The Microfinance Disappointment: An Explanation based on Risk Aversion*

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Abstract

Take up of Microcredit by the poor for investment in businesses or human capital turned out to be very low. We show that this could be explained by risk aversion without relying on fixed costs or other forms of non-convexity in the technology if the investment is aimed at increasing the probability of success. Under this structure, rational risk-averse agents choose corner solutions, unlike the case of a risky investment with an exogenous probability of success. Our online experiment confirms our theoretical predictions regarding the differences in agents' choices when facing the two types of investments.

Keywords— Risk aversion, Microfinance, Investment, Poverty, Development, Inequality
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1 Introduction

There is a large body of research, and a widely held view, that the persistence of poverty in developing countries is partly explained by credit constraints preventing the poor from accessing profitable investment opportunities. From this, policy makers have concluded that a key intervention for alleviating poverty is to provide affordable credit. In the last few decades this policy has been implemented on a large scale. Thousands of microcredit NGOs were established and they made billions of dollars of low-interest loans to the poor, offering hope for a significant reduction in poverty. The UN declared 2005 the "Year of Microcredit," and the 2006 Nobel Peace Prize was awarded to Muhammad Yunus and the Grameen Bank for their contribution to reducing world poverty.

But in the years that followed, the results were disappointing. Recent research has documented that access to credit did not have a positive effect on the income of the poor, who turn down the opportunity to finance investments in their businesses. Banerjee et al. (2015) find, in a randomized evaluation in India, low take-up of microcredit; no increase in households that are business owners, and despite some increase in the size of existing businesses, the average business remained small and not very profitable. Low take up and limited impact on business creation is also found in other places (see, for instance, Banerjee et al. (2013), Crépon et al. (2015), Angelucci et al. (2015)). Tarozzi et al. (2015) find higher take up in Ethiopia, but, similarly to other regions, no significant impact on business creation. Meager (2019) jointly estimates the effect across seven studies and finds that the impact of microcredit on household business is unlikely to be transformative and may be negligible. In a subsequent meta-analysis, Meager (2022) finds a precise zero effect for poor households and uncertain yet large effects for wealthier households with business experience.[1]

The large gap between the high expectations for microcredit and the disappointing outcomes requires an explanation. We show that this gap can be explained by risk aversion. Specifically, in our model, investment increases the probability that a risky project will succeed. By structuring the model in this way, we propose an explanation that doesn't rely on any form of increasing marginal returns to investment, such as a fixed cost or an s-shape production function. These forms of non-convexities are often employed in the literature, even though they are inconsistent with the evidence.

In particular, we show that investment projects with a binary outcome of success or failure, where investment increases the probability of success at a constant or diminishing rate, could lead the risk-averse poor to avoid any investment, despite the high expected return at low levels of investment. For projects of this nature - where investment increases the probability of success - the expected utility of a risk-averse agent as a function of investment is typically U-shaped. In addition, a decline in risk aversion leads to an increase in expected utility at high levels of the investment. Therefore, if risk aversion declines with wealth, the poor choose a corner solution with no investment, while those with sufficient wealth choose the high-end corner.

To understand the logic of the U-shaped expected utility, consider a lottery with zero expected return: with probability p the outcome of the lottery is a prize of one dollar, and with the complementary probability $1 - p$, it is zero. The cost of generating a probability of success p is equal to p dollars. That is, with no investment the probability of winning the prize is zero, with investment of one dollar the probability is one, and if the investment is half a dollar p is one half, and so on. In this case, any individual is clearly indifferent between no investment and investing the maximum ($p = 1$), where with probability one the agent simply receives the dollar invested back. The out-

[1] In addition, Meager (2022) discusses some harmful effects of microcredit and provides further references.

come is certain and identical in both cases. For any investment strictly between the two corners, the expected return is the same as for the two corners, but the realization is uncertain. Therefore, by definition of risk aversion, any risk averse individual would strictly prefer the corners over any other investment strictly between zero and one.[2]

To understand why the poor might avoid a high expected return investment that the wealthy would invest in, consider two changes to the lottery. First, the reward in case of a successful outcome is greater than one, so that the expected return of the lottery is positive. Second, the investment is limited to be strictly below one, so that success cannot be guaranteed by high investment. Risk averse agents, who would typically choose between one of the two corners, now face a tradeoff between avoiding risk (by not investing) and enjoying an expected positive return (by investing the maximum possible). If the reward is not too high and risk aversion declines with wealth, there would be a wealth threshold above which individuals invest in the project and below which they don't.[3]

We believe that our simple result – that risk aversion can lead to corner solutions, despite the absence of fixed costs or any other non-convexity – may have been overlooked in the existing literature because of the conventional modeling of risky investment, where the probability of success is exogenous. If the agent decides how much to invest in an asset, but the investment has no effect on the probability of success, only on the reward if the investment is successful, the expected utility of a risk averse agent is a concave function of investment or an inverse U-shape, leading to an interior solution. The optimal investment increases with wealth (if risk aversion is declining with wealth), but the change is continuous.[4]

Thus, one might wonder why the poor don't invest in projects in which the probability of success is given, and the investment increases the size of the reward if investment results in success? We propose that projects that are available to the poor include both margins of investments. Poor individuals can invest to increase the reward in case of success, and they also have the option to invest in order to increase the probability of success – and without any investment in that margin the probability of success is rather low. We show in section 3.3 that, for the same expected return, a risk averse agent will always prefer to invest in increasing the probability rather than in increasing the reward: investing in the probability second-order stochastically dominates investing in the reward. Thus, as long as a significant part of the return to investment is in the form of a higher probability of success, our results hold.

Investment in our model cannot be diversified among independent projects to eliminate the

[2] Unfortunately, we cannot provide a complete answer to the question of how general our U-shape result is. We prove it holds for CARA utility functions. The intuition for our U-shaped expected utility doesn't depend on the specific form of the agent's preferences. In Appendix B.1 we provide a numerical example that shows that the result extends also to the case of a CRRA function, albeit with an "approximate" rather than an exact U-shape. This suggests that our qualitative results hold more generally, albeit in a weaker form. In any case, the result that agents' investment is discontinuous in risk aversion still holds in the example, and may well hold more generally.

[3] In an extended model presented in Appendix C, we show that our main result doesn't depend on any constraints on borrowing. Moreover, even if agents could declare bankruptcy (in the case that they borrowed, were unsuccessful in their investment, and could not repay the entire debt), and liability is limited, the results still hold as long as: (1) The wealth of individuals after bankruptcy is correlated with their wealth before bankruptcy (e.g., they can hide some wealth), and (2) bankruptcy following an unsuccessful investment leaves individuals worse off, in comparison to the option of not investing.

[4] In such a framework, the S-shape of wealth dynamics, required for a poverty trap, is achieved by assuming a fixed cost (see, for instance, Acemoglu and Zilibotti (1997), and Banerjee (2000)). Aghion and Bolton (1997) model the probability of success as an endogenous outcome of investment, but they do not show our main result.

risk. This is, of course, standard in theories that are based on risk aversion. We propose that investment augments the expected productivity of an existing indivisible asset – the individual's labor, which is, for poor people, their main productive asset. The investment could be in human capital that increases the probability of finding a well-paying, stable job, or investing in a small business in which the owner's labor is the main factor of production.[5]

We designed an online experiment to test the model's predictions. Participants were recruited at random from a representative sample in the Czech Republic. Participants decided how much to invest in three different games, with an endowment of 150 CZK ($\approx$ 5.75 Euro the time of the experiment) in each of the games. In the "probability game"the reward for wining was 270 CZK. The probability of winning the prize was a function of the participant's investment. The higher the investment, the higher the probability of winning the reward. Participants lost the entire sum invested with the complementary probability. The probability as a function of investment was set such that the expected return of the probability game was constant at 50%. In the "reward game", the prize was determined by the decision of the participant: it was equal to three times the investment. The probability of winning the prize was set to 50%, as was the probability of losing the sum invested. Note that the expected return of the reward game was constant at 50%, as it was for the probability game.

Consistent with the model's predictions, when we limit the analysis to the risk-averse participants who understood the game, the results of the two games show that participants tend to choose the corners in the probability game significantly more than in the reward game. In particular, in the reward game the distribution of investment was unimodal (with a mean of 81 CZK and a median of 90 CZK). In the probability game the distribution of the investment (by the same participants) was bimodal with significantly more corner (or near corner) investment decisions (0 or 30 CZK and 120 or 150 CZK).

The third game was a "step-by-step game." 30 CZK of each participant's endowment, of the 150 CZK, was invested by the experimenter on behalf of the participant, in a lottery in which they can win 270 CZK with a probability of 1/6 and zero otherwise. The participants were then asked to make four subsequent decisions about how to invest each additional 30 CZK. In each step they had the option to direct investment to increase the probability of success, or to increase the reward they receive if successful. Rewards and probabilities were set such that the expected return was constant at 50% in each of the stages for both investment options.

Consistent with the outcome that investment in increasing the probability second-order stochastically dominates investment in increasing the reward, when the risk averse participants could choose between the two margins of investments they opted to increase the probability of their success, rather than increasing the reward, in the majority of junctions. Specifically, slightly more than 70% of the risk averse participants invested in increasing the probability in at least three of the four steps, whereas slightly less than 10% invested in increasing the reward in at least three steps. The remaining risk averse participants (slightly less 20%), split their investment equally between the two margins.[6]

[5]For instance, an individual whose business is providing services such as plumbing or electricity services, or even simple manual tasks, could invest in augmenting relevant skills, health and physical abilities; invest in marketing the services; purchase useful complementary tools, or spend money on anything else that increases the probability that the business is successful. Other small businesses are not that different. The owner has her own time and could augment the expected income of the business with investment in complementary factors or intermediate goods, such as a larger stock and more space for storage in a shop, or more fertilizer, tools and irrigation equipment in farming. We are aware that the poor do diversify to reduce risk, but, of course, diversification is limited, and cannot remove risk altogether.

[6]We are unaware of previous experiments that test the choice of risk averse individuals between risky

Our main contribution is to propose a theory that could explain why the poor tend to turn down the opportunity to borrow in order to invest in high return projects. The theory is based on risk aversion, which is central in the life of the poor, without relying on fixed costs or any other non-convexity in the production technology. We discuss the related literature, including the evidence on the importance of risk aversion in the lives of the poor, and the evidence suggesting that fixed costs are negligible in many investment opportunities facing the poor, in the next section. We postpone the discussion of policy implications to the paper's concluding section, after presenting the model and the experiment.

2 Related Literature

A key assumption of our theory is that the poor are risk averse and that reducing exposure to risk is central in their lives. The facts seem consistent. Banerjee and Duflo (2011) argue that "[r]isk is a central fact of life for the poor, who often run small businesses or farms ... with no assurance of regular employment. In such lives a bad break can have disastrous consequences" (p. 133). They further argue that the poor are constantly worrying about the future, particularly about imminent disasters, and take a variety of ingenious and costly precautionary measures to limit the risks they are exposed to, such as managing their businesses conservatively and diversifying their portfolio of activities, including by marriage and temporarily migration (pp. 141 - 143). Consistent with this, Morduch (1990) presents evidence suggesting that the poor avoid profitable but risky technologies. Bryan et al. (2014) shows that the poor avoid low cost seasonal migration that is highly rewarding because of the fear of failure, and Karlan et al. (2014) and Cole et al. (2017) show that insurance against adverse weather shocks can induce farmers to invest more in high-return risky production options.[7]

Risk aversion declines with income and is particularly significant among those who live in extreme poverty – the same people who are a major target of poverty-reduction policies, such as microfinance (Andrisani (1978), Hill et al. (1985), Cicchetti and Dubin (1994), and Shaw (1996).) The World Bank (2001) report shows that "[the] poor are highly risk averse and reluctant to engage in the high-risk, high-return activities that could lift them out of poverty" (p. 138), and "[a]s households move closer to extreme poverty and destitution, they become very risk averse" (p. 145). Finally, Banerjee and Duflo (2011) argue, as consistent with the structure of our model, that investment is often equivalent to buying a lottery ticket (p. 87). For instance, the outcome of schooling is employment by the government or a large firm, if successful, or subsistence self-employment, if not.

Much of the earlier literature that offers explanations for the persistence of poverty abstracts from risk aversion. This literature proposes theories based on credit constraints combined with increasing marginal returns to investment, such as fixed costs or S-shape production functions.[8] In

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alternatives as predicted by Second-Order Stochastic Dominance.

