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Risk allocation under symmetric information and market power

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Working Paper No. 123

Risk Allocation under symmetric information and market power

by

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Risk allocation of financial contracts under symmetric information and market power

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Abstract

External corporate financing typically involves contracts presenting a majority of the financial risks of the entrepreneurial activity on the entrepreneur. In academic literature, this one-sided risk allocation is usually justified by the informational advantages and unobservable actions of the entrepreneur. This article develops two alternative behavioral explanations for this observation. By conducting a non-computer-based laboratory experiment, we created an environment, in which adverse selection and moral hazard (as classical problems related to asymmetric information) could be eliminated. The fact that resulting contracts between the investors and entrepreneurs in the experiment on average imposed most of the financial risks on the entrepreneur challenges classical academic explanations based on asymmetric information.

Keywords: Inequality aversion, asymmetric information, random effects, probit, experiment, ultimatum game

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1. Introduction

The relationship between an entrepreneur and an external investor, like a bank or a venture capital investor, is a popular topic in academic literature. When these two parties negotiate the conditions of their cooperation, they particularly have to agree on the distribution of state dependent profits and losses. Because there is a wide range of forms of external financing, there are plenty of ways to share profits and losses.

This article focuses on the question: What influences the risk allocation between an entrepreneur and an investor? There is a major difference in the risk allocation of debt financing, for example, by taking out a bank loan, and equity financing, such as selling stocks. In the case of insolvency and liquidation of a company, claims of outside investors owning debt are treated preferentially while investors owning equity only have residual claims. Because entrepreneurs are typically owners of internal equity, the use of external debt implies a different risk allocation between an entrepreneur and an investor than the use of external equity.

However the resulting risk allocation does not just vary between debt and equity contracts. For example, a bank loan with high collateral implies different risk allocation than a bank loan without any collateral. But the topic of this article is neither the exact distinction between equity and debt contracts nor distinction between debt contracts with high and low collateral. The goal of this article is to tackle the topic of risk allocation in a general and abstract manner.

In practice, contracts imposing most of the financial risks on entrepreneurs are in the majority. Mishkin (2007) shows, that the lion's share of external finance is covered by debt contracts, usually accompanied by collateral¹. Thus you can find these contracts much more often than contracts implying a more equal split of risks.

Investigation in to the reasons for the observed one-sided risk allocation of financial contracts in academic literature will reveal various theories following one line of argumentation - asymmetric information. In the standard financial economics textbook of Mishkin (2007), asymmetric information between investors and entrepreneurs is named as the decisive reason for the rare use of equity contracts and intensive use of collateral². The main argument is thus: Entrepreneurs are assumed to have an informational advantage compared to investors as well as some scope for unobservable action. To ensure that entrepreneurs do not use their informational advantage to take excessive risks, you have to impose the financial risks of their behavior on them. So to avoid the classical problems of asymmetric information, such as adverse selection and moral hazard, contracts are chosen that impose the risks on the entrepreneur. In practice, this takes the form of an intensive use of debt contracts and collateral.

Another example is an article by Gersbach and Uhlig (2006). In their model, a monopolistic informational disadvantaged bank offers equity contracts, while in a competitive market only debt contracts survive³. Their result relies on the assumption that "good" entrepreneurs strictly prefer debt contracts, while "shirkers" are indifferent between debt and equity contracts. Argumentation by Bester (1985, 1987) is similar. In his signaling model, banks are faced with two types of entrepreneurs, "good" and "bad", depending on the riskiness of their projects. Because a bank cannot observe an entrepreneur's type, it tries to reveal their types by offering separating contracts. In this model, good entrepreneurs choose a contract with relatively high collateral, while bad entrepreneurs choose a contract with less collateral but higher interest

rates⁴. Both approaches create the impression that a one-sided risk allocation is not due to the malpractice of a bank, but a privilege reserved for good entrepreneurs.

Several other academic articles describe one sided risk allocation between entrepreneurs and investors as a result of efficiency considerations under asymmetric information - this point of view is criticized here. A fundamental weakness of this popular point of view is that it remains unclear what would have been the outcome in the absence of asymmetric information. Only if the contracts offered under symmetric information differ essentially from the contracts offered under asymmetric information, can informational asymmetries be the main reason for the resulting contracts. The question tackled here is thus: Which contracts would be offered under symmetric information?

Because asymmetric information is present in reality without a doubt, one cannot answer that question by looking at empirical data from banks or venture capitalists - but controlled laboratory experiments provide the opportunity to get closer to an answer. In laboratory experiments it is possible to choose assumptions, eliminating adverse selection as well as moral hazard. But this experiment does not seek to reproduce reality more accurately than in the criticized theoretical models. Instead of the experiment seeks to provide a robustness check of finance theories based on asymmetric information.

This article is structured as follows: The experimental design is described in chapter 2. Chapter 3 includes the ex ante theoretical expectations of the experimental results, which are useful to interpret the actual results presented in chapter 4. Chapter 5 concludes the article.

2. Experimental Design

The starting point of the experimental design is the classical ultimatum game conducted by Güth, Schmittberger and Schwarze (1982). There are two agents in this popular experiment: proposers and responders.

A proposer owns a certain endowment, E . He has to formulate an offer specifying how this endowment should be distributed between the proposer and the responder. The offer has to fulfill the equality $E = x_p + x_R$. If the responder accepts the offer, the endowment is split between them exactly in the stipulated way. If the responder rejects the offer, the endowment is destroyed, and neither the proposer nor the responder receives a payoff.

The experiment of this article can be seen as a two-dimensional ultimatum game. Here the parties have to agree on the distribution of a positive payoff in one state of nature and on the distribution of a negative payoff in another state of nature. The positive payoff of the so-called project is realized with the known probability p , and the negative payoff is realized with probability $(1 - p)$. Profits were generated with probability $p = 95\%$ and implied a net-profit of $W = 50$ Experimental Money Units (EMU), while losses occurred with probability $p = 5\%$ and implied a net-loss of 100 EMU. The probabilities were public information.

Instead of a neutral framing of proposers and responders roles assigned to participants were investors and entrepreneurs. One investor was confronted by several entrepreneurs. This entrepreneurial competition was introduced to make sure the investor has some degree of bargaining power. The investor faced at least $N = 4$ entrepreneurs in every experiment. This number was chosen to guarantee perfect competition among entrepreneurs, since Dufwenberg and Gneezy (2000) showed that, in an experimental setting, the expected behavior of price competition does not appear with two competitors as suggested by Bertrand, but only with at least three or four participants.

Adverse selection and moral hazard could not arise in this experimental setting, because the characteristics of the project were public information and homogenous entrepreneurs could only realize one identical project. Adverse selection would require that entrepreneurs have heterogeneous projects at hand and hold private information about the riskiness of their individual projects. Moral hazard would require that each entrepreneur has the choice between at least two projects with different risk characteristics and cannot be forced to realize the less risky one.

