further investigation is required to establish whether this feature is common to other risky environments.

fraction of the times he/she invested funds in the risky project over the course of 20 rounds of the experiment.

Figure 2 clearly shows that managers were much more risky with the investors' money than with their own. Indeed, 52.2 % of the managers in the Own Money (small stakes) treatment invested their own funds in the safe project 90 % of the time or more. That is, more than half of managers chose the risky project *at most* twice out of 20 rounds played in the Own Money treatment. The same behavior is rare in the Risk Sharing treatment, in which only 17 % of the managers behave that way. According to Wilcoxon Ranksum test, we reject the hypothesis that the median riskiness of the managers' investments are the same in these two treatments at 6 % significance level (we perform this test using 23 independent observations from the Own Money (small stakes) treatment and 4 observations from the Risk Sharing treatment).

This evidence for the *Other People's money* effect possibly suggests that framing the subjects' task as a competition for funds leads managers to want to take more risks, risks that they obviously would not want to take if they were investing their Own Money. It is natural to search for rationalizations of this effect in the realm of behavioral economics. For instance, managers might place other people's money in a different mental account than their own (see Thaler 1985, 1999). In this case, the Other People's money effect we document is related to the *House money effect* discussed by Thaler and Johnson (1990) and Keasey and Moon (1996).

5 Conclusions

In this paper we conducted a controlled experiment to investigate the impact of competition on the risk taking behavior of laboratory capital managers who operate under the standard option-like compensation contracts. These contracts share some stylized features with those employed e.g., in hedge fund markets.[20] We find that the competition for funds does indeed lead to an equilibrium where funds are invested in an inefficient risky manner. Interestingly, this happens in the environment in which the risky asset has both lower expected return and higher variance compared with the safe asset.[21] This problem can be mitigated by either changing the contract type, restricting the watermark used in the Baseline contract or by forcing managers to reveal the projects in which funds will be invested. We find that the Transparency is the most efficient at eliminating the risky behavior of managers amongst the contracts we consider. Finally, we document that even when the incentives of the managers and the investors are completely aligned (as is the case in the Risk Sharing contract), the managers tend to invest the money of others in a significantly more riskier manner than their own.

There are several interesting characteristics of the environment in which portfolio managers operate in the real world, that we have abstracted from in this study. One of

[20] While we couch our discussion with reference to the hedge fund market, our interests are broader than that since our results hold for any market where firms compete for funds.

[21] This suggests that the effects we found in the Baseline treatment would be even stronger in the situation, in which the risky asset has a higher expected return to compensate for the additional risk of holding this asset.

these elements is the dynamic nature of the interaction between managers and their reputation. Indeed, portfolio managers often compete with each other by providing potential investors with an information regarding their past performance. The reputation channel may by itself serve as a regulatory device that pushes managers to be more cautious with the risk taking. Future work should incorporate dynamic interactions between portfolio managers and their reputational concerns into the theoretical and experimental framework. One of the interesting questions is whether reputation by itself can induce portfolio managers to efficiently invest funds in a safe asset as does imposing Transparency.

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