[7]Our model assumes that full insurance against risk (at an affordable cost) isn't available. We believe that this is a reasonable assumption justified by moral hazard and adverse selection problems. Udry (1990), Townsend (1995), and Morduch (1995) provide evidence that the poor are often insured against the risks they take, but as suggested by Banerjee (2000), these studies only observe the risky activities people have chosen to take. The poor may have foregone other investment opportunities to limit the risk they bear. Moreover, Townsend (1995) shows that full insurance is limited to some risks. In addition, the World Bank (2001) reports that "poor people, even though they need insurance most, are more likely to drop out of informal [insurance] arrangements." (p. 144). Finally, Banerjee and Duflo (2011) show that the poor avoid insurance, in particular health insurance, because "[c]redibility is always a problem with insurance products." (p.153).

[8]E.g., Dasgupta and Ray (1987), Galor and Zeira (1993), Banerjee and Newman (1993), Benabou (1996),

these models, the poor cannot benefit from high returns on the modest investments they can make, and as a result they cannot gradually escape poverty. One significant limitation of these papers, which our model resolves, is that they do not explain why the poor leave high return investment opportunities unexploited when they do have access to credit, which is what we observed when microcredit became available.

One can solve this puzzle by introducing risk to these models that are based on fixed costs (or other non-convexities). The risk averse poor might choose the safe alternative and avoid the investment, even if credit is available. The downside outcome – if the investment fails to yield the expected high return – could be too painful, leaving the poor with a low income, fewer assets, and debt. In this theory the fixed cost plays a crucial role, as it prevents the poor from investing a modest amount that exposes them to a level of risk they are willing to accept.[9]

However, Banerjee and Duflo (2011) claim that many investment opportunities, such as in education or health, offer a high expected return with no significant fixed cost. They argue that the marginal return to investment in education is high at low levels of investment: "... every little bit of education helps ... People who go on to secondary education are more likely to get a formal-sector job, but even those who don't are able to run their businesses better" (p. 82). Kraay and McKenzie (2014) survey the empirical literature and conclude that the evidence is inconsistent with technology-based poverty traps.[10]

Our model succeeds in explaining the disappointing outcomes of microcredit without relying on increasing marginal productivity (such as fixed costs).[11] We are not the first to remove increasing marginal productivity from a poverty trap model. The existing literature, however, focuses on various explanations for low investment by the poor in the absence of available credit.[12] We offer an explanation for why the poor do not invest when they do have access to credit.

There are only a few other explanations for why the poor avoid small affordable investments with high expected returns. Banerjee and Duflo (2011) suggest that the poor typically believe that the production function has an "S-shape" – the marginal return is low at low levels of investment and high at higher levels. Thus, the poor believe, despite the facts, that in order to enjoy a high return, the investment should be large. The combination of false beliefs and the risk associated with the investment push the poor to avoid it all together. "In reality, there should not be an education-

Durlauf (1996), Ghatak and Jiang (2002), Mookherjee and Ray (2003), and Mookherjee et al. (2010), among many others.

[9]The argument that risk aversion leads to under-investment isn't new, of course. It is proposed by Stiglitz (1969) and is further developed, with an emphasis on the poor, by many others (See the literature review in Banerjee (2000)).

[10]Not much capital is needed to start a business in a developing country and returns to investment are very high: 5% to 20% per month, at investment levels as low as 100 dollars (McKenzie and Woodruff (2006), de Mel et al. (2008, 2009, 2012), Fafchamps et al. (2014)). Similarly, despite high returns, many farmers decline to invest in fertilizer that is available in small quantities Duflo et al. (2011)), and many shopkeepers fail to make small inventory investments (Kremer et al. (2011)).

[11]Piketty (1997) advocates the importance of removing fixed costs from models of persistence of poverty. In his introduction he writes: "[the existing model's] mechanism is different from ours in that it relies entirely on a non-convex technology." However, he assumes a non-convex technology in effort rather than in capital.

[12]This literature includes, among others, Moav (2002) who shows that if the marginal propensity to save increases with income a poverty trap could emerge; Chakraborty and Das (2005) and Moav (2005) obtain similar results based on the interaction between health and human capital in the former and the trade-off between fertility and education in the latter; Banerjee and Mullainathan (2010) and Bernheim et al. (2015) focus on "temptation goods" and self-control problems, and Moav and Neeman (2010, 2012) focus on conspicuous consumption as reasons for low saving by the poor.

based poverty trap: Education is valuable at every level. But the fact that parents believe that education is S-shaped [...] create[s] one." (p. 89). This claim is supported by some evidence (e.g., Nguyen (2008)) but other evidence presented by the authors led them to conclude that the poor have a good understanding of their economic environment: "the poor are no less rational than anyone else – quite the contrary. Precisely because they have so little, we often find them putting much careful thought into their choices: They have to be sophisticated economists just to survive." (p. ix). Our model neither requires false beliefs about reality nor any other "behavioural" elements.

Kremer et al. (2013) argue that poor households in developing countries reveal risk aversion in small-stakes gambles that cannot be explained by any reasonable degree of risk aversion within expected utility theory, and propose that loss aversion within prospect theory may play a role. Our simple calibration, based on parameter values estimated from Augsburg et al. (2015), demonstrates that within our model, reasonable values of the risk aversion coefficient are sufficient to prevent the poor from investing, without relying on loss aversion (Appendix B.2).

More recently, Banerjee et al. (2015) propose that the low take-up of loans for starting a business could be an outcome of the lack of complementary factors such as proper training or skills, and more generally, that there is less potential for high return businesses for the poor than anticipated by microcredit enthusiasts. However, Bandiera et al. (2017) show that when poor women receive a productive asset (a couple of cows) and some relevant training, they have the skills to run a simple yet successful business that alleviates poverty in the long run. These results seem consistent with our theory. Women who could borrow the funds for the required investment and training avoid it, despite the high return. Similarly, Handa et al. (2018) find significant effects of cash transfer programs on productivity. The main difference between (a) borrowing for investment and (b) being given the asset – or the cash to purchase a productive asset with no debt – may be risk.

3 Theory

In this section we present our theoretical model and derive the following three main results:

1. In the *probability model* – the model in which an agent's investment increases the probability of success – the expected utility of an agent with a CARA utility function is U-shaped in the agent's investment. Consequently, investment is *discontinuous* in the agent's level of risk-aversion: more risk averse agents invest nothing, while less risk averse agents invest the largest amount possible.

2. In the *reward model* – the model in which an agent's investment increases the reward for success – the expected utility of an agent with any monotone increasing utility function is concave (inverse U-shaped) in the agent's investment. It follows that the agent's investment is *continuous* in the degree of risk-aversion.

3. If investment in the probability of success and investment in the reward obtained upon success are both available and generate the same expected income, then a risk averse agent prefers to invest in increasing the probability.

Our theoretical results have three main predictions regarding optimal investment choices of risk averse individuals. We examine the relevance of the theoretical results with an experiment.

1. The investment choices of individuals in the *probability game* – the experimental exercise in which an agent's investment increases the probability of success – give rise to a bimodal distribution.

2. The investment choices of individuals in the *reward game* – the experimental exercise in which an agent's investment increases the reward for success – give rise to a unimodal distribution.

3. In the *step-by-step game* there are two binary lotteries with identical expected payments that yield identical payments upon failure. Individuals can choose between investing in the probability of success or investing in a higher reward upon success. In this step-by-step game, individuals invest in the probability of success.

3.1 The Probability Model

An expected-utility-maximizing agent may invest in a project with binary outcomes: investment will be successful and generate a high return H, or it will fail, and generate a low return, $L < H$.

In the probability model, the agent controls the project's probability of success, $p \in [0, \bar{p}]$, at a linear cost $c(p) = \alpha p$ for some $\alpha > 0$. Importantly, we assume that $\bar{p} < 1$, so that, no matter how much the agent chooses to invest, they cannot ensure that investment would be successful. We assume that investment generates a positive expected return for the agent. That is, $pH + (1-p)L - \alpha p > L$ for any $p > 0$, or equivalently, $\alpha < H - L$.

Proposition 1. *The expected utility from investment in the probability model of an agent with a CARA utility function $u(x) = -e^{-\lambda x}$ is U-shaped in the agent's level of investment p. That is, there exists some threshold $\hat{p} \in [0, 1]$ such that the agent's expected utility is increasing in p on the interval $[0, \hat{p}]$ and decreasing in p on the interval $[\hat{p}, \bar{p}]$.*

The parameter $\lambda > 0$ in a CARA utility function describes the agent's Arrow-Pratt coefficient of risk aversion. A higher value of λ indicates a higher degree of risk aversion, and as λ decreases to zero, preferences converge to risk neutrality. It therefore follows that:

Proposition 2. *The optimal choice of the level of investment p of an agent with a CARA utility function with parameter λ is discontinuous in λ. There is a threshold level of risk aversion $\lambda^o > 0$ such that more risk averse agents choose the minimum investment $p = 0$, and less risk averse agents choose the maximum investment $p = \bar{p}$.*

Unfortunately, we do not have a full answer to the question of whether the results described in Propositions 1 and 2 above generalize to other utility functions. Notably, the intuition for our U-shape result that we described in the introduction doesn't depend on the specific form of the agent's preferences. In Appendix B.1 we provide a numerical example that shows that our results extend also to the case of a CRRA function, albeit with an "approximate" rather than an exact U-shape, as is the case for CARA functions. This suggests that our qualitative results hold more generally, albeit in a weaker form. In any case, the result that the agent's investment is discontinuous in their level of risk aversion holds in the example, and may hold more generally.

3.2 The Reward Model

As in the probability model, an expected-utility-maximizing agent may invest in a project with binary outcomes: investment may succeed and generate a high return, or fail, and generate a low return.

In the reward model, the agent controls the project's return upon success rather than the probability of success, which we fix at p. As in the probability model, a failed project yields a payoff of L. A successful project yields a payoff of $H(c) \geq L$, where $H(c)$ is assumed to be increasing and weakly concave in the agent's cost of investment $c \geq 0$. In this version of the model, the objective of the agent is to choose the cost of investment c to maximize expected utility, which is not necessarily CARA.

Proposition 3. *The agent's expected utility is concave in the cost of investment c. It follows that it is inverse U-shaped in c.*

As in the probability model, the agent's choice of level of investment is still decreasing in its level of risk aversion, but unlike in the probability model it is *continuous* in the level of risk aversion.[13]

3.3 Probability vs. Reward

In many situations, an agent faces a binary investment prospect in which they could invest either to increase the probability of success of a project, or invest to increase the reward upon success - or both. Which would the agent prefer?

We consider a hybrid of our probability and reward models in which the agent's expected return from investment is held fixed, regardless of whether the agent invests in probability or in reward.

Our agent faces a binary project. The project succeeds with probability $p \geq p_0 > 0$ and yields $H(p)$, or it fails and yields L, where $H(p) > L \geq 0$ for all $p \geq p_0$.

Suppose that the expected return of the project is constant so that $pH(p) + (1-p)L = C > L$ for every choice of $p \in [p_0, \bar{p}]$. The agent chooses whether to invest in the probability p with the expected reward upon success of $H(p) = \frac{C-(1-p)L}{p}$, which is decreasing in p, or invest in the reward $H(p)$ with a declining probability of success, p.

We compare the p-lottery in which the agent receives $H(p)$ with probability p and L with probability $1-p$ with the p'-lottery, where $p > p' \geq p_0$, in which the agent receives $H(p') > H(p)$ with probability p' and L with probability $1-p'$. Our assumption that $pH(p) + (1-p)L \equiv C > L$ is fixed implies that these two lotteries return the same expected income to the agent.

Proposition 4. *Suppose that $p > p' \geq p_0$. A p-lottery that pays $H(p)$ and L with probabilities p and $1-p$, respectively, generates a higher expected utility for a risk averse individual than a p'-lottery that pays $H(p') > H(p)$ and L with probabilities p' and $1-p'$, respectively.*

It follows that under the circumstances described in this section, a risk averse individual would prefer to invest in the probability of success than invest in the reward upon success.

4 Empirical examination

We tested our theoretical predictions using an online experiment, drawing our participants from the Czech Republic. Participants answered a set of questions and made four incentivized decisions. The first decision elicited risk aversion. The next three decisions were investment decisions corresponding to the three main predictions of our theory: investment in the probability of success, to test the prediction of corner solutions; investment in a given probability of success, to test

[13] Specifically, if $\{u_n\}$ is a sequence of utility functions that converges to a utility function u and $\{c_n\}$ and c are the associated costs of investment, then if u_n exhibits more/less risk aversion than u_{n+1} then c_n is smaller/larger than c_{n+1} and the sequence $\{c_n\}$ converges to c.

the prediction of interior decisions, and a choice between investing in increasing the probability of reward or or investing to increase the reward, to test the prediction that risk averse individuals prefer to invest to increase the probability. At the end of the experiment, the outcome of one of the decisions was randomly selected for payment.