In every round, the investor had to formulate a take-it-or-leave-it offer that an entrepreneur could only accept or reject. The investor had to specify two terms of the contract. First, how should net-profits of $W = 50$ EMU be distributed between the investor and the entrepreneur in the case of success? Second, how should the losses of $L = 100$ EMU be distributed in the case of failure? Losses have not been distributed directly, but indirectly by the choice of collateral. The stipulated amount of collateral had to be part of the interval $S \in [0,50]$.

The project-involved costs of $C = 100$ EMU provided one half by each the investor and the entrepreneur. As the investment of the investor was 50 EMU in each round, he could perfectly collateralize his investment by choosing maximal collateral $S_{max} = 50$. In this scenario, the entrepreneur had to bear all losses or risks of the project. If the contract did not include any collateral, or $S_{min} = 0$, the risks of the project were split equally between the two parties.

An investor was endowed with 50 EMU for each round that he had to use to invest in only one project. The investor could use this capital in every round independent of results in

preceding rounds. That is, even if an investor participated in a failed project, he received a new endowment.

The financial endowment of the entrepreneur is different. He or she owns 50 EMU for investment and 50 EMU for collateral in each round. The 50 EMU investment capital is thought of not as financial capital, but human capital endowment. That is, the entrepreneur will be endowed with another 50 EMU of this capital even if he participates in a failed project, because one can devote effort to a project even if financially bankrupt. Consequentially, this capital is available for an entrepreneur independent of results in preceding rounds.

This is not true for the 50 EMU collateral endowment. If an entrepreneur participated in a failed project and had to provide a positive amount of collateral, or $S > 0$, this kind of capital was no longer available. So this kind of capital should be considered as the real property an entrepreneur can offer as collateral. But once the investor makes use of this collateral, it cannot be used in a further round.

The consequence of this assumption is that, if an entrepreneur participates in a failed project and agreed upon positive collateral, he was excluded from upcoming rounds. An excluded entrepreneur was replaced by another entrepreneur, to make sure that the bargaining power of the investor did not change during a session. Thus investors had a major advantage, because they participated in every project and could not be excluded from upcoming rounds. This should reflect the advantage of investors in practice implied by their ability to diversify their economic activities, while entrepreneurs usually hold much more concentrated asset portfolios.

The following course of events was repeated for 10 rounds. First, the investor, who was in a different room from the entrepreneurs, formulated an offer. The offer was observed by all entrepreneurs, who could decide anonymously whether they want to accept or reject the offer. If at least one entrepreneur accepted the offer, a project took place. If more than one entrepreneur accepted the offer, one of these entrepreneurs was drawn randomly, and his or her project was realized. A random generator decided whether a project was a success or a failure. In the case of success, net profits were distributed according to the contract. In the case of failure both parties lost their investment of 50 EMU, and the agreed upon collateral was used. After each round, all parties were informed whether the project was a success or a failure. I refer to the appendix, which includes experimental instructions for further detail.

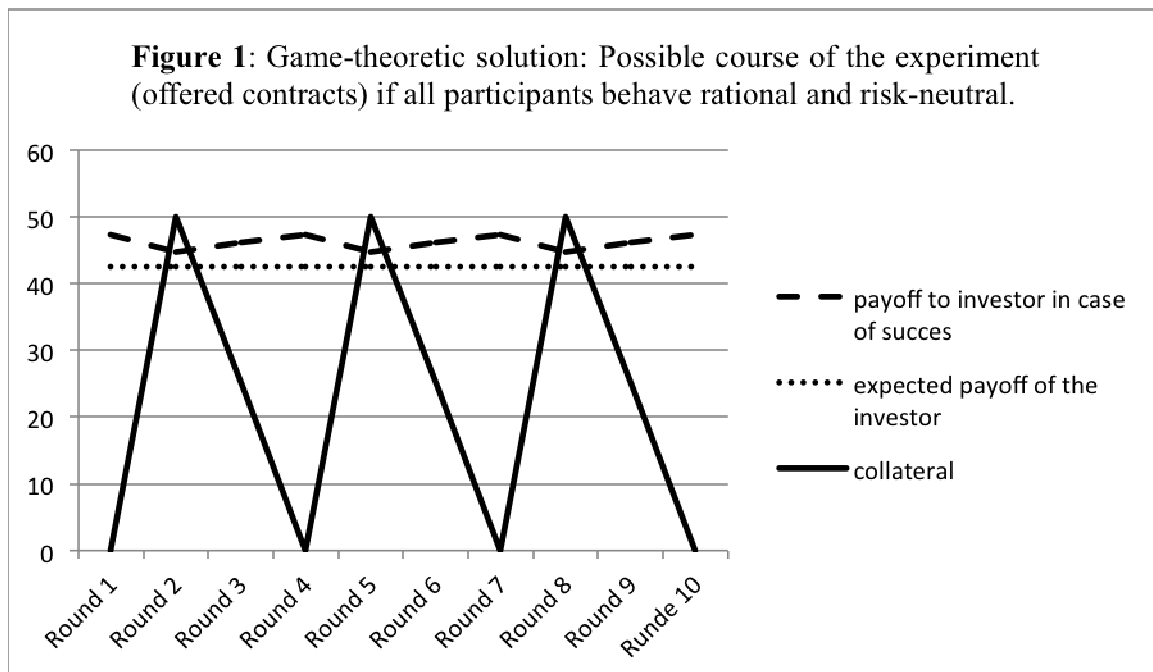
3. Game theoretic solution and expectations

To derive a game-theoretic solution it is necessary to analyze how rational and risk-neutral individuals would behave in this experiment. If entrepreneurs fulfill both assumptions, they will accept any offer implying a positive expected payoff for the entrepreneur. That is, entrepreneurs had to accept any contract that fulfills the following participation constraint of an entrepreneur:

$$E(\pi_E) = pW_E + (1 - p)L_E = p(50 - W_I) - (1 - p)(50 + S) \geq 0 \text{ gilt.} \quad (1)$$

