# Equity-based microfinance and risk preferences[*]

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**Abstract**

The microfinance industry serves over 140 million borrowers worldwide, and has been hailed as a means of fighting poverty and stimulating growth of small businesses in low- and middle-income countries. Yet evidence from several countries suggests a negligible average impact of microcredit on the performance of small businesses. In this paper, I explore the impact of equity-like microfinance contracts with performance-contingent payments, which provide a greater amount of risk-sharing than the standard rigid microcredit contract. I conduct artefactual field experiments with a sample of business owners who were participating in two broader field experiments in Kenya and Pakistan that had provided their businesses with large capital injections. I find that contracts with performance-contingent repayments outperform standard microcredit contracts, by stimulating more profitable investment choices, especially for the most risk-averse individuals. Loss-averse individuals also particularly value equity-like contracts, which provide downside protection in return for upside profit sharing. However, individuals who exhibit non-linear probability weighting prefer debt contracts, especially in the presence of a skewed profits distribution (where there is a low probability of very high outcomes, which such individuals overweight). I structurally estimate these three distinct dimensions of risk preferences using a prospect-theoretic model and show that relatively simple tweaks to contract design (specifically, capping upside profit sharing) can improve the feasibility of equity-like contracts. By utilising financial technology developments that improve screening and monitoring, and by taking into consideration three distinct elements of risk preferences, financial institutions that cater to small firms can unlock new forms of performance-contingent capital to provide better risk-sharing and improve client welfare.

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# 1 Introduction

The microfinance industry serves over 140 million borrowers worldwide (Rigol & Roth, 2021), it has been hailed as a means of fighting poverty and stimulating growth of small businesses in low- and middle-income countries, and it has led to a Nobel Peace Price for Muhammad Yunus and Grameen Bank. The classic microcredit contract, characterised by a rigid and high-frequency repayment structure, has many theoretically appealing features that are particularly relevant in settings with high asymmetric information and low contract enforcement ability. These contractual features can mitigate problems of adverse selection and moral hazard in lending to low-income individuals, and microfinance institutions (MFIs) were indeed successful in rapidly expanding microcredit programmes while maintaining very high repayment rates, often over 99% (Cai et al., 2021). Yet the first wave of experimental evaluations of the classic microcredit product identified negligible average impacts on borrowers, including little impact on the profits of the small businesses for whom it was hoped that microcredit would stimulate entrepreneurship and growth in developing countries (Banerjee, Karlan, & Zinman, 2015). These disappointing results are particularly puzzling in light of several studies that provided capital as grants to microenterprises and identified very high returns among these capital-constrained small firms (Bandiera et al., 2017; De Mel, McKenzie, & Woodruff, 2008, 2019; Fafchamps, McKenzie, Quinn, & Woodruff, 2014).

Motivated by the puzzle of why the classic microcredit contract was not able to unlock these high underlying business returns, a growing recent literature has sought to adapt the structure of the classic (rigid) microcredit contract to better align required repayments with income streams. This has often taken the form of grace periods that clients can exercise to skip loan payments in a particular period. The majority of the results from this literature have shown positive impacts of more flexible microcredit loans in terms of stimulating greater business investment and leading to higher profits, but sometimes at the cost of higher default rates (Barboni & Agarwal, 2021; Battaglia, Gulesci, & Madestam, 2021; Brune, Giné, & Karlan, 2022; Crepon, De Haas, Devoto, & Parriente, 2022; Field, Pande, Papp, & Rigol, 2013). Thus, while attractive to many borrowers, such contracts may be unattractive to MFIs in equilibrium since they expose them to greater downside risk of loan defaults, while the MFIs do not capture any of the upside from the more profitable business investment generated by the greater repayment flexibility.

In this paper, I investigate a more direct way to link repayments to income, and to align the performance of microcredit borrowers and lenders. Specifically, I explore the impact of introducing 'equity-like' microfinance contracts into the portfolio of products that MFIs offer to their small business clients. Equity-like microfinance contracts (henceforth, 'microequity'), characterised by performance-contingent repayments, may be preferred to more rigid debt contracts for financing the investments of the many small businesses that have high but volatile returns, and especially for the most risk-averse business owners (De Mel, McKenzie, & Woodruff, 2019; Fischer, 2013). I draw on insights from behavioral finance, which have not previously been applied in the development economics and finance literature, to demonstrate the nuanced role of risk preferences as a mechanism. I work with a policy-relevant sample at a critical time for their decision making: over 700 microenterprise owners who had expressed an interest in expanding their business. These individuals were participating in two separate field experiments (in Kenya and Pakistan) that offered them a relatively large amount of financing. Kenya represents an ideal setting to leverage technological developments to test out novel financial contract structures, given its position as the mobile money capital of the region, which has led to a significant increase in digital financial literacy (Suri, 2017). Pakistan also presents an important setting to test equity-like contracts, for a different reason – an equity-based product, though not restricted to any one particular religion or group, has the potential to reach hundreds of millions of financially excluded Muslim business owners (El-Gamal, El-Komi, Karlan, & Osman, 2014; IMF, 2015; Nimrah, Michael, & Xavier, 2008; World Bank, 2012).

In the first part of this paper, I use artefactual field experiments to explore preferences for microequity compared to microcredit and the impacts of microequity on investment behavior. I show that microequity contracts led to business owners choosing more profitable investments than under debt financing (a 0.35 standard deviation increase in expected return). Using simple (non-parametric) risk preference measures elicited from incentivised behavioral games, I show that the increase in expected return is greatest for the most risk-averse and the most loss-averse business owners, which suggests the benefit of the implicit insurance and downside protection provided by microequity contracts. I also validate the predictive power of the risk preference measures "outside of the lab", by showing that they are strongly correlated with take-up of the actual financial product that was offered in each of the two broader field experiments from which business owners are drawn.

Results from the first part of the paper suggest significant positive impacts of microequity on business investment behavior, with particular benefits for the most risk- and loss-averse individuals. Performance-contingent contracts were not previously optimal in many settings in low- and middle-income countries due to costly state verification, adverse selection and moral hazard (Stiglitz, 1975; Stiglitz & Weiss, 1981; Townsend, 1979). Recent financial technology developments mitigate some of the traditional supply-side challenges to the implementation of microequity contracts, suggesting that MFIs could offer such contracts to some of their higher-potential clients. MFIs could capture some of the upside from the resulting higher-expected-return microenterprise investments, while improving client welfare by providing downside risk-sharing. However, in the second part of the paper, I propose a novel *demand*-side challenge to implementing microequity contracts. To more explicitly explore the welfare impacts of different counterfactual contract designs, it is necessary to go beyond simple non-parametric proxies for risk aversion. I proceed by structurally estimating the three risk preference parameters of a Cumulative Prospect Theory model. The artefactual field experiment provides an ideal setting to estimate individual-level risk preferences and explore welfare consequences of introducing new financial contracts, controlling for several potential confounds that would exist in the field (Barberis, 2013; G. Harrison & Ng, 2016). This is particularly true for richer models of risk preferences that go beyond just utility curvature, and especially for measuring probability weighting (the possibility that individuals use transformed rather than objective probabilities for decision-making), in which there is a fundamental identification problem in separating probability weighting from biased beliefs (Barberis & Huang, 2008; Dimmock, Kouwenberg, Mitchell, & Peijnenburg, 2021). There is increasing evidence that probability weighting has an impact on asset pricing, especially in the case of positively skewed returns distributions (Barberis, 2013).[1] In the development economics and finance literature, there is relatively little work on the interaction of non-expected-utility measures of risk preferences and small business investment and growth, despite a vast literature in behavioral development economics (Kremer, Rao, & Schilbach, 2019).[2] If a significant share of business owners exhibit probability weighting, such a behavioral mechanism may be particularly important in low- and middle-income countries, where firm outcome distributions are particularly skewed compared to high-income countries (Hsieh & Olken, 2014).