4.1 Experimental design

In the first incentivized decision (Decision 1), the participants were presented with a portfolio of 11 choices between a lottery and a safe option (inspired by Dohmen et al. (2010)). In the lottery, they could either win 1,300 CZK (≈ 49.8 Euro) with 50% chance or 0 CZK otherwise. The amount in the safe option increased in each row by increment of 100 CZK from 0 CZK up to 1,000 CZK (see Appendix Table D.1). The participants were asked to select the row in which they preferred the safe option over the lottery. The switching point is assumed to capture individuals' preferences towards risk.

The remaining incentivized decisions (Decisions 2, 3, and 4) corresponded to the investment decisions in three investment games: (i) the "reward game"; (ii) the "the probability game"; and (iii) "the step-by-step investment" (for the visual summary of the games see Figure 1). The games are designed to have equal expected returns. Prior to each game, the participants were endowed with 150 CZK (≈ 5.75 Euro) and were provided with detailed instructions, followed by a set of control questions to check the level of their understanding. For every correct answer the participants received 5 CZK. If any of the control questions were answered incorrectly, we repeated the instructions and asked a different set of control questions (in which case the first set of questions would not be payment relevant anymore). Summary tables with all of the decision options were always displayed on participants' screens (see Appendix Figures D.1 and D.2).

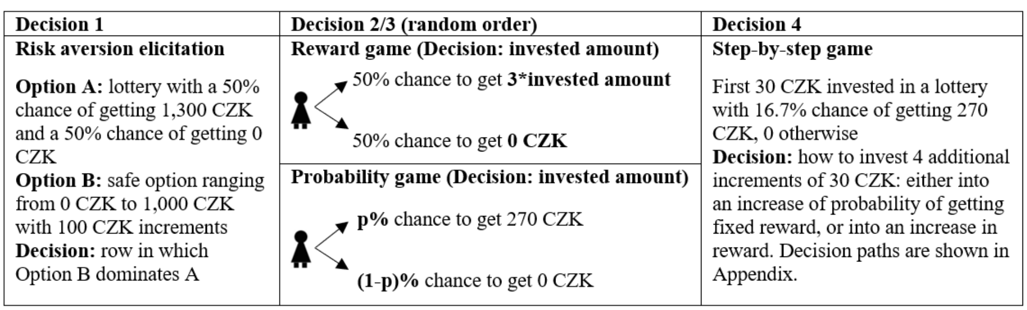


Figure 1: Experimental decisions

The "reward game" represented the conventional scenario in which the probability of success of an investment project was exogenously given. Participants invested (part of) their endowment to get a reward in case of success. The success of their investment was determined by a roll of a fair die. Instead of dots, our die had three sides with a star on it and three blank sides. The participants had a 50% chance of rolling a star, in which case their investment tripled, and a 50% chance of rolling an empty side, in which case they received 0. This gave an expected rate of return of 50%.

In the "probability game", there was an exogenous, fixed reward of 270 CZK and the participants could influence their probability of winning. Every 30 CZK invested added a star on their die and increased their chance of getting the reward by 16.7%. There were five dice available with

1, 2, 3, 4, or 5 stars representing a 16.7%, 33.3%, 50%, 66.7% or 83.3% chance of winning. The task in this game was to invest the amount that corresponds to the participant's preferred chance of winning a fixed amount. The non-standard die options ensured that participants understood which die had a higher chance of winning even if they could not calculate the probability of winning themselves. The expected rate of return is again 50%. The participants kept the non-invested money with certainty. The order of the reward and the probability games was randomized.

Finally, in the "step-by-step game" the participants were informed that the first fraction (30 CZK) of their endowment was invested for them such that they had a 16.7% chance of getting 270 CZK and an 83.3% chance of getting 0. The participants were asked to make four sequential investment decisions. In each step, they were asked to invest an additional 30 CZK either into increasing the reward (keeping the probability of winning the reward fixed) or to increase the probability of winning by 16.7% (while keeping the reward fixed). All pathways are displayed in Appendix Table D.2. The probabilities and rewards were calculated to ensure equal expected returns in each step. After the participants revealed their decision paths, they made their last payoff-relevant investment decision and decided on how much of 150 CZK they would like to invest, where the probabilities and rewards were taken from their decision path.

After the final decision and the last set of questions, we let the participants see the outcomes of all four incentivized decisions before one of them was selected for payment. First, the participants let the computer select one of 11 rows that would determine the outcome of their Decision 1 in the risk elicitation task. If the participants chose a lottery in the selected row, they would play the lottery and win 1,300 CZK with 50% chance and 0 otherwise. If the participant chose a safe option instead, they would be reminded of the amount they would definitely receive if this decision was selected for payment. Afterwards, the participants were reminded of their investment decisions in the other three games (following the order they played the games). The computer displayed the invested amount, the probability of rolling a star, expected reward, and the non-invested amount they were definitely taking home. The participants then rolled the digital dice and were presented the outcomes of their decisions 2, 3, and 4. In the final step, the participants asked the computer to determine which of the decisions will be selected for payment. While the first decision was selected with 10% probability, the investment decisions 2, 3, and 4 were selected with 30% probability each.[14] All the instructions were clearly communicated to the participants prior to the game and reiterated in the outcome summary. The experimental protocol is available in an Online Appendix.

4.2 Final sample and randomization balance

The experiment was conducted in cooperation with IPSOS, a global market research company. Our sample comprises 846 individuals randomly selected from their representative sample of more than 22,000 people living in the Czech Republic. Around 47% of our sample is female. The average respondent is 43.5 years old, earns on average 19,789.6 CZK, and lives in a household with 35,484.6 CZK net income per month, statistics similar to the average net household and personal income per month in 2020 (Czech Statistical Office, 2020). The monthly threshold for a household to be considered in poverty is, according to the same report, 19,227 CZK. Therefore, for the purpose of

[14] For a small sample of 102 participants Decision 1 was not incentivized. These participants are not significantly different from the other participants in terms of the observable characteristics and the two distributions of the decisions are similar (p-value of Kolmogorov-Smirnoff test equals 0.423). Given that the measure of risk aversion is essential for presenting the results, we decided to incentivize the risk elicitation among the rest of the participants, and we assigned this decision only a 10% chance of being selected for payment.

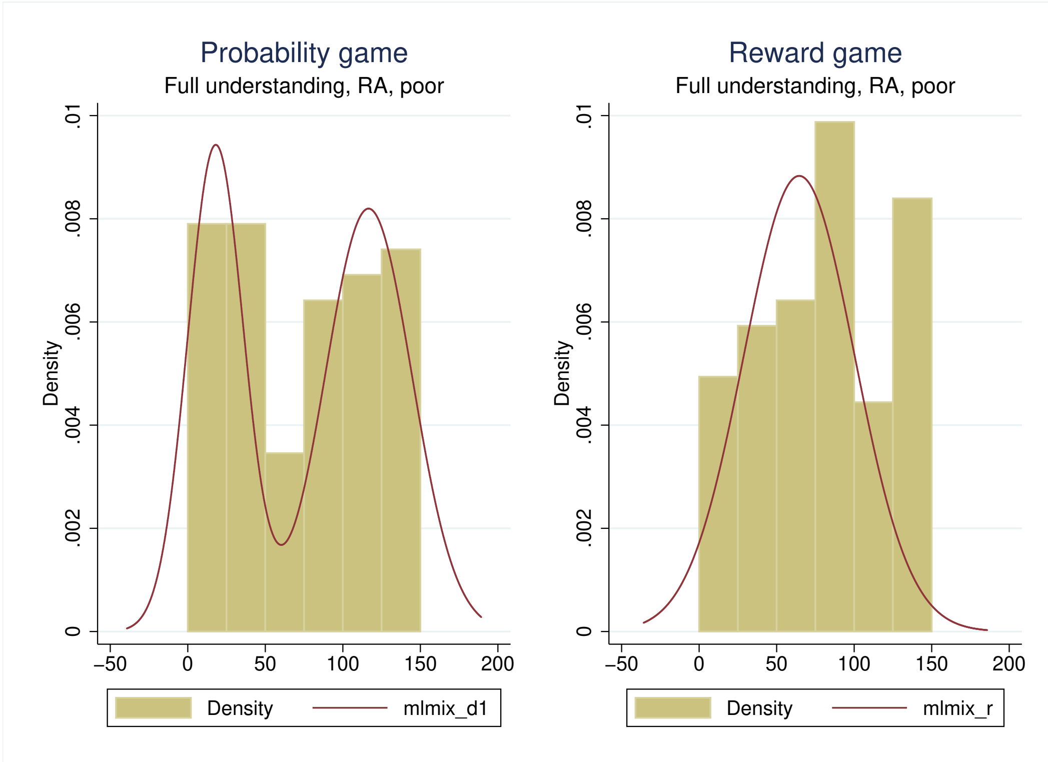
our analysis, we define people to be poor if they indicated that their household income is below 20,000 CZK per month. It took the participants on average 27 minutes to fill out the survey. Around 9.1% of the respondents gave primary education as their highest achieved education level, 34.1% finished secondary school with a school leaving examination, 38.6% finished vocational school, and 18.2% have received university level education. Around half of the sample is married and 36.2% have at least one child in the household living with them. There are no significant differences in the distributions of the responses in our categorical variables (e.g., region they live in, the number of inhabitants, marital status, employment type, etc.). Sample descriptive statistics and randomization balance checks are presented in the Appendix Table D.3.

Understanding the games is crucial for the interpretation of our results. If the participants do not understand the instructions, we cannot be sure whether the decision patterns are due to lack of understanding or due to the games themselves. While 49.7% of people understood both games fully (i.e., they answered all of the control questions correctly), 68.0% understood them well (i.e., they made at most one mistake in understanding each game). In our analysis, we will focus on the within-subject analysis of people with good/full understanding. We can rule out order effects given that the order of the games was randomized, and the randomization balance confirms that the participants who played the probability game first are on average the same as the participants who played the reward game first.

The crucial variable for our analysis is the participant's risk preferences. We used two measures of risk aversion, following closely the rich literature on the elicitation of risk preferences (e.g., Dohmen et al. (2010)). First, we asked participants a general question to rate their willingness to take risks on a 10-point scale (a general question is often used to elicit risk preferences and has been found to predict risk-taking behavior well (Dohmen et al., 2010)). In our sample, 59% of people ranked themselves below 5 on the 10-point scale and they would be considered as risk-averse. The average and modal response (5.2 and 5 respectively) and the distribution of responses is very similar to the distribution among a German representative sample analyzed by Dohmen et al. (2011). Second, as mentioned above, we asked the participants to look at eleven options in a lottery, in which they had a 50% chance of winning 1,300 CZK and a 50% chance of winning 0 CZK) and a safe option which ranged from 0 to 1,000 with increments of 100 CZK. A risk neutral individual prefers a lottery in rows 1 to 7 and a safe option in rows 8 to 11. Individuals are considered risk averse if they switch above row 7, and not risk averse if they do not. According to this measure, 74.8% of the participants are risk averse, 6.7% are risk neutral, and 18.5% are risk loving. Similar proportions (78%, 13%, and 9%) were found among the representative sample of adults in Germany (Dohmen et al., 2010). In our analysis, we present the results using the first measure but we replicate and present all the results with respect to the second risk-aversion measure in Appendix Figures D.7, D.8 and Appendix Table D.7.

4.3 Results

To test our first theoretical prediction, we look primarily at the differences in the investment choices in the probability versus reward game. In this analysis, we use within-subject design, and hence for each individual we observe their decisions in both the probability game and the reward game. Our theory predicts that we would see higher dispersion of investments in the probability game compared to the reward game for the risk-averse participants (prediction 1). This is because in the probability game we expect risk-averse participants to invest either (close to) the minimum or maximum amount from their endowment, resulting in a bimodal distribution of the investment choices. In the reward game, we expect the risk-averse participants to choose to invest some interior positive amount, resulting in a unimodal distribution of the investment choices (prediction 2).



Note: Histogram of investment decisions in the probability and reward game for poor risk-averse participants. Overlaid is the distribution predicted by the Finite Mixture Models.