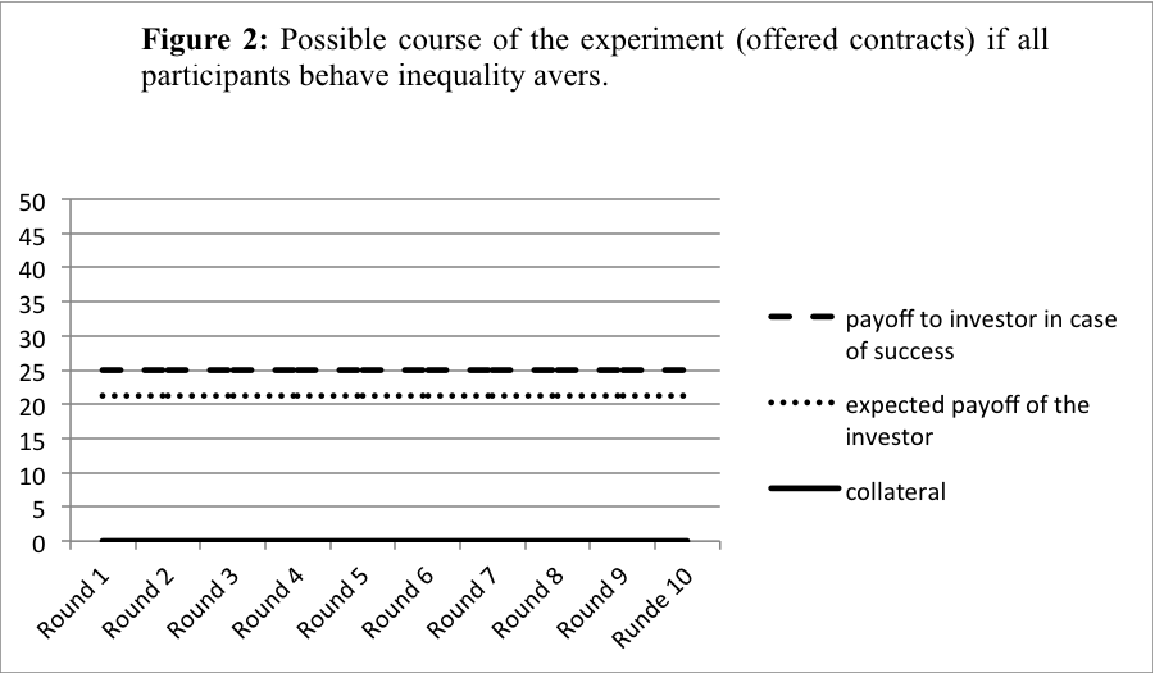
The right-hand side of condition (1) says that the expected payoff of an entrepreneur is the sum of the positive payoff to the entrepreneur in the case of success W_E and the negative payoff in the case of failure L_E , weighted by the associated probabilities. Variable W_E results from the difference between the overall net profits 50 EMU and the payoff to the investor in the case of success W_I . The negative payoff L_E is the sum of the entrepreneur's lost investment (50 EMU) plus the stipulated amount of collateral S .

If the investor behaves rationally and risk-neutrally as well, he should make an offer implying a much bigger expected payoff for him than for the entrepreneur. Figure 1 depicts a possible course of the investor's offers if both parties are rational and risk neutral. Because the entrepreneurs are risk neutral, they will be indifferent between offers with large or small collateral as long as the expected payoff is the same and nonnegative. So while the amount of collateral, depicted by the continuous line, is expected to vary in the interval $[0,50]$, the contracted payoff to the investor in case of success W_I should vary in the interval $[\frac{pW - (1-p)L}{p}, \frac{pW - (1-p)0.5L}{p}] = [44.74, 47.37]$. Thus investors can make any offer as long as the entrepreneur's participation constraint is fulfilled.



Experienced readers of experimental literature know that game-theoretical expectations are usually not very successful in describing the actual course of events. So it makes sense to form more appropriate expectations by assuming that people will behave like in other ultimatum game experiments. We know from the ultimatum game that people do not accept just any positive offer. Instead they only accept those offers distributing the endowment

approximately equally, that is, $x_P \approx x_R$. If participants of this experiment also demonstrate inequality aversion, they should distribute the profits and losses of a project evenly. With the concrete experimental design and strict inequality-averse agents, entrepreneurs should not accept an offer with positive collateral, because this would imply an unequal split of risks. If an investor chooses $S = 0$, both parties will lose 50 EMU in the case of failure, implying an equal split of losses. If participants are consequent about inequality aversion, they will agree upon a contract where net profits of 50 EMU are also split evenly that is, $W_I = W_E = 25$ EMU. Figure 2 depicts what this kind of behavior would imply.



4. Results

Expectations formed in chapter 3 will be helpful, to attain a reasonable interpretation of the results presented in the following chapter. In part 4.1 descriptive statistics are analyzed to provide a first impression of the course of events in the experiment. Chapter 4.2 offers two alternative behavioral explanations for observed behavior.

4.1 Descriptive statistics

The described experiment was conducted five times with a varying number of participants. Fifty contract offers have been formulated, involving 31 different participants acting as entrepreneurs and delivering 260 observations.

The average offer was $\bar{W}_I = 29.72$ and $\bar{S} = 27.66$. The average value of the payoff to investors in the case of success is much lower than the expected interval of [44.74, 47.37], assuming rational and risk-neutral agents. But the value of \bar{W}_I is quite close to the equal split expected under the assumption of a strong inequality aversion of the participants. There seems to be even more evidence for an equal distribution of profits. In 29 of 50 rounds, the value of W_I was in the interval [20, 30] surrounding the equal split. In 11 of 50 rounds, W_I was exactly 25 EMU.

A look at the distribution of losses delivers a different picture. As a review, an equal distribution of losses would have implied zero collateral, but the average collateral of $\bar{S} = 27.66$ is much greater than this. In 40 of 50 rounds, the investor demanded positive collateral. In 22 of 50 rounds, the demanded collateral was at least 40 EMU. In 9 of 50 rounds, the investor even asked for maximum collateral of 50 EMU.