Results from the second part of the paper do reveal that a significant share of individuals exhibit probability weighting (overweighting of small probabilities), as well as a significant share who are loss averse. This provides a new perspective on the constraints to implementation of microequity contracts, which would not be evident within a simple expected utility framework where risk preferences are fully captured by utility function curvature. I find that individuals with greater utility curvature do have a greater preference for microequity contracts, as one would also expect from the standard expected utility framework. Individuals with greater utility curvature also choose higher-risk, higher-return investments when financed with equity rather than debt contracts. The more nuanced result comes from the two other dimensions of risk preferences in the prospect-theoretic framework: loss aversion, and probability weighting. I find that most business owners are loss-averse, with a loss aversion parameter of 2.04, firmly within the range of 2.00 to 2.25 that has been estimated in the literature (Brown, Imai, Vieider, & Camerer, 2021; DellaVigna, 2018; Kremer et al., 2019). Loss aversion provides another strong motivation for microequity contracts: loss-averse individuals are particularly sensitive to losses compared to gains, and they value the downside protection of equity contracts, in return for which they are more willing to share the upside.

[1] Holzmeister et al. (2020) provide global survey evidence that skewness matters much more for investment decisions than variance, despite return volatility being the most common risk measure in academic models.

[2] An exception to this is Carney, Kremer, Lin, and Rao (2022), who show the benefits to loss-averse clients of asset-collateralised loans for consumer goods.

However, the third dimension of risk preferences — probability weighting — which has received very little attention in the development economics and microfinance literature, works in the opposite direction. I estimate a bimodal distribution for probability weighting, with a large group of individuals who exhibit an "inverse-S-shaped" probability weighting function (that leads to them significantly overweight small probabilities and to underweight large probabilities), and a smaller group of individuals with close to "standard" (linear) probability weighting.[3] I find that individuals who overweight small probabilities have *lower* demand for equity compared to debt, and benefit less from equity contracts. This is especially the case when they face a positively skewed distribution of business profits (which is the distribution observed in the data from the two broader field experiments from which participants are drawn, and likely also to be the case in many developing countries, where outcome distributions for firms are particularly skewed (Hsieh & Olken, 2014)). Specifically, individuals who exhibit probability weighting underweight the (objectively high) probability of relatively low-profit outcomes, which is where the downside protection of equity contracts would be most valuable. Importantly, they also overweight the (objectively low) probability of obtaining very high profits, which they would have to share with the capital provider under an equity contract.

In the final part of the paper, I discuss implications for unlocking new forms of performance-contingent capital for small firms in developing countries, while taking into consideration risk preferences when evaluating welfare, but without trying to explicitly screen for or change people's risk preferences (which are likely deeply embedded (Fehr-Duda & Epper, 2012)). I use counterfactual contract simulations to show that a hybrid contract that contains both debt- and equity-like features can improve welfare for individuals who overweight small probabilities. It does so by providing the benefit of performance-contingent repayments — downside loss-sharing — while capping the upside for the capital provider in the very high profit state of the world (which is subjectively overweighted by such individuals, but not so by a more sophisticated financial institution). In the conclusion, I discuss the potential for implementing such contracts on a large scale, especially in light of the significant uptake of digital financial technology in low-income countries since the outbreak of Covid-19.[4] Designing financial products well-suited to the risk preferences of clients may also be driven by legal requirements in the future; for example, those defined in the Markets in Financial Instruments Directive (MiFID).

[3] It is important to note that, due to the controlled setting of the artefactual field experiment, the estimated probability weighting function is not being driven by subjective probabilities, but rather a distortion of the true objective probabilities presented to participants in the investment games. For example, individuals may agree that the probability of a fair coin landing on heads is 0.5, but in their decision-making they distort that probability (Kahneman, 1979; Wu & Gonzalez, 1996). The main effect of the weighting function is to overweight the tails of the distribution it is applied to (Barberis & Huang, 2008).

[4] Such hybrid contracts, while novel in this context, are increasingly being used in high-income settings. For example, digital payments firms in many countries provide income-contingent loans through their point of sales system (Rishabh & Schäublin, 2021).

While the MiFID asks banks to collect information on clients' risk preferences (Article 36(4), The European Parliament and the European Council, 2006), the directive is silent about how such an ambitious goal can be achieved (Erner, Klos, & Langer, 2013).

This paper contributes by drawing together two distinct strands of research: microfinance and behavioral finance. There is an extensive theoretical and empirical literature investigating the impact of microcredit contracts (Cai et al., 2021). In their summary of the first wave of microcredit impact evaluations, Banerjee et al. (2015) identify the following key challenges for the next generation of microfinance studies: (i) investigating how innovations to microfinance contract structure can improve take-up rates and effectiveness; (ii) addressing the limited evidence on graduated borrowers; and (iii) broadening our understanding of non-credit microfinance activities. Further, De Mel, Mckenzie, and Woodruff (2019) highlight the lack of conceptual work on microequity contracts.[5] I contribute to these objectives, by investigating the viability of equity-like contracts, using a highly relevant sample of existing small business owners who are looking to expand with the purchase of a fixed asset. My paper is also close in spirit to Fischer (2013), who uses an artefactual field experiment to overlay profit sharing on top of joint liability credit arrangements, and finds that the inclusion of equity-like features can incentivise higher risk-return investments, especially for the most risk-averse. He measures risk aversion using a simple elicitation exercise based on an expected utility framework. In using a broader conception of risk preferences than is mostly taken in the development economics and microfinance literature, I also respond to increasing calls for more work on "behavioral firms" in developing countries (Kremer et al., 2019). I demonstrate the nuanced result that the two main departures from expected utility (reference-dependent preferences and probability weighting) may actually work in opposite directions when it comes to the effect of financial contract structure, which can be taken into consideration to design more effective financing contracts for small businesses.

In taking a prospect-theoretic approach to investigating investment behavior, I draw upon a growing literature in behavioral finance and asset pricing that has thus far focused almost exclusively on high-income countries. Insights on the role of reference-dependent preferences for investment behavior include the seminal work of Barberis and Huang (2008); Benartzi and Thaler (1995); Shefrin and Statman (2000), as well as several important more recent contributions (Barberis, Jin, & Wang, 2019; Imas, 2016).[6] A smaller literature has focused on the role of the often neglected second component of non-expected-utility models, probability weighting. Barberis and Huang (2008) establish the asset pricing implications of skewness-loving preferences, and several other important contributions demon-

[5] An exception would be the literature on a related contractual arrangement, sharecropping, in which there is extensive theoretical and empirical work (Burchardi, Gulesci, Lerva, & Sulaiman, 2019; Stiglitz, 1975; Stiglitz & Weiss, 1981).