Figure 2: The comparison of investment decisions in the probability and return game

In Figure 2 we visually compare the decisions of the participants in the probability game (left) and the reward game (right). On top of the histograms, we overlaid finite mixture models to model the distributions of choices in the two games. In line with our predictions, we find a bimodal distribution of the investment choices in the probability game, and a unimodal distribution in the reward game. The patterns are even more pronounced if we exclude people who invested the same amount across all three games (shown in Appendix Figures D.6 and D.8).[15] The bimodality is observed only among poor risk-averse individuals (see Appendix Figures D.3 and D.4 for the comparison of distributions). We also find that risk-averse individuals from wealthier backgrounds tend to invest the maximum in the probability game, but in the reward game, they tend to invest some interior positive amount, and that the risk-neutral or risk-loving individuals behave similarly in probability and reward games.

[15]Some people have a tendency to stick to one number across multiple investment decisions because they want to ensure consistency in their choices or because of lack of understanding/interest in the games. In our case, 37 percent of the risk averse participants, and around 29 percent of not risk averse participants invested the exactly same amount in the probability, reward, and step-by-step games. We can rule out that selection of the equal choice would be caused by identical position of the investment choice, given that the order of the investment choices (0 CZK, 30 CZK, up to 150 CZK) was randomized in each game.

	Full understanding		Not full understanding	
	Risk averse	Not risk averse	Risk averse	Not risk averse
	(1)	(2)	(3)	(4)
Low income				
Invested 0 CZK	**0.0741**	-0.0217	0.0244	-0.0222
	(0.029)	(0.049)	(0.037)	(0.059)
Invested 30 CZK	0.0494	**-0.1304**	0.0122	<0.0001
	(0.043)	(0.074)	(0.044)	(0.084)
Invested 60 CZK	**-0.0741**	0.0217	-0.0515	<0.0001
	(0.042)	(0.073)	(0.047)	(0.078)
Invested 90 CZK	**-0.0864**	0.0217	0.0121	0.0889
	(0.047)	(0.066)	(0.032)	(0.083)
Invested 120 CZK	0.0617	0.0435	0.0548	-0.0222
	(0.041)	(0.062)	(0.044)	(0.067)
Invested 150 CZK	-0.0247	0.0652	-0.0520	-0.0444
	(0.046)	(0.065)	(0.044)	(0.078)
n	162	92	187	90

Note: Invest 0 (up to 150) represents the dependent variable in a probit regression regressed on a treatment dummy, which equals 1 for the probability game and 0 for the return game. The estimated coefficients represent the marginal values and measure how much more likely people are to invest if they play the probability game compared to the reward game. The numbers in brackets are standard deviations. The first two columns show the results for risk averse/not risk averse people with full understanding, the last two columns show the results for risk averse/not risk averse people without full understanding.

Table 1: Differences in investment probabilities between the two games

To test for the difference in dispersion of choices between the two games, we use Levene's test on the equality of standard deviations. We can reject the hypothesis that the standard deviation of the decisions in the reward game is equal to or higher than the standard deviation of the decisions in the probability game (p=0.036). In other words, the decisions in the probability game are significantly more dispersed compared to the decisions in the reward game.

Next, we run six probit regressions for each investment decision separately (see Table 1). The dependent variable in each regression is a dummy variable equal to 1 if the investment was selected and 0 otherwise. Our independent variable is a dummy variable which equals 1 if the decision is made in the probability game, and 0 if the decision is made in the reward game. The estimated coefficients represent the marginal values and measure how much more/less likely is the decision selected in the probability game relative to the reward game. Standard errors, clustered at individual level, are displayed in brackets. Risk averse individuals are significantly more likely to invest 0, 120 and 150 CZK in the probability game compared to the reward game (p= 0.033, p=0.062 , and p= 0.005, respectively), and are significantly more likely to invest 60 CZK or 90 CZK in the reward game compared to the probability game (p=0.006, and p=0.026 respectively). In the reward game, the participants tend to invest some positive amount, which is consistent with the predicted interior solution by the model, but in the probability game, the same individuals tend to invest closer to the corners. We do not see any patterns among non risk averse participants and participants without full understanding (shown in columns 2, 3, and 4 in Table 1). The results hold even for the participants with good (rather than full) understanding, if other risk aversion measures are used, and if we control for the order of the games and other covariates (such as gender, age, education, personal income, etc.). The results are presented in Appendix Tables D.5, D.6, and D.7.

We use the step-by-step game to test our third prediction in which, if the participants have an option to choose between investment into reward or probability, risk averse individuals would prefer the latter (for the same expected return). As described above, the participants make four consecutive decisions, in which they either increase the probability of winning a fixed reward, or increase the reward, while keeping the probability unchanged. The decision paths in the step-by-step game allow us to check whether the second-order stochastic dominance holds. We pool the four decisions and see that 70.4% of the risk-averse participants invested predominantly in the probability of winning (they increased the probability three to four times) and the percentage is even higher (72.3%) for very risk averse individuals. Among others, 9.9% of the sample invested predominantly in the reward game and the remaining 19.8% split their investment equally into return and probability. We conclude that if people have an option to either increase the probability of success or increase their reward, they strongly prefer the first option.

5 Conclusion

High hopes of significantly reducing poverty through microfinance were dashed by disappointing results. Our main contribution is in proposing a theory that could explain why the poor tend to turn down the opportunity to borrow money to pursue high return investments. The theory is based on risk aversion, which is central in the life of the poor, and does not rely on fixed costs or any other non-convexity in the production technology. Non-convexities are commonly used in the related theoretical literature, but seem to be inconsistent with the facts. Our theory is consistent with existing evidence and supported by the findings from our experiment.

We believe that for effective poverty-reduction policy, identifying the effect of microcredit on business creation and on reduction in poverty is crucial but insufficient. Understanding the reason for its failure is important, in particular because the evidence is inconsistent with the existing theoretical literature. We hope that our theory and findings bring us a step closer to understanding the issue, provide guidance to future empirical studies and identify useful policy implications.

The main policy implication that we can draw from our theory, and that should be further tested, is that to facilitate investment by the poor, policy should be aimed at reducing the risk they face. One example would be to condition repayment of debt on outcomes, with a higher interest rate when investment yields successful outcomes, and forgiveness of most of the debt in case of failure. Consistently, Battaglia et al. (2018) find that repayment flexibility improves businesses outcomes via risk taking. It is worth noting that in our experiment women invest less than men, consistent with existing evidence that women are more risk averse. Therefore, special attention could be given to reducing the risk attached to investments made by women. Another reasonable conclusion is that the path for economic growth and reduction of poverty isn't more small businesses but rather, as in developed countries, more jobs that pay higher wages. Perhaps, as proposed by Banerjee et al. (2015) the majority of the poor lack the training and skills to be successful entrepreneurs and business owners, and there is less potential for high return businesses run by the poor than is anticipated by microcredit enthusiasts. However, it could be the case that the major hurdle to investment in businesses is the high level of risk aversion among those who live in extreme poverty. In this case, offering credit to established businesses could be a promising approach, as these businesses could grow and create more jobs.[16] Perhaps, therefore, microcredit does provide a significant benefit of an increase in labor demand and wages, but this is, of course, beyond the focus of our paper.[17]

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[16] A positive effect of microcredit on established business was identified by several studies, e.g., Meager (2022).

[17] This benefit, even if significant, cannot be identified by most empirical studies, because the randomized control trials designed to test the effect of microcredit cannot identify general equilibrium effects. Breza and Kinnan (2021) investigated what happened in Andhra Pradesh, India, when microcredit institutions were shut down in 2010. They found that this was followed by a notable decrease in wages in rural areas.

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Appendices

A Proofs

Proof of Proposition 1

Proposition 1. *The agent's expected utility function $U(p)$ is U-shaped in p. Namely, it is non-increasing on an interval $[0, \hat{p}]$ and increasing on the interval $[\hat{p}, \overline{p}]$ for some $\hat{p} \in [0, \overline{p}]$. Notice that $U(p)$ may be either nonincreasing or nondecreasing on the entire range.*

Proof. We show that if U is increasing at some p, then it is increasing for all $p' > p$. The agent's expected utility is equal to

$$U(p) \equiv -pe^{-\lambda(H-\alpha p)} - (1-p)e^{-\lambda(L-\alpha p)}$$

and its derivative with respect to p is equal to

$$U'(p) = (1+\lambda\alpha p)\, e^{\lambda\alpha p}\left(e^{-\lambda L} - e^{-\lambda H}\right) - \lambda\alpha e^{\lambda\alpha p} e^{-\lambda L}.$$

Suppose that U is increasing at p, or $U'(p) > 0$. It follows that

$$\begin{aligned} U''(p) &= \lambda\alpha\left[(2+\lambda\alpha p)\, e^{\lambda\alpha p}\left(e^{-\lambda L} - e^{-\lambda H}\right) - \lambda\alpha e^{\lambda\alpha p} e^{-\lambda L}\right] \\ &= \lambda\alpha\left[U'(p) + e^{\lambda\alpha p}\left(e^{-\lambda L} - e^{-\lambda H}\right)\right] \\ &> 0, \end{aligned}$$

which implies that $U'(p') > U'(p)$ for all $p' > p$ or that U continues to increase throughout the remainder of its range. ■

Proof of Proposition 2

Proposition 2. *The agent's choice of p is discontinuous in its level of risk aversion λ. There exists a threshold level of risk aversion $\lambda^o > 0$ such that more risk averse agents with $\lambda > \lambda^o$ choose the minimal probability $p = 0$, and less risk averse agents with $\lambda < \lambda^o$ choose the maximal probability $p = \overline{p}$.*

Proof. Recall that von Neumann-Morgenstern utility functions are only unique up to affine transformations. Hence, the utility function $u(x) = -e^{-\lambda x}$ is equivalent to the utility function $u(x) = \frac{1-e^{-\lambda x}}{\lambda}$, which converges to a linear function as λ tends to zero by L'Hôpital's Rule. This implies that the agent becomes risk neutral and so prefers the lottery $(H - \alpha\overline{p}, L - \alpha\overline{p}; \overline{p}, 1-\overline{p})$ over the certain outcome L. By continuity, this is also the case for all agents with small enough level of risk aversion λ.

An agent prefers the certain outcome L over the lottery $(H - \alpha\overline{p}, L - \alpha\overline{p}; \overline{p}, 1-\overline{p})$ if and only if

$$-pe^{-\lambda(H-\alpha p)} - (1-p)e^{-\lambda(L-\alpha p)} < -e^{-\lambda L}$$

if and only if

$$pe^{\lambda(\alpha p + L - H)} + (1-p)e^{\lambda\alpha p} > 1.$$

As λ increases to infinity, $e^{\lambda(\alpha p+L-H)}$ tends to zero, but $e^{\lambda\alpha p}$ tends to infinity, which implies that the last inequality is satisfied for all λ large enough.

Finally, the fact that an agent with a smaller λ is less risk averse than an agent with a larger λ implies that any lottery that is preferred over a certain outcome by the former is also preferred by the latter. It therefore follows that there exists a threshold level of risk aversion $\lambda^o > 0$ such that more risk averse agents with $\lambda > \lambda^o$ choose the minimal probability $p = 0$, and less risk averse agents with $\lambda < \lambda^o$ choose the maximal probability $p = \overline{p}$. ■

Proof of Proposition 3

Proposition 3. *The agent's expected utility function $V(c)$ is concave in its cost of investment c. It follows that it is either increasing throughout its range, decreasing throughout its range, or is inverse U-shaped in c.*

Proof. The first and second derivatives of $V(c)$ are given by

$$V'(c) = pu'(B + H(c) - c)\left(H'(c) - 1\right) - (1 - p)u'(B + L - c)$$

and

$$V''(c) = pu''(B + H(c) - c)\left(H'(c) - 1\right)^2 + pu'(B + H(c) - c)H''(c) + (1 - p)u''(B + L - c),$$

respectively. The conclusion follows from the concavity of the functions $u(\cdot)$ and $H(\cdot)$. ■

Proof of Proposition 4

Proposition 4. *A p-lottery that pays $H(p)$ and L with probabilities p and $1 - p$, respectively, generates a higher expected utility to a risk averse individual than a p'-lottery that pays $H(p') > H(p)$ and L with probabilities p' and $1 - p'$, respectively, if $p > p' \geq p_0$.*

Proof. Follows immediately from the fact that the p-lottery second-order-stochastically-dominates the p'-lottery. ■

B CRRA utility and a simple calibration

In this section we show that the discontinuity result may also hold for a CRRA utility function. However, as the numerical example below illustrates, the local maxima can be interior rather than corner, and may change with the initial wealth. Specifically, richer people may make higher investments. Then we provide a simple calibration, using CRRA utility function and data from Augsburg et al. (2015), which suggests that, under reasonable values of relative risk aversion, poor agents do not invest.