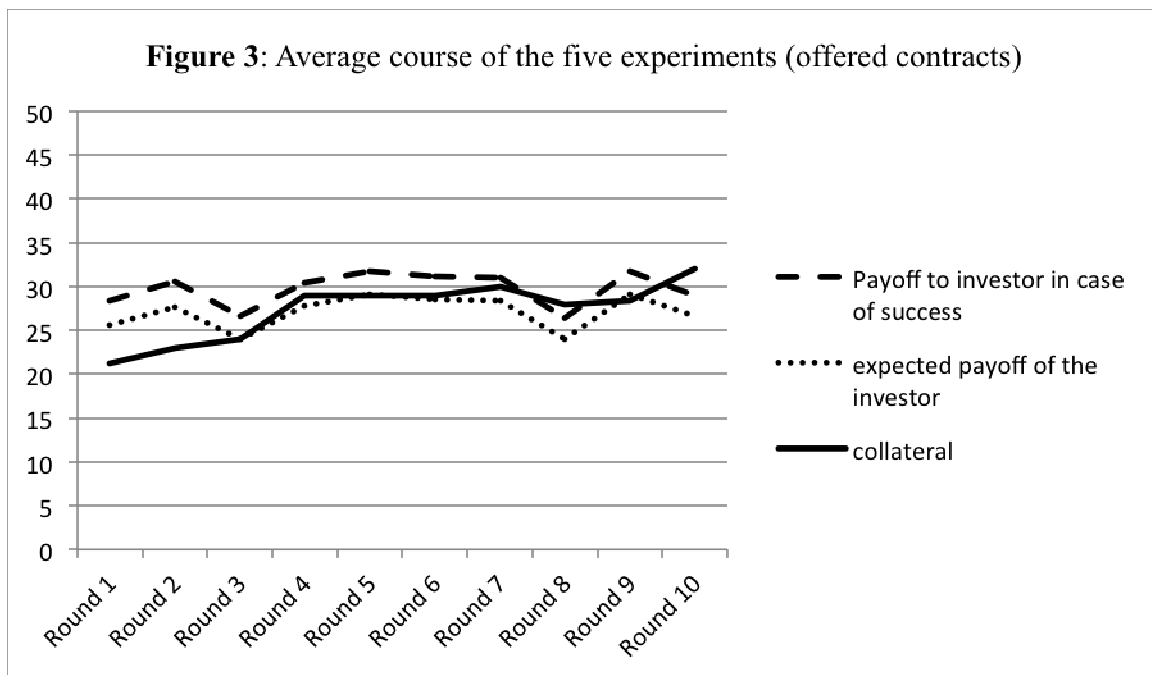


Figure 3 depicts the average course of all experiments. The dashed line, depicting the payoff to investors in the good state of the world, does not move around the expected value of 25 under the assumption of strict inequality-averse individuals, but it is not far away from it. The curve progression of the continuous line, which depicts collateral, is much more surprising for two reasons. First, the amount of collateral is much bigger than expected already in the first round. Second, the amount of demanded collateral increases as time elapses. So it seems as if

investors have learned during an experimental session that entrepreneurs react less sensitively to changes in collateral than to changes in the distribution of net profits.

So the risk allocation chosen in the experiment discriminated against entrepreneurs. Because there was no asymmetric information in the environment, classical explanations of finance literature cannot be used here. Chapter 4.2 will develop two alternative theories explaining the behavior observed in the experiment.

4.2 Behavioral Explanations

The presentation of both behavioral theories will be structured in the same way. First a theoretical functional form is developed to reproduce the observed behavior. In a second step, each theory is tested within an appropriate econometric model. Finally an intuitive interpretation of results will be delivered.

4.2.1 Asymmetric inequality aversion caused by catastrophe blindness of the entrepreneur

We have seen that profits were distributed more or less equally in at least four of five experiments, while losses were mainly imposed on the entrepreneur. On the one hand, the amount of demanded collateral usually grew during the sessions, suggesting investors have learned that entrepreneurs are not very sensitive to changes in this contractual component. On the other hand, the share of net profits demanded by investors did not show such a tendency, suggesting that entrepreneurs reacted very sensitively if investors demanded a bigger part of the profits. So there seems to be some evidence for asymmetry in the inequality aversion among entrepreneurs.

Using the results of the ultimatum game, Fehr and Schmidt (1999) developed a utility function able to represent behavioral patterns of individuals showing inequality aversion⁵.

$$U(x_i) = x_i - \alpha_i \max\{x_j - x_i, 0\} \quad (2)$$

Formula (2) says that individual i benefits from his absolute payoff x_i , which is trivial. But the individual suffers a loss of utility, if individual j receives a bigger payoff x_j , that is if $x_j > x_i$. The strength of the utility loss of an unequal distribution depends on the size of α_i .

However this utility function is only able to depict preferences of individuals participating in the classical ultimatum game, because in this experiment, the proposer and the responder only had to agree upon the distribution of the definite endowment E . So it is necessary to modify this utility function for the two-dimensional case with profits and losses. The modified utility function takes the following form:

$$\begin{aligned} U_E &= E(\pi_E) - \alpha_1 \max\{W_I - W_E, 0\} - \alpha_2 \max\{L_E - L_I, 0\} \\ &= pW_E - (1-p)L_E - \alpha_1 \max\{W_I - W_E, 0\} - \alpha_2 \max\{L_E - L_I, 0\} \\ &= p(50 - W_I) - (1-p)(50 + S) - \alpha_1 \max\{W_I - 25, 0\} - \alpha_2 S/2 \end{aligned} \quad (3)$$

An inequality-averse entrepreneur should react to three characteristics of the offered contract. First, the utility should be positively related to the expected payoff to the entrepreneur, that is $E(\pi_E) = p(50 - W_I) - (1-p)(50 + S)$. Second, the utility of an entrepreneur should fall, if net profits are distributed unequally that is, if $W_I - 25 > 0$. Third, the entrepreneur's utility should fall if losses are distributed unevenly, which was the case if $S > 0$. Notice in the experiment that participants had to distribute 100 EMU of losses but only 50 EMU of net-profits. So, to make sure α_1 and α_2 were comparable with each other the chosen amount of collateral S had to be divided by two.

Even though Figure 3 only depicts the average offer of investors and not the acceptance rate of entrepreneurs, it suggests that entrepreneurs reacted more sensitively to an unequal distribution of profits than to an unequal distribution of losses. This leads to the following hypothesis:

Hypothesis 1: Entrepreneurs suffer a greater loss of utility from an unequal distribution of profits than from an unequal distribution of losses, that is $|\alpha_1| > |\alpha_2|$ or $\alpha_1/\alpha_2 > 1$.

Now the utility function of formula (3) will be tested econometrically. The econometric model used for this purpose is a random effects probit model. This model is quite popular to analyze responder behavior in ultimatum games and was used for example by Kagel and Wolfe (2001), Cooper, Feltovich, Roth, and Zwick (2003), or Poulsen and Tan (2007).

The dependent variable in this regression is $Accept_{it}$, which is a binary-coded variable taking on value one if entrepreneur i accepts an offer in round t , and zero otherwise. The independent variables in this model are the characteristics of the offered contract that should be decisive for the decision of entrepreneurs according to (3). Several control variables have been used as a robustness check. There are time-invariant variables, including mainly characteristics of the entrepreneur as well as time-variant variables, which control for the dynamics of the experiment. Descriptive statistics of the independent variables are depicted in Table 1.