[6] See also Abdellaoui, Bleichrodt, and Paraschiv (2007); Berkelaar, Kouwenberg, and Post (2004); Camerer (2004); Carlson and Lazrak (2015); D. A. Chapman and Polkovnichenko (2011); He and Zhou (2011); Polkovnichenko (2005); Wakker and Deneffe (1996).

strate how probability weighting can explain many financial market phenomena (Carlson & Lazrak, 2015; D. A. Chapman & Polkovnichenko, 2009; De Giorgi & Legg, 2012; Fehr-Duda & Epper, 2012; Polkovnichenko & Zhao, 2013; Prelec, 2000). My results are also consistent with recent work by Dimmock et al. (2021), who show that individuals who exhibit non-linear probability weighting and overweight low-probability tail events (such as making very large profits from their investment decisions) have a "preference for skewness" in investment choices. Spalt (2013) shows that overweighting of small probabilities leads individuals to overvalue deeply out-of-the-money options, which employers can exploit in designing compensation packages. I demonstrate the flipside of this – small business owners with non-linear probability weighting are much less likely to "*sell* skewness" by entering into equity contracts that share profits in overweighted high-profit states of the world. I also provide what to my knowledge is the first piece of evidence that loss-averse business owners have a greater preference for equity financing and choose more profitable investments under equity contracts compared to debt financing, and I show this using both "cleanly" estimated risk preferences as well as data on business decisions "outside of the lab". While the business owners in my sample manage relatively small firms by high-income country standards, such small firms account for a large share of employment in many low- and middle-income countries. A key challenge for many countries is how to stimulate growth for such firms, and there is increasing academic and policy interest in addressing financial constraints to the most growth-oriented of these businesses. Further, while poor by high-income standards, these small business owners are experts in decision-making under risk. They have to deal with frequent hazards such as droughts, floods, pests, and diseases that affect their investments, utilising often very complex and sophisticated forms of risk management, where getting the decisions right is a matter of life and death, (Collins, Morduch, Rutherford, & Ruthven, 2009; Fafchamps, 2003; Verschoor & D'Exelle, 2020).

In Section 2, the setting of the studies in Kenya and Pakistan is described. Section 3 outlines the experimental design, with reduced form results presented in Section 4. Section 5 presents the estimation of risk preference parameters, and welfare analysis under different counterfactual contracts. Section 6 concludes.

# 2 Study setting

I conduct artefactual field experiments with over 700 microenterprise owners who were taking part in two separate microfinance field experiments in Kenya and Pakistan, which are described in more detail in Bari, Malik, Meki, and Quinn (2021) and Cordaro et al. (2022). The artefactual field experiment consisted of a series of investment games, conducted during a baseline workshop with business owners before they were randomly assigned to microfinance contracts in the broader field experiments. This policy-relevant sample of growth-oriented business owners – at a moment when they are looking to expand their operations through the financing of a large asset – provides an ideal setting to explore the preference for and effect of microequity contracts, since equity-based contracts are unlikely to be appropriate for subsistence-level microenterprises who have little intention in expanding their business operations.

The first experiment was implemented in Pakistan between 2017 and 2018. Pakistan presents an ideal setting to test equity-like contracts – an equity-based product, though not restricted to any one particular religion or group, has the potential to reach hundreds of millions of financially excluded Muslim business owners (El-Gamal et al., 2014; IMF, 2015; Nimrah et al., 2008; World Bank, 2012). Microfinance has grown rapidly in the country, with the number of active borrowers more than doubling from 2014 to 2019 and the total loan portfolio increasing by 400% (MIX, 2019; Pakistan Microfinance Network, 2019, 2020b). The average loan amount is approximately $300, typically to be repaid in 12 months, and at interest rates ranging from 0 to 40%. Of all loans, approximately 70% are structured as individual-liability. Prior to Covid-19, the sector had maintained very low default rates, with write-offs less than 1% of the gross loan portfolio (Pakistan Microfinance Network, 2019). As of 2019, there were 46 registered microfinance providers in Pakistan, falling into two categories, which have quite different funding structures: microfinance banks (MFBs), and non-bank microfinance companies (NBFCs).[7]

I worked with Akhuwat, a NBFC. As of 2019, Akhuwat was the largest microfinance provider in the whole of Pakistan in terms of both geographical spread as well as number of borrowers, with a market share of around 13%, comprising over 891,000 active borrowers across 811 branches, and an outstanding portfolio of PKR 16.4 billion (approximately US$106 million at the prevailing market rates) (Pakistan Microfinance Network, 2020a). Akuwat is based in Lahore, and I sampled from microenterprises in and around Lahore that had passed a relatively simple screening process of having graduated from repaying small-scale business loans, and reaching the maximum borrowing amount of approximately $475. Clients who had expressed an interest in expanding their business with the purchase of a fixed asset (up to the value of $1,900) were invited to a baseline workshop, where enumerators conducted a detailed household survey and incentivised behavioral games to elicit risk preferences. The investment games used in this paper took place during this workshop, which lasted approximately half a day, and before any of the sample was randomly assigned to be offered the microfinance contract. Detailed summary statistics are presented in the appendix. The average participant

[7] The key distinction concerns deposits: MFBs are permitted to accept deposits, whereas NBFCs are not. For this reason, MFBs are regulated by the central bank (whereas NBFCs are regulated by the securities commission). MFBs and NBFCs each serve around half of active borrowers. MFBs' primary source of funding is public deposits, with borrowing constituting less than 10% (borrowing is mostly from local banks and development finance institutions). About 75% of funds for NBFCs come from debt, provided mainly from the apex funding agency, the Pakistan Microfinance Investment Company, which provides subsidised loans to NBFCs (Malik et al., 2020).

was 38 years old, with eight years of formal education, and ten years of experience in their current business. The mean number of employees was just above one. The most popular business sector was rickshaw driving (20%), followed by clothing and footwear production (11%), food and drink sales (10%), and retail trade in the form of fabric and garment sales (7%). Average monthly business profits were $245 (median $219), and average monthly household consumption expenditure was $211 (median $180), which puts the average household in the second quintile of the overall distribution for household consumption in Pakistan. As a comparison to two of the most prominent studies on capital returns in microenterprises, average microenterprise profits in De Mel et al. (2008) and Fafchamps et al. (2014) were approximately $25. The average business in my sample is much larger in terms of business profits, which is unsurprising given that the target population was graduated borrowers.

The second experiment was implemented in Kenya between 2017 and 2020. Kenya represents an ideal setting to leverage technological developments to test out novel financial contract structures, given its position as the mobile money capital of the region, which has led to a significant increase in digital financial literacy (Suri, 2017). I collaborated with one of the largest multinational food companies in the world, as part of a larger project described in Cordaro et al. (2022). The company had developed a route-to-market micro-distribution program using self-employed micro-distributors in Kenya. The distribution system is built around small warehouses (called 'stockpoints'), which are located in both rural and urban areas. Stockpoints receive deliveries of chewing gum, which they sell alongside various other products. Micro-distributors purchase chewing gum (as well as other products) from stockpoints, before selling to customers (often on foot). They initially purchase the gum from the stockpoints with an up-front discount to the market price, which must be paid in full. They additionally receive performance-related pay in the form of an end-of-month bonus via mobile money (M-Pesa) for every bag of gum sold. There is no obligation for distributors to sell gum exclusively, but selling the company's product is relatively profitable, and they have a strong incentive to stay in the program. This setting is common to many route-to-market distribution programs run by multinational corporations around the world.

I worked with micro-distributors within the company's supply chain who expressed an interest in purchasing a fixed asset for their business. This was a single type of transportation asset – a bicycle (in contrast with the Pakistani setting, where sector of operation and asset choice was much more heterogeneous). The unique setting of the experiment, in particular the availability of administrative data on business performance, permitted the implementation of performance-contingent financing contracts in the broader field experiment (described further in the appendix). The average participant in the sample was 31 years old, with monthly sales from all micro-distribution activities of $995, and mean profits of $133. The artefactual field experiments were intentionally implemented using exactly the same procedure as the Pakistan experiment. The detailed household survey, risk preference elicitation exercises and investment games took place during the baseline workshop to the broader field experiment, lasting approximately half a day, and before any of the sample was randomly assigned to be offered microfinance contracts.