B.1 The case of CRRA

Assume a CRRA utility function of the form $u(x) = \frac{x^{1-\sigma}-1}{1-\sigma}$. In this case, our expected utility function that corresponds to the one in section 3 becomes[18]

$$U(p) = p\frac{(B + H - \mu)^{1-\sigma} - 1}{1 - \sigma} + (1 - p)\frac{(B + L - \mu)^{1-\sigma} - 1}{1 - \sigma} \tag{B.1}$$

Figure B.1 draws the expected utility for different levels of wealth , which corresponds to the values $\sigma = 1$, $H = 5.5, L = 0.6875, \alpha = 3, \bar{p} = 0.8$.[19]

[18] We denote by μ the cost of investment and keep, in this subsection, the assumption made in our model, $\mu = c(p) = \alpha p$.

[19] This corresponds to $u(x) = \ln(x)$.

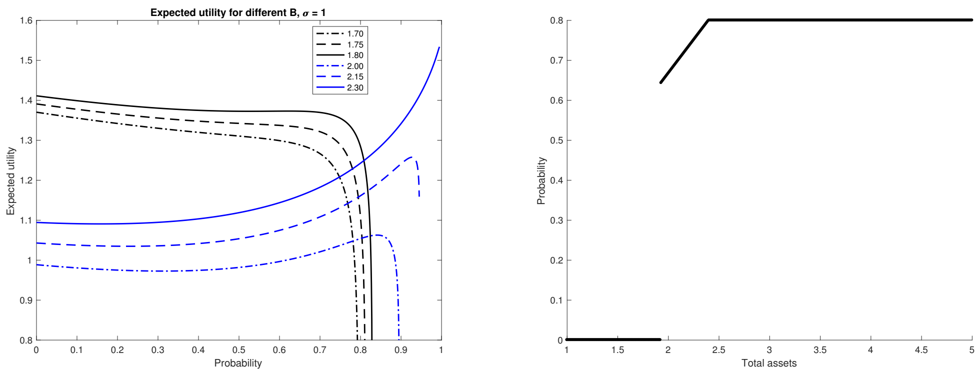


Figure B.1: Left panel: Expected utility as a function of probability (levels adjusted by constant for convenience of presentation on one figure). Right panel: Optimal probability.

The left panel of Figure B.1 shows that while for a relatively low initial wealth agents (black curves) the optimum is achieved at $p = 0$, for a relatively high initial wealth agents (blue curves) the optimum is achieved at strictly positive and relatively high level of P. More importantly, the U-shaped pattern still exists but it does not have to occur allover the range $[0, 1]$ (blue curves). The right panel of Figure B.1 shows that the discontinuity in optimal choice of probability still holds. Specifically, for a relatively low initial wealth, $B < 1.93$ agents choose not to invest. Finally, throughout the range $1.93 < B < 2.40$, the optimal value of p increases with wealth.[20]

B.2 A Simple Calibration

We use data from Augsburg et al. (2015) who studied the effect of microcredits in Bosnia. They conducted an experiment by providing randomly loans to those who were rejected by MFI. To facilitate their study, the authors collected data on various socioeconomic variables, ranging from household consumption and assets to income and savings choices.

The data we use includes: 1) **assetvalue** which corresponds to Endowment B in the model; 2) **y_max** which corresponds to the return H in the good state of the world; 3) **bm_expenses** which corresponds to investment μ. ; 4) **past_success** which is used to compute probability of success P.[21]

To calculate the probability of success, p, we use the question *previous year was successful financially*. We assume that those who strongly agreed with the statement could be considered successful. Then, we create a dummy variable that takes value 1 if a person was successful and 0 – otherwise. Next, we sort the sample based on the asset value B, from smallest to the largest. Then, we divide this sorted sample into 30 income groups by the value of total assets that they own: the

[20] Remember that in the CARA case the U-shaped pattern holds for the whole range between 0 and 1. This implies that if it is optimal for the agent to invest, it occurs at $\bar{p}$. This made our analytical problem tractable.

[21] Variable corresponding to B was calculated by the authors as the total value of assets owned by the respondents. H comes from the question "*Imagine that you do receive the loan from EKI and have a very good month/year, economic conditions are flourishing and stable and there is great demand for your product/service... What would be the* ***maximum*** *amount of profit this business of yours receives in such a situation over the next month/year?*". μ corresponds to the question "*average yearly expenses of main business*" P is calculated based on the question "*Please respond to the following statements on a scale of* 1 (*Disagree*) 2 (*Neutral*) 3 (*Strongly Agree*). *Previous year was successful financially*".

first group contains 18 poorest respondents, the second – the next 18 poorest poorest, etc. Finally, for each group we compute the share of people within a group who were successful. Such share is an estimate of the probability of success p for a given income group. We notice that the minimal value of p is $0.(22)$, which corresponds to the lowest income group and the maximal value is 0.88, which corresponds to the highest income group. Similarly, we aggregate μ and B, by taking the mean of individual μ and B, respectively, for a given income group.

For the purpose of the calibration we assume that the probability is a linear function of investment $p = \gamma\mu$, $L = 0$ and take $\bar{p} = 0.88$, $H = 62 \times 10^3$ from the data. We also assume that the maximum μ from the data corresponds to $\bar{p}$ and use it to calculate γ.

We plot the probability of success as a function of total assets for different levels of σ in the range considered acceptable in the literature. The figure illustrates our main results: for reasonably low levels risk aversion poor individuals choose to avoid investment, and a continuous rise in wealth leads to a discontinuous jump in investment.

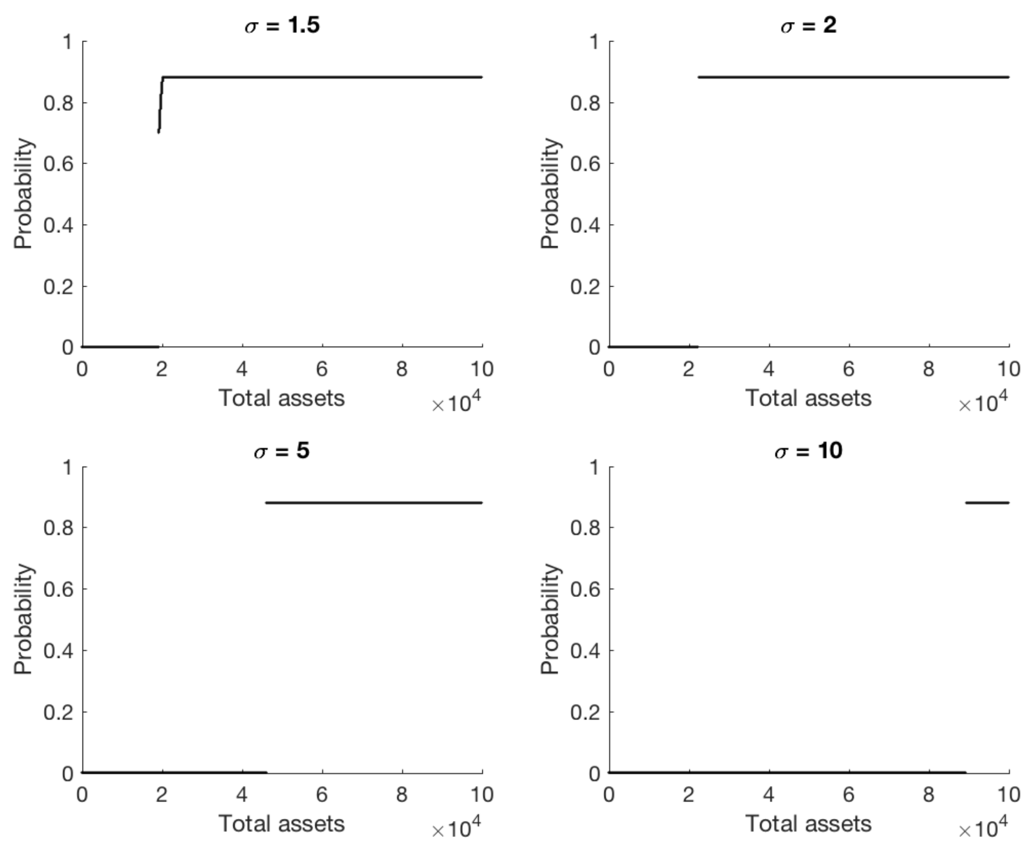


Figure B.2: $H = 62000$, $L = 0$, $\underline{p} = 0$, $\bar{p} = 0.88$

C A Model with a Resource Constrained Agent

In this section, we show that the results of the simple model continue to hold when the model is embedded in a competitive financial market with the possibility of bankruptcy (when the investment project fails and the agent pays only part of the debt). As in the simple model, individuals can invest in the probability of success of a risky project with an exogenous binary outcome of high or low income. They can augment their investment with a loan and pay the competitive risk-adjusted interest rate in a perfect loan market, which takes into account the probability of a low-income outcome and bankruptcy. We assume that individuals' wealth is unobserved by the financial intermediary, and the interest rate is determined by a zero-profit condition, under limited liability: only the income from the investment project can be used to pay back the debt.

We show that an individual's choice of investment is discontinuous in its degree of risk aversion, and therefore in wealth, assuming that risk aversion declines with wealth. This implies that individuals face a tradeoff between a safe, low return option, and a risky, high expected return option. If an individual chooses the safe option, her initial wealth is augmented by low income. If she invests in the project, the end outcome in case of failure is that she is left with her initial wealth and the low income from the unsuccessful project, net of the investment cost. If this initial wealth is low then risk aversion is high: the disutility from losing the low income in the risk free option is high. This leads to our main result: despite the absence of non-convexities in the production technology, optimization implies that the poor behave as if there is a fixed cost which prevents them from investing in a high return project despite the fact that credit is available at a competitive rate.

Suppose that the agent has an initial income of $B \geq 0$ that it can use in order invest in a risky binary project as described in the previous section. An investment of size $c(p) = \alpha p$ generates an additional income H with probability p and an additional income L, $0 < L < H$, with probability $1 - p$, where $0 < \alpha < H - L$.

An investment that is larger than B requires the agent to borrow. Suppose that the agent has access to a competitive credit market in which the riskless interest rate is normalized to zero. A loan of size $b \geq 0$ can be obtained at the interest rate $r(b)$ that allows lenders to break even. We assume that B is non-verifiable to lenders so that an individual who borrows any amount return a maximum amount L if its additional income is realized to be L, and a maximum amount H if it is realized to be H. We assume that the success of the project as well as the agent's choice of probability p are verifiable (for example, because the project requires investment in observable physical capital) so that lenders are able to asses the correct interest rate to charge the loan, and would refuse loans that are larger than what is needed in order to finance the agent's investment.[22] Finally, we assume that in case of indifference, the agent prefers a larger to a smaller loan (this last assumption is not necessary for our results, but it simplifies the analysis below).

Suppose that the individual has a CARA utility function and chooses the probability p at cost $c(p) = \alpha p$ as described above.

Proposition 5. *The agent finances its entire investment $c(p) = \alpha p$ through a loan.*

Proof. If $c(p) \leq L$ then the individual is indifferent with respect to how it finances its investment because regardless of whether it finances the investment from its own funds or through a loan, its

[22]Note that the agent may want to borrow a larger amount than the amount necessary to finance its investment because such a loan provides insurance to the agent: an agent who borrows such a larger amount enjoys a certain income that is paid back only upon success. Lenders may be reluctant to lend larger sums because of moral hazard considerations, and in any case, the point of this paper is that poor agents cannot reduce or eliminate their exposure to risk, which such larger loans would facilitate.

income is $B + H - c(p)$ and $B + L - c(p)$ following success and failure of the project, respectively. It therefore follows that if $c(p) \leq L$ then the individual will finance its investment entirely through a loan.