Time-invariant control variables include *sex*, *age*, *marital status*, *income*, *risk aversion*, and *entrepreneur-investor-ratio*. Participants had to complete a questionnaire, which can be seen in the appendix, right after the experiment. The participants could choose one out of five income classes ($\leq \text{€}400$, $\text{€}401\text{-}\text{€}1000$, $\text{€}1001\text{-}\text{€}2000$, $\text{€}2001\text{-}\text{€}3000$, $> \text{€}3000$) for the econometric analysis, the middle of each class was chosen ($\text{€}200$, $\text{€}700$, $\text{€}1500$, $\text{€}2500$). Because no participant earned more than $\text{€}3000$, no problems related to censored data arose. To check individual risk aversion, participants were asked the following: Which lotteries would you prefer to a definite payoff of $\text{€}100$? Participants marked the lottery with the lowest expected payoff they preferred toward a definite payment of $\text{€}100$. The difference between the lottery with the lowest expected payoff and $\text{€}100$ was calculated as an individual risk premium used for econometric analysis.

Time-variant control variables should control for the dynamics of each experiment. While the variable *accumulated experimental profits* needs no explanation, the remaining variables do. The variable *project participation in preceding round* was 1 for individual i if his/her project was realized in the preceding round, and 0 otherwise. The variable *failure in preceding round* was 1 for all individuals, if the realized project in the preceding round failed, and zero otherwise. The variable *acceptance rate in preceding round* is the share of entrepreneurs who accepted the offer in the preceding round.

Some individual characteristics of participants for which the questionnaire asked have not been used as control variables, since they have not been statistically significant in several estimates. These questions were related to their job/field of study, number of children, and individual impatience.

Table 1: Descriptive statistics of the independent variables

Characteristics of the contract	Mean	Standard deviation	Min	Max
Expected payoff to the entrepreneur	15.296	8.527	0.75	30
Unequal distribution of profits	6.376	7.442	0	20
Unequal distribution of losses (= S/2)	15.177	8.905	0	25
Time-invariant control variables				
Sex (1 = male)	0.469	0.5000	0	1
Age	31.008	17.502	18	79
Marital status (married/divorced/widowed = 1)	0.19	0.395	0	1
Income	765.385	826.185	200	2500
Risk aversion	29.523	25.870	-20	120
#Entrepreneurs/#Investors	5.615	1.646	4	8
Time-variant variables				
Accumulated experimental profits	15.008	26,537	0	145
Project participation in preceding round	0.165	0.372	0	1
Failure in preceding round	0.112	0.315	0	1
Acceptance rate in preceding round	0.588	0.270	0	1

If entrepreneurs are asymmetrically inequality-averse, the ratio of the two coefficients representing α_1 and α_2 from formula (3) should be bigger than 1⁶. The results of the econometric model representing the theoretical model of formula (3) can be seen in Table 2.

Table 2: Results of the random effects probit model representing the theoretical model of formula (3) (*, **, *** represent the significance levels 10%, 5% and 1%)

Dependent variable: binary acceptance decision

(1 = accept, 0 = reject)

Independent variables	coefficient	p-value
Characteristics of the contract		
Expected payoff to the entrepreneur	-0.004	0.923
Unequal distribution of profits	-0.121**	0.019
Unequal distribution of losses (= S/2)	-0.098***	0.000
Time-invariant control variables		
Sex (1 = male)	1.048***	0.003
Age	0.035	0.175
Marital status	-0.155	0.806
Income	-0.001*	0.092
Risk aversion	-0.008	0.169
#entrepreneurs/#investors	-0.032	0.792
Time-variant variables		
Accumulated experimental profits	0.002	0.759
Project participation in preceding round	0.108	0.697
Failure in preceding round	0.796**	0.031
Acceptance rate in preceding round	0.767*	0.057
Statistics about the regression as a whole		
Log-Likelihood	-134.655	
McFadden's R ²	0.162	
Prob > Chi2	0.000	
#Observations	260	
Individuals	31	

Table 2 reveals that the expected payoff of a contract offer did not have significant influence on the decisions of entrepreneurs to accept or reject an offer. So the expectation of purely rational and risk-neutral entrepreneurs must be rejected. The expectation of inequality-averse entrepreneurs was more successful. Both equality-related coefficients show the expected negative sign. The negative influence of an unequal distribution of profits has a p-value of 1.9%, while the negative influence of an unequal loss distribution is statistically even more reliable. But with figure 3 in mind, the value of the ratio $\widehat{\alpha}_1/\widehat{\alpha}_2 = 1.234$ is less pronounced than expected. This ratio shows that entrepreneurs were more concerned about an equal split of profits than about an equal split of losses. But due to the small value of the ratio, some doubt remains regarding, whether hypothesis 1 is true, remains.

There are two mentionable significant control variables as well. First, male entrepreneurs were more willing to accept offers than female entrepreneurs. Second, failure in the preceding round increased the willingness of participants, to accept the offer in the following round. Involvement in the experimental procedure creates the impression that participants believed that two failures in a row cannot happen, increasing their willingness to accept any offer. Of

course, this “lightning never strikes twice in the same place”-heuristic is far from being rational, since the probability of failure was 5% in every round, regardless of previous results.

The pseudo-R² used here, was developed by McFadden (1974). This measure relates the log-likelihood function of the estimated model $\mathcal{L}_1 = -134.655$ to the log-likelihood function of a model with just one constant $\mathcal{L}_0 = -160.738$, that is $1 - \mathcal{L}_{ur}/\mathcal{L}_0$ ⁷. The value of McFadden’s R² of this model is 16.2%. The null hypotheses of a Wald test, that all coefficients are zero, can be rejected, which can be seen in the low associated p-value (Prob > Chi2).

With these econometric results at hand, an intuitive interpretation of the results can be delivered. The first question is thus: How is asymmetric inequality aversion expressed in real life? For example, in a loan contract, the distribution of entrepreneurial profits depends on the fixed interest payment. The distribution of losses or risks depends on the contracted collateral. So, if entrepreneurs behave asymmetrically inequality-averse, they should react quite sensitive to an increase of interest rates and less sensitive to an increase of collateral. Experimentally observed asymmetric inequality aversion could explain the tendency to use financial contracts imposing a majority of risks to entrepreneurs.

Are people in reality more offended by high interest rates than by high collateral? The term of a “usurious interest rate” describes an immorally high interest rate, violating social norms. But an analogous term for immorally high collateral is not commonly used. This is surprising, since both interest rates and collateral should both influence an entrepreneur’s utility. How can one component of a loan contract take an immoral form, while another component cannot?

Returning to the results of the experiment, what can explain why losses could be distributed less equally than profits? Catastrophe blindness on the side of the entrepreneurs could be an explanation⁸. The term describes people’s irrational tendency to ignore possible catastrophic scenarios with small probabilities. That is that people wrongly assume that the probability of a negative scenario, like a house fire or a certain disease, is zero and consequently fail to undertake certain measures. Maybe entrepreneurs in the experiment completely ignored the probability of 5% of a failed project. If one (wrongly) assumes that a certain state of the world cannot occur, then the element of a contract referring to this state will be ignored as well. So maybe individuals just do not develop a perception of fairness for arrangements related to unlikely situations.