# 3 Experimental design

I now describe the activities in the artefactual field experiment, which provides an ideal setting to estimate individual-level risk preferences and investigate investment behavior, controlling for several potential confounds that would exist in the field (Barberis, 2013; G. Harrison & Ng, 2016). This is particularly true for richer models of risk preferences that go beyond just utility curvature, and I begin by explaining the process for eliciting risk preferences, which I use both in a non-parametric way for heterogeneity analysis in the reduced-form regressions in Seciton 4, as well as a more structural approach in Section 5 to explore the welfare consequences of introducing different financial contracts. I also provide evidence that these elicited risk measures have predictive power for actual business decisions made by individuals “outside of the lab”.

## 3.1 Measuring risk preferences

Participants in the Kenyan and Pakistani experiments were each asked 44 questions to measure risk preferences. This included domain-specific self-reported measures of risk attitudes as well as incentivised elicitation exercises involving choices over different investment options (binary lotteries that varied in payoffs and probabilities). This allows the construction of simple indices of general risk aversion, loss aversion and probability weighting, as well as structural estimation of parameters imposing specific functional forms for utility.

The self-reported measure of risk attitudes involved each business owner rating on a scale of 1 to 10 their willingness to take risks in the following domains: (i) their financial matters; (ii) their business; (iii) having faith in other people; and (iv) their general perception about whether they were a person fully willing to take risks or more likely to avoid risks.[8] I complement these self-reported measures with a more narrowly defined incentivised activity, using a certainty-equivalent elicitation technique that provided the best trade-off between comprehension and quality of data for this population of small business owners, as discovered through extensive piloting.[9] Respondents were posed a series of 30

[8] The questions were adapted from Dohmen et al. (2011), who show using a large sample that these measures were strongly correlated with risk taking in incentivised tasks. The authors also argue for the merit of such measures given their relative ease for participant understanding and implementation in the field. In my setting, I also find a strong correlation between the self-reported and the incentivised measures.

[9] See the appendix for a detailed discussion of the different methods considered, drawing upon the work of Barr and Packard (2002) , Vieider et al. (2015), Binswanger (1981), G. W. Harrison and Elisabet Rutström (2008), and Holt and Laury (2002).

questions, in which they were required to choose between a certain amount of money or an uncertain investment prospect, with two possible outcomes: (i) zero; or (ii) 1,000 units of local currency.[10] The appendix provides details on the script used to explain the activity (using business terminology and framing to aid comprehension), the diagrams displaying the investment choices, and the physical instruments used to explain probabilities. To allow for estimation of probability weighting, the 30 questions were split into three sets of ten, with variation in the probability of the good outcome in the uncertain investment prospect. In each set of ten questions, the participant had to choose between a risky prospect with probability of good outcome $p_g \in \{0.25, 0.50, 0.75\}$ and a certain amount of money, with the certain payment increasing from zero (a test of comprehension, since all of the risky prospects had non-zero expected value) up to 1,000, in increments of 100. For each set of ten questions, I calculate the certainty equivalent of the particular risky prospect offered in that set. I follow the method of Dimmock et al. (2021) and calculate a non-parametric measure of probability weighting as the difference in risk premium observed between the set of questions with $p_g = 0.25$ and those with $p_g = 0.75$, where the risk premium is defined as the difference between the certainty equivalent and the expected value of the prospect (the expected value for the prospect with $p_g = 0.25$ is 250 and for the prospect with $p_g = 0.75$ it is 750 ). The use of $p_g \in \{0.25, 0.50, 0.75\}$ as probabilities is also common in the literature (Humphrey & Verschoor, 2004a, 2004b). The benefit of the non-parametric approach is to avoid assuming a specific functional form for probability weighting. Further, if individuals use narrow framing (i.e. not integrating outcomes with existing wealth) and utility curvature affects the responses, taking the difference between the premiums largely removes the influence of curvature, because curvature affects all premiums similarly (Dimmock et al., 2021). In Section 5, I do impose some structure on the estimation in order to conduct counterfactual contract and welfare analysis using individual-level risk preference parameter estimates.

Finally, to measure loss aversion, business owners were asked ten questions, based on the method used in Bartling, Fehr, and Herz (2014), and very similar to that used in the large recent population representative survey of individual-level loss aversion by J. Chapman, Snowberg, Wang, and Camerer (2022). In each question, business individuals could accept or reject (walking away with zero) an equal-probability binary-outcome prospect that either paid 1,000 or incurred a loss of $x$, with $x$ beginning at 0 and gradually increasing to a loss of 1,000, in increments of 100. If a loss was incurred in the activity, then the amount would be taken from the participation fee of 1,000 that all business owners received for taking part in the broader survey and workshop for the field experiment i.e. it was a real loss from their payment for participating in the session. Before conducting all activities, participants were informed that at the end of the behavioral games session one of the incentivised activities would be selected for payment by physically drawing a ball from a bag, thereby requiring attentive responses

[10] All numerical quantities were displayed in Kenyan schillings or Pakistani rupees respectively, which happened to have a very similar exchange rate at the time of approximately one US dollar to 100 local currency.

to all questions, and allowing the use of relatively large amounts for payoffs (approximately three times median daily business profits for individuals in the sample).[11]

A natural question may arise as to whether these risk measures that were elicited in the more artificial "lab-in-field" setting have predictive power for actual business decisions made by individuals. In the appendix, I present evidence from "outside of the lab", which demonstrates the predictive power of these risk measures in the actual decisions taken by business owners in the broader field experiments from which the sample is drawn. Specifically, in the broader Pakistani experiment (Bari et al., 2021), where the two financing contracts on offer featured either a fixed repayment schedule or a more flexible repayment schedule, I find that the pre-specified certainty-equivalent risk measure is highly predictive of outcomes. Using that measure, the most risk-averse individuals have significantly higher take-up of the flexible repayment contract compared to the fixed repayment contract, they are more likely to use the flexible repayment option when faced with business shocks, and eventually they benefit more from the flexible contract in terms of business and household outcomes (compared to similarly risk-averse individuals who were only offered the fixed repayment contract). In the broader Kenyan experiment (Cordaro et al., 2022), where a number of different contracts were offered, including a fixed-repayment debt contract and an equity-like contract involving a 10% share of gross profits (which in that case were observable due to the availability of administrative data on stock purchases), the risk preference measures also have strong predictive power. Specifically, more risk-averse individuals have a significantly greater take-up of the equity contract compared to the debt contract. Similarly, more loss-averse individuals also have relatively greater take-up of equity contracts compared to debt. (The equity contracts also lead to significantly greater overall business profits than the debt contract). Finally, we see the opposite effect for individuals with non-linear probability weighting: they have relatively *lower* selection into equity contracts compared to their selection into debt contracts. In summary, the three risk preference measured used in this paper do have predictive power outside of the field using actual take-up data from the broader field experiments, with patterns of take-up that are consistent with the results that I describe in the following sections.

## 3.2 Microequity investment game

Following the risk preference elicitation activities, business owners were carefully introduced to the microequity investment game. The game was designed to mirror key aspects of "real-world" business investment behavior, with the aim of understanding the impact of different financing contract structures on investment choice, and the role of risk preferences. The game was calibrated using

[11] Charness, Gneezy, and Halladay (2016) show that paying for only a randomly selected subset of all activities is at least as effective as paying for all of them, and can actually be more effective by avoiding wealth effects and hedging within the behavioral games session.

pilot data and simulations from a simple model, described in the appendix. The microequity game was explained to participants using business-related vignettes, after which they were asked a number of questions to test understanding. The basic structure of the game involved each participant being given 200 units of local currency as initial capital.[12] There were two decision rounds, and in each round participants had a choice of five binary-outcome investment options. The 'bad' outcome for each of the investment options was a payoff of $x_b = 0$, and there were five possible 'good' outcomes $x_g \in \{100, 400, 700, 1000, 1300\}$. Each of the five outcomes had an associated cost: $c \in \{0, 100, 200, 300, 400\}$. The five investment options, illustrated in Table 1, therefore monotonically increase in expected return and risk. In each decision round, the participant was required to choose one of the investment options, conditional on it being affordable. Affordability for the first-round decision was determined by an initial amount of capital that was provided in the activity (the use of outside funds were not permitted). The second-round choice was a function of the first-round capital as well as the return from the realisation of the investment option chosen in the first round (that is, first-round proceeds were carried forward to second-round decisions, after which the game ended). Further details of the protocol, script and explanatory diagrams and instruments are provided in the appendix.