If $c(p) > L$ then borrowing allows the individual to insure itself against risk because an individual who borrows the entire amount necessary for investment $c(p)$ returns only L if the project fails and so enjoys an income of B in that case, whereas an individual who borrows a smaller amount and relies on its own funds (but still chooses the same probability p) still has to pay back L if the project fails so only enjoys a smaller income than B in that case (note that a same probability p produces equal expected incomes in the two cases and that lenders earn zero profits). A bigger loan implies that the induced lottery second-order-stochastically-dominates the lottery induced by a smaller loan. So every risk averse individual would prefer a bigger loan over a smaller loan. It therefore follows that in this case the agent would borrow the largest amount possible, which is equal to $c(p)$.[23,24] ■

We show that, as in the case described in the simple model, the agent's expected utility is U-shaped in p. The fact that individuals borrow the entire amount needed to finance their investment implies that the individual's induced expected utility function $U(p)$ is given by:

$$U(p) = \begin{cases} pu(B + H - \alpha p) + (1 - p)u(B + L - \alpha p) & \text{if } p < \frac{L}{\alpha} \\ pu(B + H - L - \alpha + \frac{L}{p}) + (1 - p)u(B) & \text{if } \frac{L}{\alpha} \leq p \end{cases} \tag{C.1}$$

because an individual who borrows an amount $c(p) = \alpha p < L$ returns αp in both states of the world, and an individual who borrows an amount $c(p) = \alpha p \geq L$ returns L if the project fails, and $L + \alpha - \frac{L}{p}$ if the project succeeds, so that $p\left(\frac{\alpha p - (1-p)L}{p}\right) + (1 - p)L = \alpha p$ overall.[25]

Proposition 6. *The individual's induced expected utility function $U(p)$ that is described in (C.1) is U-shaped in p.*

Proof. For values of p that are such that $c(p) < L$ or $p < \frac{L}{\alpha}$, it is possible to show that the function $U(p) = pu(B + H - \alpha p) + (1 - p)u(B + L - \alpha p)$ is U-shaped using a similar argument to the one used in the proof of Proposition 1.

For values of p that are such that $c(p) \geq L$ or $p \geq \frac{L}{\alpha}$, we need to show that the function $U(p) = pu(B + H - L - \alpha + \frac{L}{p}) + (1 - p)u(B)$ is increasing in p. This implies that $U(p)$ is U-shaped over its entire range because $U(p)$ is continuous so the argument is valid regardless whether $U(p)$ is decreasing, increasing, or U-shaped for $p \in [0, \frac{L}{\alpha}]$.

The derivative of $U(p)$ with respect to $p \geq \frac{L}{\alpha}$ is equal to

$$U'(p) = -pu'\left(B + H - L - \alpha + \frac{L}{p}\right)\frac{L}{p^2} + u\left(B + H - L - \alpha + \frac{L}{p}\right) - u(B).$$

For our CARA utility function, $u(x) = -e^{-\lambda x}$ and $u'(x) = \lambda e^{-\lambda x}$. So, $U'(p) > 0$ if and only if:

$$\lambda\left(H - L - \alpha + \frac{L}{p}\right) > \ln\left(1 + \frac{\lambda L}{p}\right).$$

---

[23] The reasoning above implies that the agent would like to borrow possibly even more than $c(p)$, but we assume that lenders would refuse larger loans (see the discussion in footnote 22).

[24] Lenders will obviously not lend more than $\min\{c(p), (1 - p)L + pH\}$. However, the assumption that $(1 - p)L + pH - c(p) > L$ ensures that this minimum is obtained on $c(p) = \alpha p$.

[25] Observe that $\frac{\alpha p - (1-p)L}{p} \leq \frac{pH + (1-p)L - (1-p)L}{p} = H$ so the individual can indeed return the loan if the project succeeds.

The conclusion follows from our assumption that $H - L > \alpha$ together with the fact that $x > \ln(1+x)$ for all $x > 0$. ■

It follows that like in the simple model, also in this model we have:

Proposition 7. *The agent's choice of* p *is discontinuous in its level of risk aversion* λ*. There exists a threshold level of risk aversion* λ^o *such that more risk averse agents with* $\lambda > \lambda^o$ *choose the minimal probability* $p = \underline{p}$*, and less risk averse agents with* $\lambda < \lambda^o$ *choose the maximal probability* $p = \overline{p}$*.*

Proof. Follows from the same argument as in the proof of Proposition 2. ■

If agents with a smaller initial income (bequest) B are also more risk averse in the sense that their CARA utility function has a larger risk coefficient parameter λ then we have:

Corollary. *The agent's choice of* p *is discontinuous in its initial income* $(bequest)$ B*. There exists a threshold level of income* B^o *such that poorer agents who have a smaller initial income* $B < B^o$ *choose the minimal probability* $p = \underline{p}$*, and richer agents who have a larger initial income* $B > B^o$ *choose the maximal probability* $p = \overline{p}$*.*

D Experiment

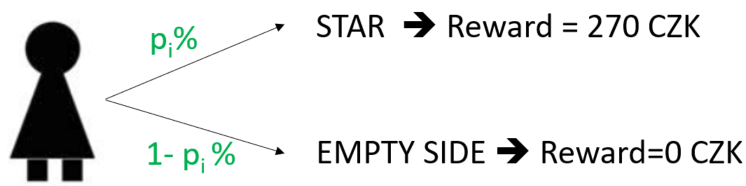
In this section, we provide additional details about the experimental design, and offer further supportive results. In subsection D.1 we (visually) describe four incentivized decisions of our respondents, provide randomization balance, and describe respondents' characteristics. In subsection D.2 we replicate the main results for various subsamples and we look at the distribution of the investment choices by gender.

D.1 Design, sample descriptive statistics, and randomization balance

	Option A **50% chance of getting 1300 CZK and 50% chance of getting 0 CZK.**	**Option B** **100% chance (sure reward)**
1	50% chance 1300 CZK and 50% chance 0 CZK.	0 CZK
2	50% chance 1300 CZK and 50% chance 0 CZK.	100 CZK
3	50% chance 1300 CZK and 50% chance 0 CZK.	200 CZK
4	50% chance 1300 CZK and 50% chance 0 CZK.	300 CZK
5	50% chance 1300 CZK and 50% chance 0 CZK.	400 CZK
6	50% chance 1300 CZK and 50% chance 0 CZK.	500 CZK
7	50% chance 1300 CZK and 50% chance 0 CZK.	600 CZK
8	50% chance 1300 CZK and 50% chance 0 CZK.	700 CZK
9	50% chance 1300 CZK and 50% chance 0 CZK.	800 CZK
10	50% chance 1300 CZK and 50% chance 0 CZK.	900 CZK
11	50% chance 1300 CZK and 50% chance 0 CZK.	1000 CZK

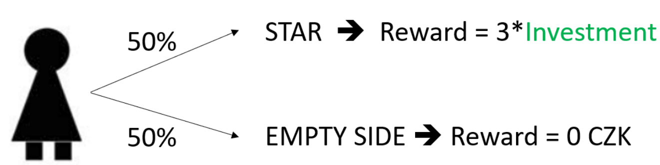
Table D.1: Decision 1: Risk elicitation

The order of the second and third incentivized decisions was randomized to rule out order effects. In each investment decisions the participants were endowed with 150 CZK which they could either kept for themselves or invest (a portion of) it. The participants received detailed description of the task followed by an example and a set of four control questions. The visual guides in Figures D.1 and D.2 were displayed on the screens in each decision step.



My decision				If I roll a STAR:		If I roll an EMPTY SIDE:	
I invest:	I take home for sure:	The number of stars on the sides of my die:	The chance I get 270 CZK is:	I receive	I will go home with:	I receive	I will go home with:
0 CZK	150 CZK	I won't roll	0 %	0 CZK	150 CZK	0 CZK	150 CZK
30 CZK	120 CZK	★	16,7 %	270 CZK	390 CZK	0 CZK	120 CZK
60 CZK	90 CZK	★★	33,3 %	270 CZK	360 CZK	0 CZK	90 CZK
90 CZK	60 CZK	★★★	50 %	270 CZK	330 CZK	0 CZK	60CZK
120 CZK	30 CZK	★★★★	66,7 %	270 CZK	300 CZK	0 CZK	30 CZK
150 CZK	0 CZK	★★★★★	83,3 %	270 CZK	270 CZK	0 CZK	0 CZK

Figure D.1: Decision 2/3: Investment decision in the Probability game



My decision		With 50% chance I roll a star:		With 50% chance I roll an empty side:	
I invest:	which means I will surely take home:	I receive:	which means I will take home:	I receive:	which means I will take home:
0 CZK	150 CZK	0 CZK	0 + 150 = **150 CZK**	0 CZK	150 CZK
30 CZK	120 CZK	90 CZK	90 + 120 = **210 CZK**	0 CZK	120 CZK
60 CZK	90 CZK	180 CZK	180 + 90 = **270 CZK**	0 CZK	90 CZK
90 CZK	60 CZK	270 CZK	270 + 60 = **330 CZK**	0 CZK	60CZK
120 CZK	30 CZK	360 CZK	360 + 30 = **390 CZK**	0 CZK	30 CZK
150 CZK	0 CZK	450 CZK	450 + 0 = **450 CZK**	0 CZK	0 CZK

Figure D.2: Decision 2/3: Investment decision in the Reward game

<table>
<tr><th>Decision 0
(given)
(invest 30 CZK)</th><th>Decision 1
(invest 30 CZK)</th><th>Decision 2
(invest 30 CZK)</th><th>Decision 3
(invest 30 CZK)</th><th>Decision 4
(invest 30 CZK)</th></tr>
<tr><td rowspan="16">[1]
p=16.7% 270 CZK
q=83.3% 0 CZK</td><td rowspan="8">[1.1]
p=33.3% 270 CZK
q=66.7% 0 CZK</td><td rowspan="4">[1.1.1]
p=50.0% 270 CZK
q=50.0% 0 CZK</td><td rowspan="2">[1.1.1.1]
p=66.7% 270 CZK
q=33.3% 0 CZK</td><td>p=83.3% 270 CZK
q=16.7% 0 CZK</td></tr>
<tr><td>p=66.7% 337.5 CZK
q=33.3% 0 CZK</td></tr>
<tr><td rowspan="2">[1.1.1.2]
p=50.0% 360 CZK
q=50.0% 0 CZK</td><td>p=62.5% 360 CZK
q=27.5% 0 CZK</td></tr>
<tr><td>p=50.0% 450 CZK
q=50.0% 0 CZK</td></tr>
<tr><td rowspan="4">[1.1.2]
p=33.3% 405 CZK
q=66.7% 0 CZK</td><td rowspan="2">[1.1.2.1]
p=44.4% 405 CZK
q=55.6% 0 CZK</td><td>p=55.6% 405 CZK
q=44.4% 0 CZK</td></tr>
<tr><td>p=44.4% 506.3 CZK
q=55.6% 0 CZK</td></tr>
<tr><td rowspan="2">[1.1.2.2]
p=33.3% 540 CZK
q=66.7% 0 CZK</td><td>p=41.7% 540 CZK
q=58.3% 0 CZK</td></tr>
<tr><td>p=33.3% 675 CZK
q=66.7% 0 CZK</td></tr>
<tr><td rowspan="8">[1.2]
p=16.7% 540 CZK
q=83.3% 0 CZK</td><td rowspan="4">[1.2.1]
p=25.0% 540 CZK
q=75.0% 0 CZK</td><td rowspan="2">[1.2.1.1]
p=33.3% 540 CZK
q=66.7% 0 CZK</td><td>p=41.7% 540 CZK
q=58.3% 0 CZK</td></tr>
<tr><td>p=33.3% 675 CZK
q=66.7% 0 CZK</td></tr>
<tr><td rowspan="2">[1.2.1.2]
p=25.0% 720 CZK
q=75.0% 0 CZK</td><td>p=31.3% 720 CZK
q=68.7% 0 CZK</td></tr>
<tr><td>p=25.0% 900 CZK
q=75.0% 0 CZK</td></tr>
<tr><td rowspan="4">[1.2.2]
p=16.7% 810 CZK
q=83.3% 0 CZK</td><td rowspan="2">[1.2.2.1]
p=22.2% 810 CZK
q=77.8% 0 CZK</td><td>p=27.8% 810 CZK
q=72.2% 0 CZK</td></tr>
<tr><td>p=22.2% 1012.5 CZK
q=77.8% 0 CZK</td></tr>
<tr><td rowspan="2">[1.2.2.2]
p=16.7% 1080 CZK
q=83.3% 0 CZK</td><td>p=20.8% 1080 CZK
q=83.3% 0 CZK</td></tr>
<tr><td>p=16.7% 1350 CZK
q=83.3% 0 CZK</td></tr>
</table>

Table D.2: Decision 4: Investment decisions in the Step-by-step game

In Table D.3, we provide descriptive statistics of the participants randomly selected into playing the reward game first (column 1) compared to those playing the probability game first (column 2). In column 3, we display mean differences between the two values, and the p-value as a result of the test testing whether the mean difference equals zero. Except for two variables (the number of people in the household, and full understanding of the games), there is no significant difference between the two groups.