The influence of blindness to catastrophe on contracts is not limited to financial topics. When people sign the contract of a sports club, they might be focused on the monthly costs ignoring other aspects of the contract, like the cancellation period. The reason for this might be that people (wrongly) think at the moment of the signing that it is unlikely they will ever withdraw from the contract. But once their athletic ambitions have vanished, they are surprised they have ever been willing to accept such a long cancellation period.

4.2.2 Interaction-inequality aversion

The implied prediction of hypotheses 1 was that the resulting distribution of profits should be closer to an equal split than the distribution of losses. This theory was quite successful in explaining the devolution of four experiments, but it was not capable of describing experiment number 3 (see appendix for a graphical illustration of every single experiment). In 9 out of 10 rounds of this experiment, the investor did not ask for collateral, implying an even distribution of losses. At the same time, the investor in this experiment demanded a relatively

high share of profits, resulting in a strong inequality of profit distribution. So the weakness of the theory in chapter 4.2.1 was its incapability to explain the observed behavior of this “outlier-experiment”. This chapter attempts to address this problem by developing a more general utility function capable of explaining the behavior of every experiment.

What all experiments had in common was the fact that contracts at the end of each experimental session usually implied an equal split of one dimension of the contract. Thus, maybe the following utility function is more appropriate to reproduce observed behavior:

$$\begin{aligned}
 U_E &= E(\pi_E) - \alpha * \max\{W_I - W_E, 0\} * \max\{L_E - L_I, 0\} \\
 &= pW_E - (1 - p)L_E - \alpha * \max\{W_I - W_E, 0\} * \max\{L_E - L_I, 0\} \\
 &= p(50 - W_I) - (1 - p)(50 + S) - \alpha * \max\{W_I - 25, 0\} * S/2
 \end{aligned}
 \tag{4}$$

There are only two terms included in this utility function. The term of interaction between an unequal distribution of profits and an unequal distribution of losses always takes on the value of zero if the contract implies an equal distribution in at least one dimension. This utility function would have implied that investors had some scope for an unequal distribution of profits, that is $W_I > 25$, if they chose an equal distribution of losses, that is $S = 0$. Alternatively, the investors could have chosen an equal distribution of profits, that is $W_I = 25$, to use their bargaining power to demand an advantageous risk allocation, that is $S > 0$. This leads to the following hypothesis:

Hypothesis 2: Entrepreneurs with interaction-inequality aversion should accept any offer implying an equal distribution of (at least) one contractual dimension and a nonnegative expected payoff to the entrepreneur. Assuming a constant nonnegative expected payoff to the entrepreneur, contracts implying an unequal split in both dimensions should be rejected with a higher probability than contracts implying an equal split in one dimension.

A random effects model has also been developed to test the utility function of equality (4). Table 3 shows the results of this regression.

Table 3: Results of the random effects probit model representing the theoretical model of formula (4) (*, **, *** represent the significance levels 10%, 5% and 1%)

Dependent variable: binary acceptance decision

(1 = accept, 0 = reject)

Independent variables	coefficient	p-value
Characteristics of the contract		
Expected payoff to the entrepreneur	-0.005	0.754
Inequality-Interaction	-0.002***	0.000
Time-invariant control variables		
Sex (1 = male)	0.965***	0.003
Age	0.059**	0.014
Marital status	-0.341	0.556
Income	-0.001*	0.060
Risk aversion	-0.006	0.213
#entrepreneurs/#investors	-0.023	0.844
Time-variant variables		
Accumulated experimental profits	0.000	0.976
Project participation in preceding round	0.071	0.798
Failure in preceding round	0.954**	0.009
Acceptance rate in preceding round	0.578*	0.134
Statistics about the regression as a whole		
Log-Likelihood	-135.6389	
McFadden's R ²	0.156	
Prob > Chi2	0.000	
#Observations	260	
Individuals	31	

Again the expected payoff to entrepreneurs does not have significant influence on the decision to accept or reject an offer. The term of interaction between an unequal distribution of profits and an unequal distribution of losses has a highly significant negative influence. So there is evidence in favor of hypothesis 2.

In this econometric model, a greater number of control variables has significant influence. First, male participants were again more willing to accept offers. Second, older participants were more willing to accept offers. Third, a failed project in the preceding round has a positive influence on the probability of accepting an offer.

McFadden's R² is slightly lower than the pseudo R² of the econometric model of chapter 4.2.1. This is not surprising, since this model includes one fewer independent variable. The p-value of the Wald test is still extremely low, showing that the model as a whole is significant.

Do people really show the suggested behavioral pattern of a higher willingness to accept such two-dimensional contracts that imply an equal or fair treatment in one dimension? To the author's best knowledge, no scientific article has described this kind of behavioral pattern so far.

A closer look at the literature about the ultimatum game at this moment could provide further insight. Güth, Marchand and Rulliere (1997) performed a modification of the ultimatum game with responder competition. They have shown that responders' tolerance to unequal offers increased with the number of responders faced by the proposer. So in the one-dimensional ultimatum game, responders were willing to accept relatively unfair distributions of the definite endowment, because otherwise a competing responder would have accepted the offer.

What does this mean for the two-dimensional ultimatum game described here? Equality (4) suggests that inequality tolerance grows in only one dimension. The participants' pride may prove to be an intuitive explanation. Maybe it is easier for individuals to tell themselves they have not been "hornswoggled" by the investor if the offer is fair in one dimension. Offering a contract implying an unequal split in two dimensions makes the implied disadvantages too obvious. Offering a contract implying equality in one dimension might create the impression of a placatory compromise, while really there is none.

It is hard to find a convincing example from the real world for this behavioral pattern. Employment contracts broadly discussed in the media are contracts of professional football players. These contracts often imply a fixed monthly payment as well as a variable compensation per game. Toward the end of a player's career, when he has his best days behind him, players often sign so-called "performance-related contracts". These contracts imply a relatively low monthly payment but still high payments per game. So older players have to accept contract offers, implying a relatively strong decrease in their fixed payment, but they can keep their variable compensation on a stable level. These kinds of contracts allocate the risks of the physical health of aging players away from the club to the players. But why are players unwilling to accept cut backs in both dimensions of their contract? The described interaction-term fairness could be an explanation for the observed structure of contracts of individuals with decreasing bargaining power.

5. Conclusion

The preceding chapter has shown that a one-sided risk allocation between an investor and entrepreneur is not necessarily the result of asymmetric information. The described laboratory setting with an investor with bargaining power and competing entrepreneurs was also able to rebuilt simplified contracts observed in reality. Still, this article does not seek to display asymmetric information as irrelevant for financial contracts. The problem of theories based on asymmetric information is, that they create the impression that financial contracts with a one-sided risk allocation to the disadvantage of entrepreneurs are morally correct and socially desirable. This article aimed to take a more critical look at common financial contracts.