Table 1: **MICROEQUITY GAME INVESTMENT OPTIONS**

| INVESTMENT OPTION | COST | PAYOFF: LOW | PAYOFF: HIGH | EXPECTED PROFIT |
|---|---|---|---|---|
| 1 | 0 | 0 | 100 | 50 |
| 2 | 100 | 0 | 400 | 100 |
| 3 | 200 | 0 | 700 | 150 |
| 4 | 300 | 0 | 1000 | 200 |
| 5 | 400 | 0 | 1300 | 250 |

*Note*: This table illustrates the five investment options that business owners could choose from in the microequity game.

The experiment consisted of three types of treatment, with each business owner receiving each of the treatments (i.e. a within-subject experiment), with the order of treatments randomised:[13]

(i). **Control Treatment (CT):** The participant was provided with an initial capital endowment of 200, thereby limiting the choice of investment in the first round to the first three options (as

[12] I used real currency throughout, to maximise comprehension and avoid the artificial feel of tokens.

[13] It is important to note that, when communicating with participants, the word 'treatment' was never used, nor were the words 'debt' or 'equity'; instead the more neutral words 'loan contract' and 'sharing contract' were used (in the local language). The purpose of the experiment was to study the effect of the contractual structure on investment behavior, rather than any effect driven by using those possibly emotive terms.

investment options 4 and 5 cost above 200, though they may be affordable to the participant in the second round, if the outcome of the first round was high).

(ii). **Debt Treatment (DT):** In additional to the initial capital endowment of 200, participants received 500 as a zero-interest loan, to be repaid at the end of the two-round game. This mimics ‘external debt capital’ that the participant can use to finance higher risk-reward investment options if they wish (specifically, it opens up the possibility of choosing investment options 4 and 5).

(iii). **Equity Treatment (ET):** Like DT, the participant receives an initial endowment of 200 and external financing of 500, which in this treatment is in the form of equity-like performance-contingent financing. Specifically, the participant was required to share whatever wealth remained at the end of the second round, net of all gains and losses arising from the realisation of the investment choices. This treatment was also implemented twice, once with a sharing ratio of 25%, and once with a sharing ratio of 50%.

The net payoff to participants at the end of the investment game can be summarised in more general terms (and nesting the two treatments) by:

$$Y_T = W_T(1 - \alpha.ET) - DT.k, \tag{1}$$

where $Y_T$ is the net payoff to individuals after settling contractual payments, $W_T$ is final wealth after realisation of round 1 and round 2 investment outcomes, $k$ is the amount of external financing provided in DT and ET (i.e. 500 in the setup described above), and $\alpha \in \{0.5, 0.25\}$ controls the sharing ratio for ET.

The game was designed using simulations and a simple model with a utility maximising agent choosing investment options over multiple rounds to maximise terminal profits. To summarise the model predictions, agents are more likely to choose investment options with the highest expected return under the equity contract, compared to the debt contract, and the effect is greater for agents with greater utility curvature, and those that are more loss averse. The appendix provides further details of the model and simulations, including a number of robustness checks to demonstrate that the main predictions are not highly sensitive to a particular choice of initial capital level $W_0$, the amount of external capital $k$, or the number of rounds in the game $T$. The final parameters were chosen after piloting with the aim of a simple design that would allow an understanding of the implication of differences in contractual structure on investment behavior, including the role of risk preferences.[14]

# 4 Results

I now present results from the artefactual field experiments in Pakistan and in Kenya. The main empirical specifications, outcome variable and variables for heterogeneity analysis were pre-specified.[15] The sample consists of just over 3,000 observations, representing one decision per respondent for each of the four treatment arms, with the order of financing treatments randomised within subjects.

## Result 1: Equity leads to more profitable investment choices on average

Table 2 presents results from the following specification, estimated by OLS:

$$y_i = \beta_0 + \beta_1 DT_i + \beta_2 ET_i + \varepsilon_i, \tag{2}$$

where $y_i$ is the expected profit of the investment option chosen by individual $i$, $DT_i$ is a dummy for assignment to debt financing and $ET_i$ is a dummy indicating assignment to equity financing (initially pooling the contracts with 25% and 50% sharing ratios, and then splitting them). Standard errors are clustered at the individual level. $\beta_0$ represents the average expected return of investments chosen by individuals in the control group, whilst $\beta_1$ and $\beta_2$ represent the additional risk taken by debt-financed and equity-financed individuals relative to the control group, respectively.

Table 2 reports results. In each column, the dependent variable is the expected profit of the chosen investment option in that particular round. Column 1 displays results for just the Pakistani sample, with 2,392 observations, revealing that equity-financed business owners chose investment options in the first round of the game that were 0.35 standard deviations higher in expected return than the investments chosen by debt-financed individuals (with a $p-$value from a cross-coefficient test of less than 0.005). Column 2 repeats the exercise for the Kenyan sample, with very similar results: an effect size of 0.37 standard deviations ($p$ < 0.0005 for the difference between equity and debt). Column 3 pools the two

[14] Piloting suggested that a two-round activity would capture the main conceptual elements, while mitigating the risk of overburdening the participants given the length of the workshop. Further, I used a strategy method to elicit second-round investment decisions, rather than taking first-round decisions and drawing balls from a bag to realise the outcomes. This mitigated the risk of participants making second-round decisions because they felt that a particular investment option had good or bad luck based on the first-round realisation. Imas (2016) demonstrates the significant impact that prior outcome realisations can have on choice under uncertainty. The strategy method also permitted the elicitation of two data points: the second-round decision conditional on a: (i) low outcome from the first-round investment choice; (ii) a high first-round outcome.

[15] See https://www.socialscienceregistry.org/trials/2224. The pre-analysis plan refers to the Pakistan experiment; the Kenyan experiment was a later replication built into the wider field experiment, which was again pre-specified (see https://www.socialscienceregistry.org/trials/4789).

samples, and unsurprisingly reveals a statistically significant and economically meaningful difference between investment choice under equity and debt, with a pooled effect size of 0.35 standard deviations (or a 6.2% increase in absolute expected return, again with $p < 0.0005$ for the difference).

Column 4 investigates choices in the second round of the investment game, conditional on a low outcome in the first round, and finds that equity-financed business owners chose investment that were 0.49 standard deviations higher in expected return ($p < 0.0005$). Column 5 illustrates second-round decisions conditional on a *high* outcome in the first round, and reveals a smaller but still significantly positive effect size of 0.15 standard deviations ($p < 0.0005$). In columns 6 to 8, I test whether there is a differential impact between the 25% sharing contract or the 50% sharing contract — the magnitudes are almost identical and I cannot reject the null that there is no difference in effects ($p = 0.640$, $p = 0.650$, and $p = 0.178$ respectively across the three columns). In the next section, I proceed with the pooled equity indicator, and first-round investment decisions.