	Reward game	Probability game	Mean diff. (p-value)
Age	43.4693	43.4473	0.0219
			(0.336)
Female	0.4669	0.4675	-0.0006
			(0.112)
Number of inhabitants	3.1702	3.1680	0.0022
			(0.933)
Region	107.3806	107.3882	-0.0076
			(0.610)
Highest achieved education	5.4923	5.4870	0.0053
			(0.869)
The number of people in the household	2.6974	2.6994	**-0.0020**
			(0.062)
The number of kids in the household	1.5473	1.5479	-0.0006
			(0.339)
Net household income	35497.6289	35516.0156	-18.3839
			(0.696)
Net personal income	3.6442	3.6438	0.0004
			(0.718)
Head of household	0.6501	0.6497	0.0004
			(0.261)
Household financial decision maker	0.8144	0.8142	0.0002
			(0.566)
Smoking behavior	0.8416	0.8426	-0.0010
			(0.736)
Attend elections	0.7364	0.7373	-0.0009
			(0.949)
Healthy lifestyle	3.3759	3.3763	-0.0004
			(0.999)
Interview duration	1645.57	1644.6	0.9461
			(0.450)
Marital status	2.3333	2.3337	-0.0004
			(0.994)
Amount expected from the games	354.2458	354.3101	-0.0642
			(0.862)
Confidence to get award	5.2057	5.2071	-0.0014
			(0.805)
Employment type	4.3511	4.3550	-0.0040
			(0.164)
The highest education of the household head	1.9941	1.9964	-0.0024
			(0.343)
Full understanding of the games	0.4965	0.4970	**-0.0006**
			(0.085)
Risk averse (based on the general RA question)	5.1809	5.1822	-0.0014
			(0.902)
Risk averse (lottery)	3.9645	3.9609	0.0036
			(0.549)

Table D.3: Sample descriptive statistics and randomization balance

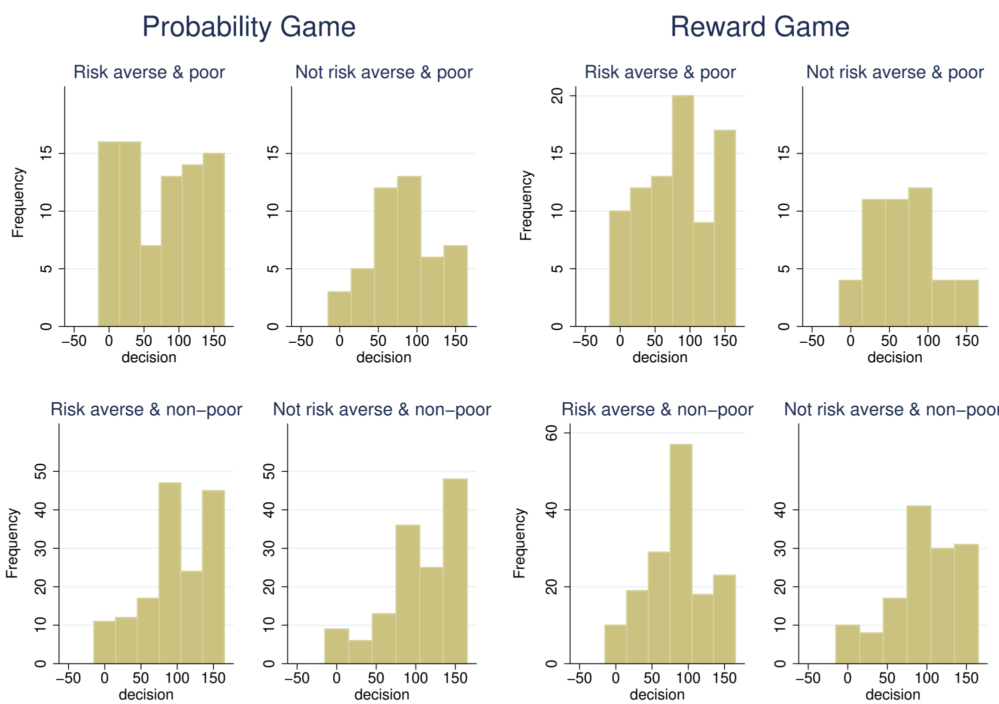
	Not Risk-averse	Risk-averse	Mean diff. (p-value)
Age	**41.6408**	**44.7680**	**-3.1272 (<0.0001)**
Female	**0.3879**	**0.5200**	**-0.1321 (<0.0001)**
Highest achieved education	5.5274	5.4660	0.0614 (0.566)
Net household income (CZK)	**37644.5**	**33990.0**	**3654.5 (0.0002)**
Net personal income	**21402.3**	**18588.0**	**2814.3 (<0.0001)**
The number of people in a household.	2.7241	2.6740	0.0501 (0.409)
The number of kids in a household.	1.5632	1.5340	0.0292 (0.477)
Marital status	2.3046	2.3540	-0.0494 (0.461)
Employment type	4.1868	4.4520	-0.2652 (0.173)
The highest education of household head	**1.7586**	**2.1500**	**-0.3914 (0.009)**
Job/position of household head	**0.9770**	**1.2200**	**-0.2430 (0.039)**
Household head	**0.6954**	**0.6200**	**0.0754 (0.001)**
Household financial decision maker	0.8276	0.8060	0.0216 (0.261)
Smoking behavior	0.8391	0.8420	-0.0029 (0.963)
Attend elections	0.7529	0.7260	0.0269 (0.216)
Healthy lifestyle	**3.5000**	**3.2900**	**0.2100 (0.0001)**
How much do you expect to win in today's games?	377.2270	337.8340	39.3930 (0.293)
How confident are you that you will win the award	**6.3276**	**4.4220**	**1.9056 (<0.0001)**

Table D.4: Comparison of people's characteristics by risk aversion

In Table D.4 we compare the difference between risk averse and not risk averse individuals. In line with existing literature, we observe that females and older people are significantly more risk averse. Risk averse participants have significantly lower personal income and live in a household with significantly lower household income. Risk averse participants do not differ in terms of highest achieved education, their employment type, marital status or household composition. While both groups expect on average the same return from the games, risk averse participants are significantly less confident about winning the awards.

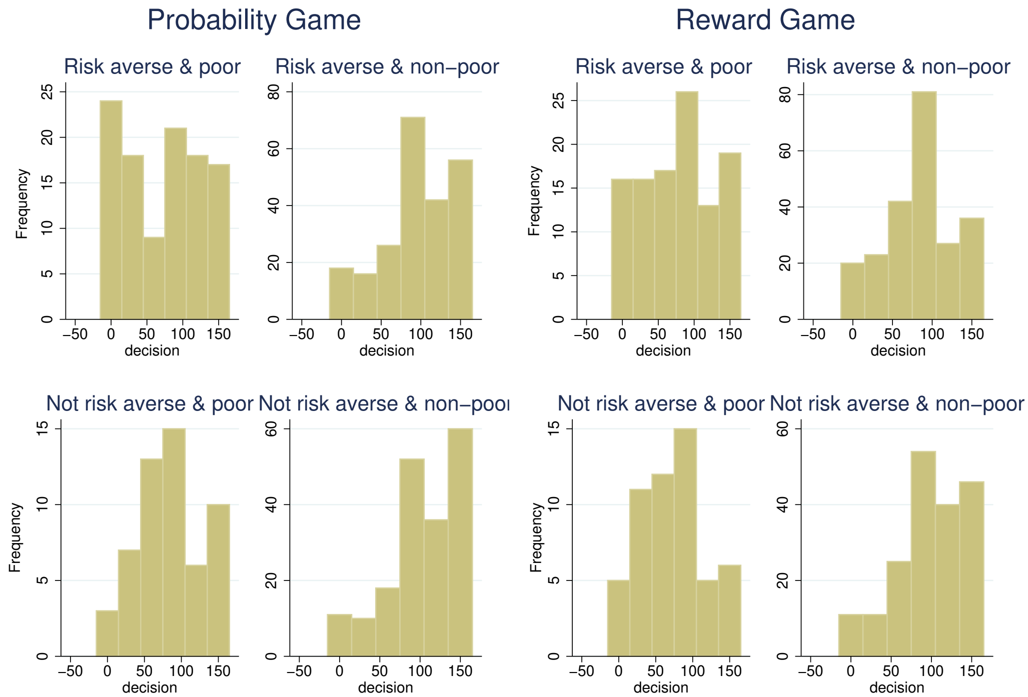
D.2 Robustness of the decision patterns

In this subsection, we present supportive evidence to our main results. In Figures D.3 and D.4 we show the investment decisions of the poor/non-poor risk/not risk averse respondents with full and poor understanding of the games in the probability and reward game. In both figures, rows divide the participants based on their household income (the upper row represents the poor with household income lower than 20,000 CZK, the lower row the participants with higher household income). The columns divide the participants based on their risk aversion (left column represents risk averse individuals, right column risk neutral and risk loving individuals). Even among people without full understanding the choices of the poor risk-averse individuals are concentrated around extreme values, while in the reward game they concentrate around middle value, keeping some money untouched. Richer risk averse individuals have a higher tendency to invest into higher values or maximum in the probability game, but the pattern in the return game to invest some positive amount remains.



Note: Each histogram shows the distribution of the investment decisions of people with full understanding in either probability or reward games. In the first row we observe the investment decisions of the poor people, in the second row the investment decisions of non-poor participants. In each game, first column represents the decisions of risk averse participants and the second one the decisions of risk neutral and risk loving participants.

Figure D.3: Investment decisions by risk aversion and household income; full understanding



Note: Each histogram shows the distribution of the investment decisions of people with good understanding in either probability or reward games. In the first row we observe the investment decisions of the poor people, in the second row the investment decisions of non-poor participants. In each game, first column represents the decisions of risk averse participants and the second one the decisions of risk neutral and risk loving participants.

Figure D.4: Investment decisions by risk aversion and household income; good understanding

In Figures D.5 up to D.8, we look at the investment decisions of the poor risk-averse respondents with full or good understanding, using general measure of risk aversion (in Figures D.5 and D.6) and the measure based on Dohmen et al. (2010) (in Figures D.7 and D.8). In all figures we are looking at the investment decisions of the same people in two different games (clean from order effects) and we see similar distribution shifts from a bimodal distribution in the probability game to a unimodal distribution in the reward game. In Figures D.6 and D.8 we see the differences even more pronounced. In these two cases we excluded a fraction of respondents who opted to invest equal amount in all three games (i.e., probability, reward as well as step-by-step game).

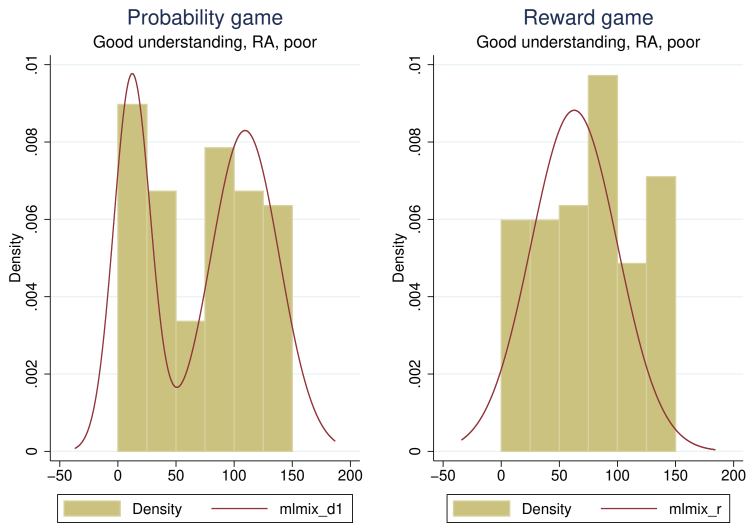


Figure D.5: Investment decision of poor risk-averse people with good understanding

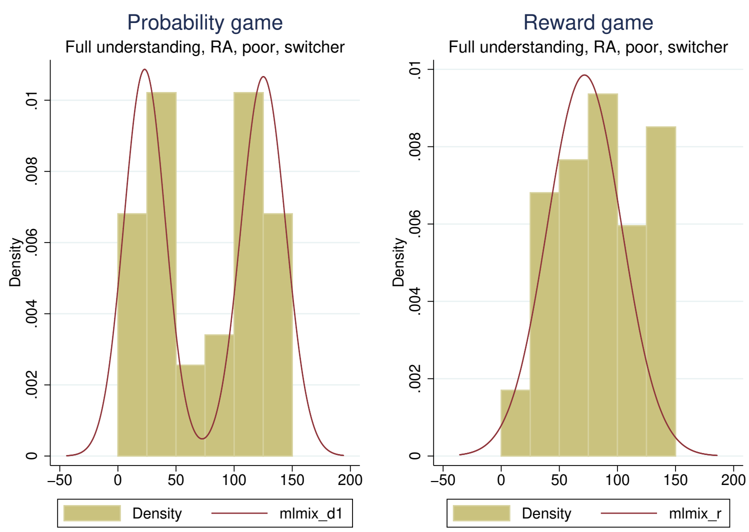


Figure D.6: Investment decision of poor risk-averse people with full understanding; excluding non-switchers