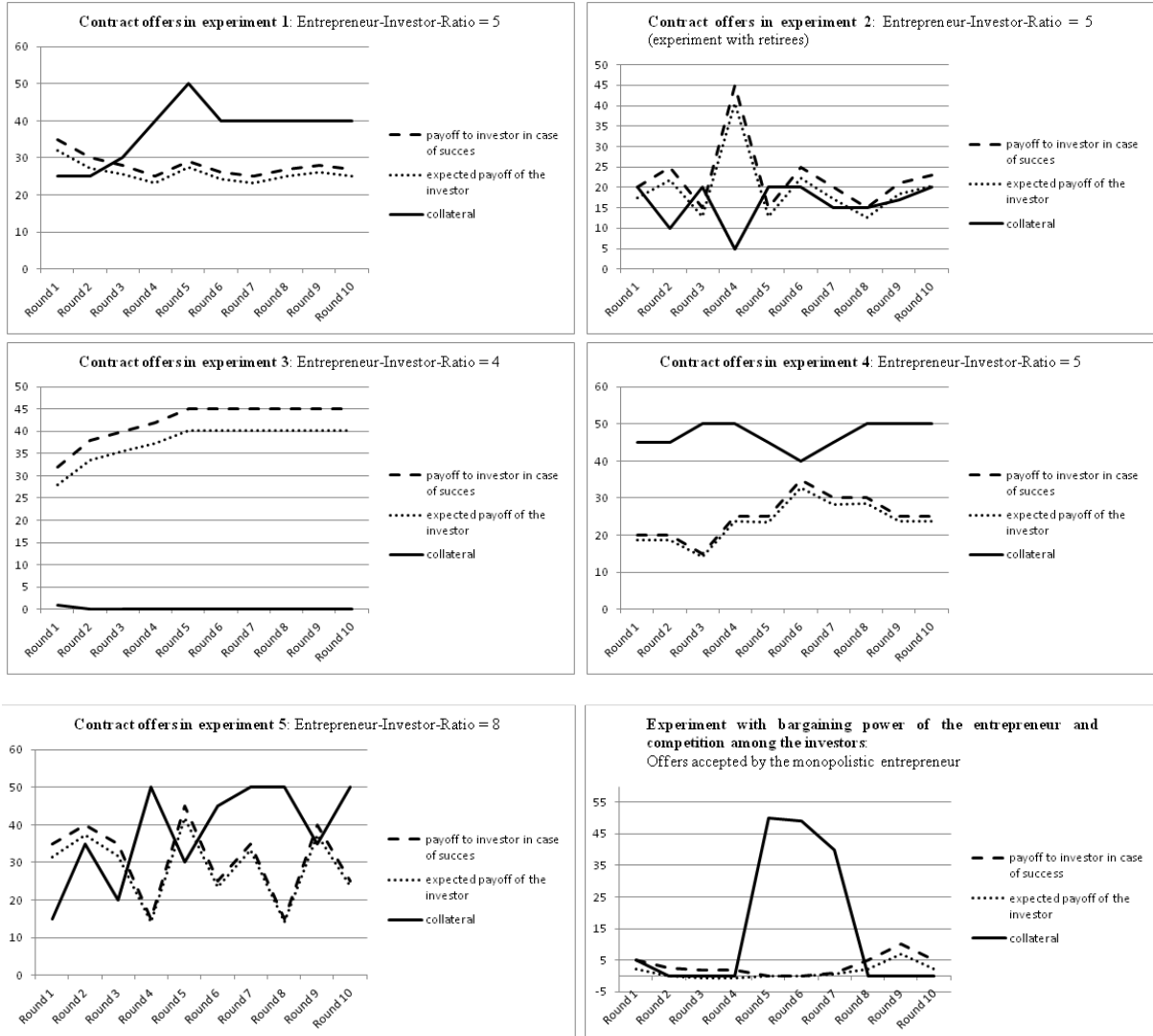
An important shortcoming of the laboratory investigation is a lack of variation in the bargaining power of the investor. For this reason, one experiment has been conducted, in which several investors competed for the allowance to finance the project of one entrepreneur. The accepted offers in all 10 rounds can be seen in the appendix. In four rounds of this experiment, the majority of risks were allocated to the entrepreneur, and in six rounds the risks were split equally. Thus it seems as if the bargaining power of the entrepreneur increases the probability of an equal split of risks, but it cannot guarantee this outcome. Further research must be done to analyze the risk allocation with bargaining power on the side of the entrepreneur.

Hopefully the derived utility functions can be verified in different and more general settings. Once this is achieved, several phenomena of financial markets that are assumed to depend on asymmetric information could possibly be explained with an alternative behavioral approach. For example, using data of a big Belgian bank, Voorderckers and Steijvers (2006) found that the amount of demanded collateral decreases if more than one bank applies for a loan to an entrepreneur⁹. The authors interpret their results as evidence for the theories of Greenbaum, Kanatas, and Venezia (1989), Sharpe (1990), and Rajan (1992) all assuming the rationality and risk neutrality of all parties as well as asymmetric information. A model of contracting with entrepreneurs possessing the described fairness attitudes could be an alternative explanation, since a bank with bargaining power will be better able to make use of the entrepreneurs' irrational behavioral patterns, resulting in higher collateral.

Perhaps a behavioral approach based on the formulated utility functions can also be developed to describe some facts of the venture capital and private equity industry. Venture capital industry clusters are usually explained by theories based on asymmetric information, the spatial proximity and density of similar investment firms are assumed to permit the realization of economies of scale in screening and monitoring these investments¹⁰. Venture capital investments imply a major risk burden to venture capital investors. As we have seen, an investor with market power contracting with entrepreneurs showing the described behavioral patterns will not incur this amount of risk, so the lack of competition in rural areas could be an alternative explanation for the lack of venture capital investments in these areas. Investors in urban clusters, on the other hand, will have a harder time misusing irrational patterns of entrepreneurs, resulting in a stronger use of venture capital and private equity investments in urban areas with strong competition among financial institutions.

Appendix

Appendix 1: Results of each experiment



Appendix 2: Experimental instructions

Roles of participants

There are six participants in every round: five entrepreneurs and one investor.

General description of the situation

Entrepreneurs can realize risky projects, but they need the financial support of an investor to do so. In every round (10 rounds overall), the investor offers financial support for just one entrepreneur. The investor chooses the conditions of financial support and advertises it. Every investor then decides whether he accepts the offer or not. If just one entrepreneur accepts the proposed offer, this entrepreneur receives financial support. If more entrepreneurs accept the offer, the entrepreneur who receives financial support is chosen randomly. If no investor accepts the offer, no project takes place.