## Result 2: Equity is most impactful for risk- and loss-averse business owners, and least impactful for those who overweight small probabilities

Risk-averse business owners may particularly benefit from the insurance-like features of microequity, which provides greater risk sharing than fixed-repayment debt contracts. There may also be a distinct benefit for individuals with reference-dependent preferences, with loss-averse business owners valuing the downside protection of equity contracts: lower payments after a negative business shock and the reduced risk of ending up below their utility reference point, compared to a fixed-repayment debt contract. In return for that downside protection, they may be willing to share in the upside, so equity contracts may be ideally designed for business owners who are more sensitive to losses than gains. In the investment game, a salient reference point is the participation fee that was promised to all participants at the end of the workshop, as is commonly used in the literature (Verschoor & D'Exelle, 2020). Table 3 presents results from estimation of the following specification:

$$y_i = \beta_0 + \beta_1 DT_i + \beta_2 ET_i + \beta_3 HighX_i + \beta_4 DT_i * HighX_i + \beta_5 ET_i * HighX_i + \varepsilon_i, \quad (3)$$

where $HighX_i$ is a dummy for individuals with an above-median value of the heterogeneity variable $X_i$. A test of $H_0 : \beta_4 = \beta_5$ indicates whether individuals with higher values of $X_i$ are differentially affected by the equity and debt treatments. The heterogeneity variables tested are non-parametric indices that capture the three distinct dimensions of risk preferences that have been identified in the literature: (i) risk aversion (which is synonymous with utility curvature in expected utility models), (ii) loss aversion, and (iii) probability weighting. For (i), I aggregate the responses from the two sets of risk preference elicitation exercises (the domain-specific self-reported measures and the decisions in the certainty equivalent task). For (ii), I aggregate the number of decisions for which each individual rejected a prospect that contained an outcome in the loss domain. For (iii), I follow the methodology of Dimmock et al. (2021) and use the difference in risk premiums inferred from certainty equivalent elicitation questions where the probability of the good outcome $p_g$ was equal to 0.25 compared to $p_g = 0.75$. I then apply a median split to all indices, so that individuals with above-median values of $X_i$ have: (i) higher risk aversion; (ii) higher loss aversion; (iii) more non-linear probability weighting (the consequence of which turns out to be over-weighting of small probabilities, as found in the rest of the literature), respectively.

Column 1 of Table 3 shows that, in the control group, more risk-averse individuals choose investment options with a lower expected profit than more risk-tolerant individuals, as one would expect – a coefficient on $Risk\,averse$ of -10.74 (significant at the 1% level), compared to the control mean of 113.48. The coefficient on $Debt * Risk\,averse$ of +1.10 does not indicate a significant differential impact of the debt contract on the investment of risk-averse individuals compared to risk-tolerant individuals, while the coefficient of +10.05 on $Equity * Risk\,averse$ indicates that the most risk-averse individuals were significantly more likely to choose higher expected profit investments than the most risk-tolerant individuals under equity financing. This is confirmed using a cross-coefficient test of equality between $Debt * Risk\,averse$ and $Equity * Risk\,averse$ ($p$ = 0.015).

Column 2 addresses a similar question, exploring the role of loss aversion. The coefficient of -6.87 on $Loss\,averse$ (significant at the 1% level) indicates that more loss-averse individuals chose investment options with a lower expected return than more loss-tolerant individuals in the control group. As in the case of risk aversion, The coefficient on $Debt * Loss\,averse$ of -1.25 does not indicate a significant differential impact of the debt contract on the investment of loss-averse individuals, while the coefficient of +7.90 on $Equity * Loss\,averse$ indicates that the most loss-averse individuals were significantly more likely to choose higher expected profit investments under equity financing. This is confirmed using a cross-coefficient test of equality between $Debt{*}Loss\,averse$ and $Equity{*}Loss\,averse$ ($p-$value = 0.013). As a robustness check, column 3 controls for both risk aversion and loss aversion at the same time, with similar patterns of greater differential impact on profitable investment for the most risk- and loss-averse individuals only under the equity contract.

Finally, column 4 explores the impact of probability weighting, with results in the opposite direction to those for risk and loss aversion. Specifically, individuals who overweight small probabilities are *less* likely to make profitable investments under equity. A test of equality between the coefficient on $Debt * Probability\,weighting$ (+7.38) and that on $Equity * Probability\,weigthing$ (-3.70) strongly rejects quality ($p$ = 0.003).

Next, I explore selection into contracts. At the end of the investment games, after each participant had made their choices under debt and equity (and before the outcomes had been realised using a physical randomisation device), each individual was asked about their preferred contract. Their choice increased the probability of that contract being selected for payment at the end of the workshop, and so it provides a direct and incentivised measure of preference over debt and equity contracts. It also complements the results in the appendix that shows the strong predictive power of the risk measures for take-up of the microfinance contracts "outside of the lab". In Table 4, I estimate a simple linear probability model, where the dependent variable in all columns is a dummy for whether the business owner chose to take an equity contract over debt for the final contract choice. Column 1 shows that risk-averse business owners are 9.5 percentage points more likely to choose an equity contract ($p$ = 0.010), compared to more risk-tolerant individuals (of whom 40.4% chose to take an equity contract). Column 2 shows that loss-averse individuals are 10.8 percentage points more likely to choose equity ($p$ = 0.004), compared to more loss-tolerant individuals (of whom 39.3% chose equity).

Column 3 reveals that individuals who exhibit greater probability weighting (leading to overweighting of small probabilities) are *less* likely to choose equity contracts. The negative coefficient is particularly large, at -18.3 percentage points ($p-$value < 0.0005), compared to an equity take-up rate of 54.4% for individuals with closer-to-linear probability weighting. In column 4, I control for all three dimensions of risk preferences in the same specification. The results are consistent in magnitude and significance with the three previous columns, revealing a greater preference for equity contracts for the most risk-averse and most loss-averse individuals (coefficients of +7.8 and +9.5 percentage points respectively, with $p$-values of 0.040 and 0.013 respectively), and much lower preference among those who overweight small probabilities (a coefficient of -19.4 percentage points, $p-$value < 0.0005). Results are therefore consistent with the previous findings in Table 3 on investment choice conditional on assignment to contract, and also consistent with the results in the appendix for take-up of the actual microfinance contract in the broader field experiments: equity contracts are preferred by the most risk-averse and the most loss-averse business owners, whereas for those who overweight small probabilities, debt is preferred.

# 5 Structural estimation of risk preference parameters, counterfactual contract analysis and welfare

The reduced form results in the previous section align with a simple and intuitive prediction: that equity contracts incentivise more profitable investment and can be particularly beneficial for the most risk-averse business owners. However, a more complex relationship emerges when allowing for the two most popular deviations from the expected utlity framework – loss aversion reveals an additional value to equity contracts, whereas probability weighting suggests a preference for debt contracts. This merits further exploration of the welfare implications of introducing microequity contracts, explicitly considering the distribution of individual risk preferences, and for which simply using take-up decisions from experiments offering new contracts provides an incomplete evaluation of welfare at best (G. Harrison & Ng, 2016).

Since probability weighting and loss aversion were identified to be important in the reduced-form results, I proceed by formally estimating a prospect-theoretic model allowing for three distinct parameters that together capture risk preferences: (i) utility function curvature, (ii) loss aversion, and (iii) probability weighting.[16] Recalling the experimental implementation, participants were asked a series of questions that elicited different aspects of risk preferences. Each decision can be modelled as a binary choice between two "prospects".[17] Each prospect has an associated utility, and one can define an index based on latent preferences of business owners to model the difference in utility between the two prospects under consideration, $PU = PU_1 - PU_2$. The utility of prospect $i$ is the probability-weighted utility of each of the prospect's outcomes:

$$PU_i = \sum_{k=1}^{n} W(p_k) \cdot U(x_k), \tag{4}$$

where :

$$W_k = \omega(p_k + \cdots + p_n) - \omega(p_{k+1} + \cdots + p_n) \tag{5}$$

for $k = 1, ..., n-1$, and

$$W_k = \omega(p_k) \tag{6}$$

for $k = n$, where $x$ are the monetary outcomes, of which there are $n$ possible outcomes for each prospect, subscript $k$ ranks outcomes from worst to best, $W(\cdot)$ is the decision weight, and $w(\cdot)$ is a probability weighting function that transforms the experimentally induced probabilities. I use the popular probability weighting function of Tversky and Kahneman (1992):

$$w(p) = \frac{p^\gamma}{(p^\gamma + (1-p)^\gamma)^{1/\gamma}}, \tag{7}$$

[16] I follow the methodology of G. Harrison and Swarthout (2016). Non-parametric methods that do not assume a functional form are also possible in principle, but they require "chaining", whereby the choices offered to a subject depend on their prior choices, which may introduce significant measurement error (Dimmock et al., 2021).