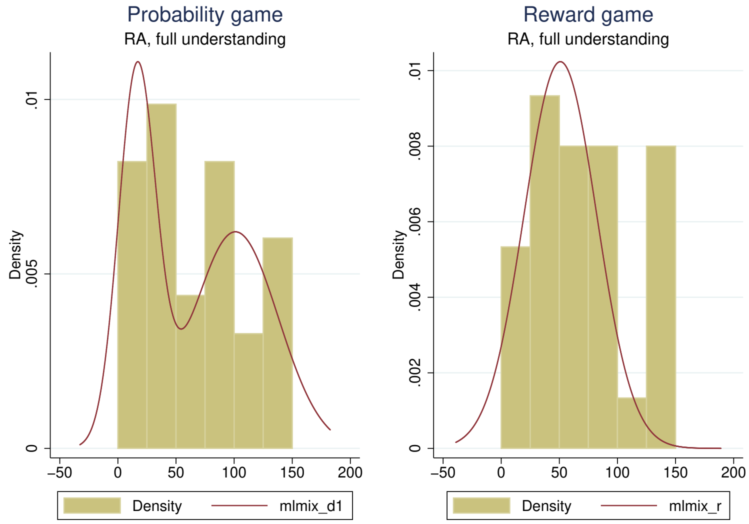


Figure D.7: Investment decision of poor risk-averse people with full understanding, risk aversion measure based on Dohmen et al. (2010)

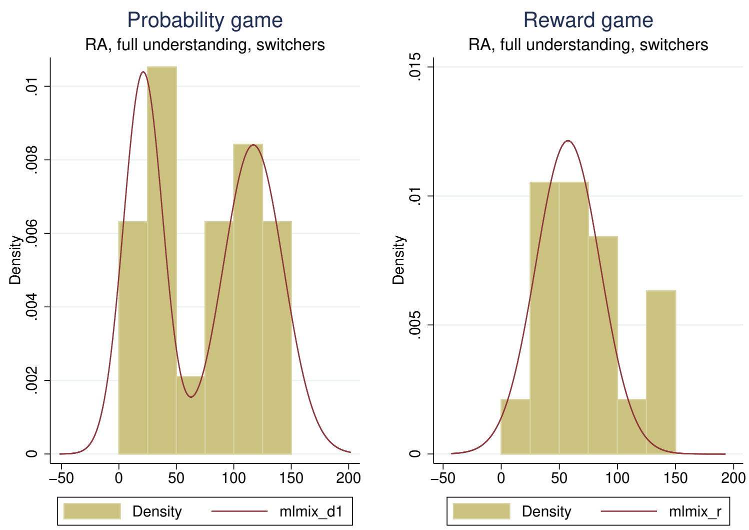


Figure D.8: Investment decision of poor risk-averse people with full understanding excluding non-switchers, risk aversion measure based on Dohmen et al. (2010)

In the following tables, we present the results from probit regressions when people did not understand the setup of the games fully (D.5), if we control for various covariates (D.6), if we use different measures of risk aversion (D.7), and if we divide people by their household income (D.8). In all tables we see that risk averse individuals tend to invest significantly more in 0 CZK, 120 CZk, and 150 CZ, and significantly less in 60 CZK or 90 CZK.

	Full understanding		Good understanding	
	Risk averse	Not risk averse	Risk averse	Not risk averse
Invested 0 CZK	**0.0295**	-0.0109	0.0179	-0.0083
	(0.014)	(0.022)	(0.013)	(0.018)
Invested 30 CZK	-0.0127	-0.0437	-0.0149	-0.0207
	(0.022)	(0.027)	(0.018)	(0.022)
Invested 60 CZK	**-0.0759**	-0.0164	**-0.0714**	-0.0249
	(0.028)	(0.031)	(0.023)	(0.027)
Invested 90 CZK	**-0.0717**	-0.0219	-0.0446	-0.0083
	(0.032)	(0.036)	(0.028)	(0.032)
Invested 120 CZK	**0.0464**	-0.0164	**0.0595**	-0.0124
	(0.025)	(0.033)	(0.022)	(0.028)
Invested 150 CZK	**0.0844**	**0.1093**	**0.0536**	**0.0747**
	(0.030)	(0.035)	(0.024)	(0.030)
n	474	366	523	328

Table D.5: Differences in investment probabilities between the two games, by the level of understanding and risk-aversion

	Model 2		Model 3		Model 4	
	RA	Not RA	RA	Not RA	RA	Not RA
Invested 0 CZK	**0.0292**	-0.0108	**0.0253**	-0.0107	**0.0185**	-0.0037
	(0.014)	(0.022)	(0.013)	(0.022)	(0.009)	(0.014)
Invested 30 CZK	-0.0118	-0.0431	-0.0128	-0.0398	-0.0123	**-0.0389**
	(0.022)	(0.026)	(0.022)	(0.025)	(0.021)	(0.021)
Invested 60 CZK	**-0.0744**	-0.0164	**-0.0744**	-0.0164	**-0.0688**	-0.0073
	(0.027)	(0.031)	(0.027)	(0.032)	(0.025)	(0.027)
Invested 90 CZK	**-0.0714**	-0.0224	**-0.0721**	-0.0225	**-0.0755**	-0.0240
	(0.032)	(0.037)	(0.032)	(0.037)	(0.034)	(0.039)
Invested 120 CZK	**0.0465**	-0.0162	**0.0464**	-0.0155	**0.0462**	-0.0154
	(0.025)	(0.033)	(0.025)	(0.033)	(0.024)	(0.033)
Invested 150 CZK	**0.0848**	**0.1091**	**0.0839**	**0.1106**	**0.0861**	**0.1261**
	(0.030)	(0.035)	(0.030)	(0.035)	(0.030)	(0.037)
n	474	366	474	366	474	366

Note: RA stands for risk averse. The estimated coefficients represent the marginal values and measure how much more likely are people invest in the amount if they play probability game compared to the return game. The numbers in brackets are standard errors. In Model 2 we also control for the order of the games, in model 3 we control for the order and household income, and in model 4 controls for all covariates.

Table D.6: Differences in investment probabilities between the two games, by different covariates

	Model 5		Model 6		Model 7	
	Simple	Covar	Simple	Covar	Simple	Covar
Invested 0 CZK	**0.0295**	**0.0185**	0.0167	0.0121	**0.0343**	0.0028
	(0.014)	(0.009)	(0.014)	(0.011)	(0.020)	(0.014)
Invested 30 CZK	-0.0127	-0.0123	-0.0250	-0.0279	-0.0147	-0.0170
	(0.022)	(0.021)	(0.019)	(0.017)	(0.026)	(0.022)
Invested 60 CZK	**-0.0759**	**-0.0688**	**-0.0667**	**-0.0169**	**-0.0686**	**-0.0598**
	(0.028)	(0.025)	(0.023)	(0.022)	(0.028)	(0.025)
Invested 90 CZK	**-0.0717**	**-0.0755**	**-0.0472**	**-0.0495**	-0.0196	-0.0198
	(0.032)	(0.034)	(0.026)	(0.027)	(0.034)	(0.037)
Invested 120 CZK	**0.0464**	**0.0462**	0.0083	0.0079	-0.0049	-0.0007
	(0.025)	(0.024)	(0.022)	(0.021)	(0.029)	(0.024)
Invested 150 CZK	**0.0844**	**0.0861**	**0.1139**	**0.1159**	**0.0735**	**0.0750**
	(0.030)	(0.030)	(0.024)	(0.024)	(0.030)	(0.030)
n	474	366	474	366	474	366

Note: The estimated coefficients represent the marginal values and measure how much more likely are people invest in the amount if they play probability game compared to the return game. The numbers in brackets are standard errors. In Model 5 we use risk aversion measure based on the general risk aversion question, in Model 6 we use risk aversion measure inspired by Dohmen et al. (2010), and in Model 7 we look at the very risk averse based on the Dohmen et al. (2010) measure. Regressions in columns titled Simple control for the treatment dummy only, regressions in columns titled Covar control also for other covariates.

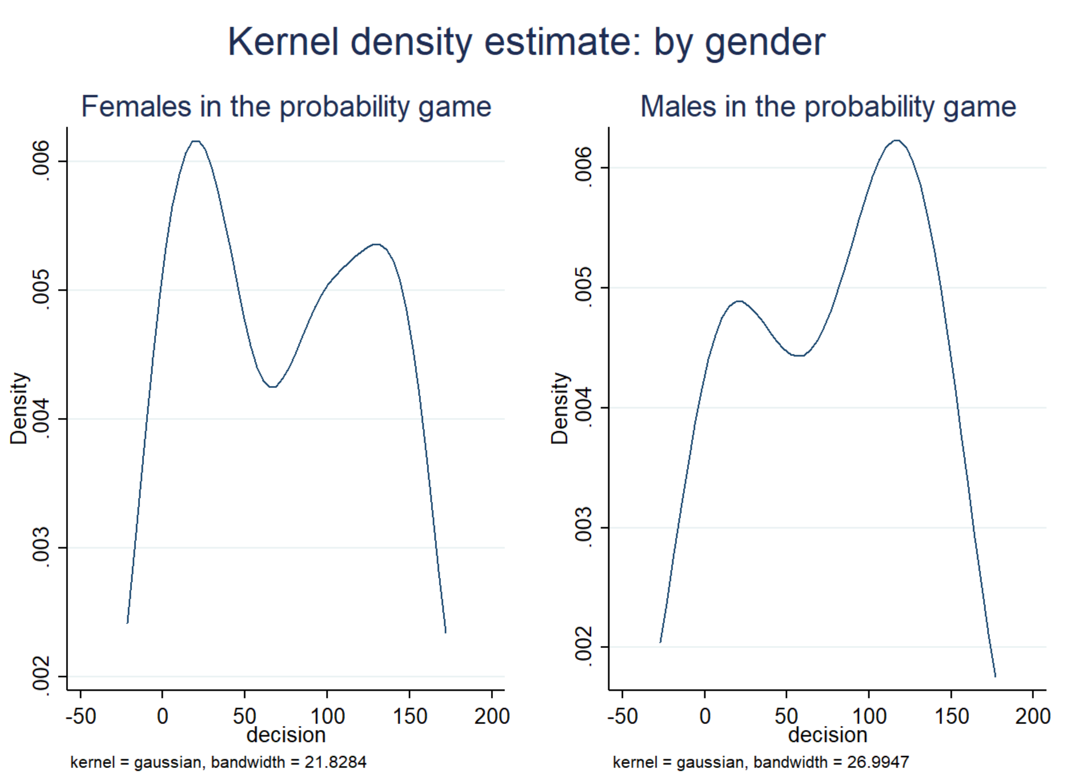
Table D.7: Differences in investment probabilities between the two games, by various measures of risk aversion

	Low HH income	Medium HH income	High HH income
Invested 0 CZK	**0.0741**	**0.0303**	-0.0351
	(0.029)	(0.017)	(0.025)
Invested 30 CZK	0.0494	**-0.0606**	-0.0175
	(0.043)	(0.028)	(0.047)
Invested 60 CZK	**-0.0741**	**-0.0909**	-0.0526
	(0.042)	(0.046)	(0.058)
Invested 90 CZK	**-0.0864**	0.0101	**-0.1930**
	(0.047)	(0.049)	(0.077)
Invested 120 CZK	0.0617	<-0.0001	**0.1053**
	(0.041)	(0.035)	(0.060)
Invested 150 CZK	-0.0247	**0.1111**	**0.1930**
	(0.046)	(0.047)	(0.064)
n	162	198	114

Note: The estimated coefficients represent the marginal values and measure how much more likely are people invest in the amount if they play probability game compared to the return game based on their household income. The numbers in brackets are standard errors. In column 1, we see that the poor respondents are more likely to invest nothing in the probability game compared to the reward game and are less likely to invest into 60 CZK or 90 CZK. The respondents with medium household income invest in the probability game significantly more into minimum or maximum amounts and in the reward game they invest significantly more in some positive but not extreme amounts. And the rich respondents have a tendency to invest significantly more into the maximum in the probability game.

Table D.8: Differences in investment probabilities between the two games, by household income

In Figure D.9 we present kernel density estimates of the investment choices in the probability game by gender. Females are known to be more risk averse. The figure suggests that in the probability game, females are more inclined to invest into minimum while males are more inclined to invest into maximum.



Note: Smoothed density function of the distribution of investment choices of females and males in the probability game, estimated using a Gaussian kernel.

Figure D.9: Comparison of density functions of the distribution of investment choices, by gender