The project

Entrepreneurs can realize identical projects. This project is successful with a probability of 95%, and it fails with a probability of 5%. The project costs 100 Experimental Monetary Units (EMU), and these costs are split equally among the investor and the entrepreneur. In the case of success, both the entrepreneur and investor get their investment of 50 EMU back. In addition, a net profit of 50 EMU is split exactly in the way described in the accepted contract offer. In the case of failure, the project delivers a zero payoff, resulting in a net loss of 100 EMU. So in this case, the investor and the entrepreneur lose their invested capital. If the accepted contract offer includes collateral, the agreed-upon collateral is transferred from the entrepreneur to the investor.

Situation of entrepreneurs

Each entrepreneur has 100 EMU in each round, consisting of two components. First, the entrepreneur has 50 EMU of investment capital, which he must use to finance one-half of the project. Consider this component as the effort of the entrepreneur, which he can bring in each round independent of preceding project results. Each entrepreneur needs financial support of 50 EMU in every round to be able to realize a project.

Second, the entrepreneur has 50 EMU of securities. This component can be used as collateral given to the investor. Think of this component as the real property of the entrepreneur's firm. If the entrepreneur and the investor agree upon a positive amount of collateral, then in the case of a project failure, this entrepreneur will not proceed to the next round and consequentially has to leave the experiment. In this case, he will be replaced by another entrepreneur. The excluded entrepreneur loses his invested capital of 50 EMU plus the amount of contracted collateral. The rest of the 50 EMU of securities that has not been used, as well as the individual net profits of past projects, remains with the excluded entrepreneur. If the offered contract includes no collateral, the entrepreneur reaches the next round even in the case of project failure, and he will not be excluded. If an entrepreneur accumulates negative profits exceeding his initial endowment of 100 EMU, the participant will receive a payoff of €0.

Situation of the investor

The investor has 50 EMU in each round to financially support the project of only one investor. The investor always reaches the next round, even in case of a failed project. The investor has to formulate a contract offer in each round, which is advertised and consequentially can be seen by every entrepreneur. The contract offer includes two aspects. First, he has to choose how the 50 EMU of net profits are distributed among him and the entrepreneur in the case of a success. Second, he has to choose how much of the securities of the entrepreneur worth 50 EMU are used as collateral in the case of a failed project. If at least one entrepreneur accepts the proposed contract, a project will be realized. If no entrepreneur accepts the offer, no project takes place. If the investor accumulates negative profits exceeding his initial endowment of 50 EMU, he will receive a payoff of €0.

Course of action

In each of the 10 rounds, the following course of action takes place:

First, the investor formulates a contract offer defining how the net profits of 50 EMU are distributed among the two involved parties and how much collateral (no more than 50 EMU) is transferred in the case of a failed project from the entrepreneur to the investor. Second, each

entrepreneur decides whether he wants to accept or reject the offer. Third, the project of one entrepreneur is realized if at least one entrepreneur accepts the offer. Otherwise, no project is realized and the next round is started immediately. In the case of success, the profits are distributed among the two parties. In the case of a failed project, the investor and the entrepreneur do not get their investment back, and the agreed upon collateral is transferred from the entrepreneur to the investor. Fourth, information about the project is advertised as described below, and the next round begins.

Distribution of information

All participants (entrepreneurs and investors) have read this explanation and therefore have identical information. Each contract offer (distribution of net profits and use of collateral) is made public. After all entrepreneurs have made their decision, the number of entrepreneurs who accepted the offer is publicly announced. It is not publicly announced which entrepreneurs accepted the offer. Whether a project was successful or not is made public immediately. Whose entrepreneur's project was finally realized is made public to all entrepreneurs, but not to the investor. If an entrepreneur is excluded from the experiment because he participated in a failed project and had to provide positive collateral, his exclusion is made public immediately.

Payoffs to participants

The experimental account balance of every participant is converted to Euros. Ten EMU correspond to €1. The experimental account balance is the sum of the initial endowment (100 EMU for entrepreneurs and 50 EMU for investors) plus the net profits of all rounds.

Appendix 3: Post-experiment questionnaire

Sex (m/f) _____

Age _____

Job _____

Field of study (if you are a student): _____

Marital status: _____

Do you have children (yes/no): _____

To which of the following classes of income do you belong?

No more than €400 €401 to €1000 €1001 to €2000 €2001 to €3000 more than €3001

Please mark the lowest future payoff you would prefer towards an immediate payoff of €100.

- | | |
|--|--|
| <input type="checkbox"/> €103 in 12 months | <input type="checkbox"/> €118 in 12 months |
| <input type="checkbox"/> €106 in 12 months | <input type="checkbox"/> €121 in 12 months |
| <input type="checkbox"/> €109 in 12 months | <input type="checkbox"/> €124 in 12 months |
| <input type="checkbox"/> €112 in 12 months | <input type="checkbox"/> €127 in 12 months |
| <input type="checkbox"/> €115 in 12 months | <input type="checkbox"/> €130 in 12 months |

Please mark the lottery with the lowest expected payoff, you would prefer towards a definite payoff of €100.

- €200 with a probability of 80% and €0 with a probability of 20%
- €180 with a probability of 80% and €0 with a probability of 20%
- €160 with a probability of 80% and €0 with a probability of 20%
- €140 with a probability of 80% and €0 with a probability of 20%
- €120 with a probability of 80% and €0 with a probability of 20%
- €100 with a probability of 80% and €0 with a probability of 20%

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¹ Mishkin (2007): Number 7 of the „8 facts about the worldwide financial structure“ says: „Collateral is a prevalent feature of debt contracts for (...) businesses.“ (p.192 ff.)

² Mishkin (2007): p.198

³ Gersbach und Uhlig (2006): In proposition 1 on p.564 the authors deduce that a monopolistic bank offers (pure) equity contracts. In Lemma 2 on p.565, the authors say that under complete competition (in pure strategies) only debt contracts can survive.

⁴ Bester (1987): For example, p.892

⁵ Fehr und Schmidt (1999): Formula (2) on p.822. Notice that the formula given here is a simplification of the function in Fehr and Schmidt (1999), because here it is assumed that individual i only suffers a loss of utility if the unequal distribution is to his own disadvantage.

⁶ Cameron and Trivedi (2009): the authors mention on p.627 that the interpretation of the ratio of two coefficients is the same for estimates with and without marginal effects.

⁷ For a comprehensive description of McFadden’s R^2 see Wooldridge (2002) p.465.

⁸ For a more detailed description of financial consequences of catastrophe blindness: Gischer, Herz, Menkhoff (2005): p.111

⁹ Voorderckers and Steijvers (2006): Table 3 on p.3078

¹⁰ For example Gompers, Kovner, and Lerner (2010)