[17] These are often referred to as "lotteries" in the literature, with many being degenerate when a fixed amount of money is offered; henceforth I adopt the more general term prospect, as used in the behavioral literature (Tversky & Kahneman, 1992; Wakker, Thaler, & Tversky, 1997).

where $\gamma$ controls the shape of the (potentially non-linear) probability weighting function, which is assumed to be separable in outcomes. One-parameter weighting functions have been found to provide an excellent fito to the data in several studies, and almost as well as the two-parameter, linear in log odds weighting functions (Wu & Gonzalez, 1996).[18] The utility function takes a simple power utility form, with constant relative risk aversion, which is the most widely-used functional form in the literature, and supported by results on panel data (Barseghyan, Molinari, O'Donoghue, & Teitelbaum, 2013; Conte, Hey, & Moffatt, 2009; Fezzi, Menapace, & Raffaelli, 2021; Fezzi et al., 2021; Wakker, 2008).[19] The utility function is defined separately over gains and losses:

$$U(x) = \begin{cases} x^{\alpha} & \text{if } x \geq 0 \\ -\lambda(-x^{\alpha}) & \text{if } x < 0, \end{cases} \tag{8}$$

where $\alpha$ controls the curvature of the utility function and $\lambda$ allows for the possibility of reference-dependent preferences.

I calculate the utility of each prospect under consideration in the 44 decisions made by each individual, based on candidate values of the parameters $\alpha$, $\lambda$, and $\gamma$, and then linking the latent index $\nabla PU = PU_1 - PU_2$ to the observed choices in the experiment using a standard cumulative distribution function $\Phi(\nabla PU)$. $\alpha$, $\lambda$, and $\gamma$ are estimated using maximum likelihood, also allowing the parameters to be functions of observable characteristics, for which I have data from the field experiments. Intuitively, identification of the loss aversion parameter $\lambda$ comes from the set of questions that offered participants a choice that included prospects where one of the outcomes was in the loss domain, and identification of the probability weighting parameter $\gamma$ comes from variation of the probability of the good outcome $p_g \in \{0.25, 0.50, 0.75\}$ in the certainty equivalent exercises.

Figure 1 illustrates the results. I estimate a utility curvature parameter with a bell-shaped curve around a mean of $\alpha = 0.74$ and a loss aversion parameter with a mean of $\lambda = 2.04$, which is remarkably close to the "classic" range of $\lambda$ between 2.00 and 2.25 that is estimated in much of the literature (Brown et al., 2021; DellaVigna, 2018; Kremer et al., 2019). For probability weighting, I estimate a bimodal distribution, with a mean of $\gamma = 0.73$, a mass at almost-linear probability weighting ($\gamma$ close to 1), and a large mass with a non-linear probability weighting parameter of between $\gamma = 0.5$ and $\gamma = 0.8$, which is also consistent with estimates in the literature from high-income countries, where

[18] A "menagerie" of functional forms for the probability weighting function are possible (Stott, 2006), including the well-known alternative of Prelec (1998).

[19] An alternative would have been to estimate a Constant Absolute Risk Aversion (CARA) utility function. However, this would create a problem of consistency of risk preferences between the relatively large stakes being analysed in the counterfactual analysis (which utilises actual asset and profit data for the businesses in the sample), compared to the amounts used to elicit preferences in the artefactual field experiments (Fezzi et al., 2021; Rabin & Thaler, 2013).

an estimate of $\gamma = 0.7$ is typical (Comeig, Holt, & Jaramillo-Gutiérrez, 2022; Dimmock et al., 2021). The fourth panel of the graph illustrates the implications of the mean value of $\gamma = 0.73$: overweighting of small probabilities and underweighting of large probabilities, generating the famous "inverse-S" shape that has been documented in the majority of empirical studies of probability weighting (Abdellaoui, 2000; Booij, Van Praag, & Van De Kuilen, 2010; Bruhin, Fehr-Duda, & Epper, 2010; Camerer & Ho, 1994; Fehr-Duda & Epper, 2012; Polkovnichenko & Zhao, 2013; Prelec, 1998; Starmer, 2000; Stott, 2006; Van De Kuilen & Wakker, 2011; Verschoor & D'Exelle, 2020; Wu & Gonzalez, 1996). Overweighting of small probabilities has particularly significant implications for the choice between debt and equity contracts when faced with a positively skewed profits distribution, as such individuals overestimate the small probability of very high business profits (a scenario in which they would have to share a large amount of money with the capital provider under an equity contract). Further, they underestimate the (objectively much larger) probability of low business profits, where equity contracts can be very beneficial in terms of loss-sharing (and where debt contracts can lead to inability to meet fixed repayments and potential default). Note that, for a symmetric distribution of returns, it is not necessarily the case that probability weighting makes the investment more attractive, since both large gains and large losses are overweighted; the key idea in this setting is that, where the distribution of outcomes is positively skewed (as it might particularly be for firm outcomes in low- and middlie-income countries (Hsieh & Olken, 2014)), business owners who exhibit an inverse-S shaped weighting function are more likely to over-weight the probability of them earning a very large return, compared to economic actors that don't exhibit probability weighting, such as financial institutions (Spalt, 2013). Similarly, Barberis and Huang (2008) show that, under the assumption of normally distributed returns, the asset pricing implications of prospect theory are no different from those of expected utility – they only differ when introducing some assets with positively skewed investment returns.

Finally, I use the estimated risk parameters to explore the welfare implications of different financial contracts. One way to define welfare is for a social planner who takes into consideration the distribution of risk preferences of small business owners, and seeks to maximise the sum of borrower welfare and the lender's profits, assuming one financial institution that provides the capital and is risk-neutral and does not exhibit probability weighting. One can then investigate the change in total welfare from the introduction of microequity contracts, compared to a situation in which only debt contracts are offered. To begin, the prospective utility for an equity-financed individual $i$ who faces $n$ possible states of the world $s$ is defined as:

$$PU_i^{equity} = \sum_{k=1}^{n} w(p_k) \cdot U\left[(1-\tau) \cdot x_s\right]), \tag{9}$$

where $\tau$ is the proportion of final wealth that is shared with the lender, using the same utility and probability weighting functions in equations 8 and 7 respectively. To calculate client welfare under equity contracts, I solve for a measure of compensating variation (Hicks, 1939), defined as the monetary amount $T$ that would need to be paid to a debt-financed individual to make their utility equal to that under the equity contract:

$$PU_i^{equity} = PU_i^{debt} = \sum_{k=1}^{n} w(p_k) \cdot U(x_s - d + T), \tag{10}$$

where $d$ represents the non-state-contingent fixed payment required under the debt contract. I assume that all individuals face an identical stochastic distribution of business profits,[20] which I take as the baseline distribution of actual business profits from the data in the field experiment. For simplicity, I then discretise the distribution into five possible states of the world, and assume a 50% return on the large capital injection, which is a plausible estimate given the returns to capital shown in the microenterprise capital grant literature (De Mel et al., 2008; Fafchamps et al., 2014). Further details of the underlying distribution of profits is provided in the appendix. A key point to note is that, for individuals who exhibit an inverse-S shaped probability weighting function, the two most likely states of the world (which have the lowest payoffs) are significantly under-weighted, while the highest-payoff states are *over*-weighted. Therefore, individuals who overweight small probabilities would not find desirable an equity contract that provides risk-sharing in low-profit states of the world in return for upside sharing in high-profit states.

I solve for individual-specific valuations of equity contracts ($T$) for different possible sharing ratios, using the individually-estimated preference parameters $\alpha$, $\lambda$, and $\gamma$. I also conduct the simulations under three different environments: (i) allowing only for expected utility preferences (EU); (ii) allowing for prospect-theoretic preferences, but without probability weighting (PU1); and (iii) allowing for prospect-theoretic preferences with probability weighting (PU2). This comparison allows one to see the difference in results from taking a broader conception of risk preferences. I assume a financing amount of \$1,500, and a required repayment rate on debt contracts of 30%. The debt is unlimited liability, meaning that borrowers must pay from savings if their business profits are low (I incorporate data on actual savings for each individual). I calculate three welfare measures: (i) the value to each business owner of the equity contract, averaged over the total sample; (ii) profits per client for the financial institution, assuming clients optimally choosing the contract that maximises their utility (iii) total surplus: the sum of (i) and (ii).

[20] I therefore do not allow for any permanent heterogeneity in business profitability. It is not unreasonable to assume that a financial institution may have a reasonable view about the distribution of profits in their population of potential clients, and may even assume a specific distribution of elicited risk preference parameters; as mentioned, the parameters I estimate in this paper are consistent with much of the previous literature.

Results are illustrated in the appendix. Intuitively, at low profit sharing ratios, clients have very high utility from the equity contract (since it provides the same capital amount as debt and requires only a very small amount of profits shared in expectation), but the MFI makes a big loss on average. As the sharing ratio increases, the MFI begins to make a profit, and the value of the equity contract to clients decreases. The 'region of feasibility' is the range of sharing ratios where the MFI is making profits and clients are getting value from equity. This range of feasibility, and the aggregate surplus, increases when moving from an expected utility framework to one that allows for for reference-dependent preferences (but not probability weighting) as well as utility curvature, which reflects the fact that loss-averse clients value the downside protection in equity. However, the pattern partially reverses when also allowing for probability weighting, consistent with the earlier reduced-form finding that individuals who overweight small probabilities actually prefer debt. Finally, I demonstrate how a simple contractual tweak can improve the range of feasibility and aggregate surplus. Specifically, I introduce a 'hybrid' contract that contains both debt- and equity-like features. The contract works by providing the same performance-contingent payment structure as the equity contract, with the difference being that the upside is capped: once payments under the hybrid contract reach a maximum amount, the contract terminates. As such, individuals who overestimate the low probability of high-profit scenarios benefit from such a contract. In the appendix, I provide further details, and illustrate the improvement in the take-up rate of equity-like contracts when implementing a cumulative payment cap, with leads to an overall increase in total welfare.

# 6 Discussion

An unresolved puzzle in the finance and development literature is how to reconcile the high returns documented in studies that provide capital grant studies to small firms with the modest returns documented in microcredit studies. This has inspired a new wave of research that adapts the classic microcredit contract to better match loan repayments to client cashflows. In this paper, I explore a more direct method of linking payments to client income: microequity contracts with performance-contingent payments. I use artefactual field experiments with small business owners who were part of field experiments in Pakistan and Kenya that had provided them with large capital injections. I find that microequity leads to more profitable investment choices, particularly for the most risk-averse individuals. Loss-averse individuals particularly value equity contracts, which provide downside protection in return for upside profit sharing. However, individuals who overweight small probabilities prefer debt contracts, especially when faced with positively skewed profits distribution. I structurally estimate these three distinct dimensions of risk preferences using a prospect-theoretic model to show that relatively simple tweaks to contract design can improve the feasibility of microequity contracts. Financial institutions that cater to micro- and small firms, by expanding the suite of products offered to include equity-like contracts, can significantly improve client welfare.

There are several supply-side reasons why MFIs do not currently include equity-like contracts in their suite of offered products (which often does include microinsurance and savings products). First, the challenge in observing profits for small informal firms ("costly state verification") suggests that non-state-contingent debt contracts may be optimal (Townsend, 1979). Second, the skillset of traditional microfinance loan officers may be quite different to the venture-capital-like skills required to identify high-potential firms for equity financing. Microcredit loan officer pay is typically linked to their portfolio's default rate, so there is little incentive for loan officers to identify businesses with higher-risk, higher-reward investment opportunities, or to lose their most promising existing clients by allowing them to graduate to a more sophisticated form of financing (Rigol & Roth, 2021). Finally, there are many legal challenges to enforcement of ownership claims if the MFI or its investors were to take an equity stake in small firms in low-income countries, and the exit options for investors in underdeveloped financial markets are unclear (De Mel, McKenzie, & Woodruff, 2019). In demonstrating the role of non-standard preferences, and specifically the overweighting of small probabilities, I propose a novel demand-side explanation for why we do not observe microequity contracts being implemented in practice, despite the positive investment effects. I also propose a relatively simple solution to this problem: a hybrid contract that contains both debt- and equity-like features can mitigate this problem by capping the upside for the capital provider in the high-profit state of the world, which is subjectively overweighted by clients with non-linear probability weighting, but not so by a more sophisticated financial institution.

Notwithstanding the traditional challenges, there have been significant recent developments in financial technology and mobile money (Higgins, 2019; Suri, 2017). This has greatly facilitated digital transactions and improved observability of income streams in an increasing number of contexts (for example, online marketplaces, or businesses that accept digital payments through point of sales systems, which have greatly increased in prevalence since Covid-19). Such developments can improve both the screening of higher-potential clients (mitigating adverse selection) and the monitoring of client transactions and performance (mitigating moral hazard concerns). This opens up many possibilities for designing equity-like microfinance contracts that involve shared ownership of an income stream, rather than shared ownership of the actual business, thereby mitigating legal enforcement issues, and utilising digital payment methods for capital disbursal and repayment. Further, taking into consideration a more holistic view of risk preferences, without necessary using sophisticated methods for measuring or changing people's preferences, can help in the design of better-tailored financing products.

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# Tables and figures

Table 2: EFFECT OF CONTRACTS ON INVESTMENT CHOICE

| | (1) Round 1: Pakistan | (2) Round 1: Kenya | (3) Round 1: Pooled | (4) Round 2: Pooled | (5) Round 3: Pooled | (6) Round 1: Pooled | (7) Round 2: Pooled | (8) Round 3: Pooled |
|---|---|---|---|---|---|---|---|---|
| Debt | 66.89 | 52.69 | 63.79 | 64.18 | 22.22 | 63.79 | 64.18 | 22.22 |
| | (2.55) | (4.66) | (2.24) | (2.03) | (2.20) | (2.24) | (2.03) | (2.20) |
| Equity | 76.71 | 66.92 | 74.58 | 76.96 | 30.82 | | | |
| | (2.17) | (3.93) | (1.90) | (1.77) | (1.91) | | | |
| Equity (25% sharing) | | | | | | 74.18 | 76.60 | 31.90 |
| | | | | | | (2.10) | (2.01) | (2.09) |
| Equity (50% sharing) | | | | | | 74.97 | 77.32 | 29.74 |
| | | | | | | (2.06) | (1.86) | (2.06) |
| Control | 109.36 | 101.20 | 111.21 | 78.79 | 178.12 | 107.58 | 77.97 | 176.47 |
| | (1.15) | (2.98) | (1.24) | (1.15) | (2.18) | (1.12) | (0.94) | (2.03) |
| Observations | 2,392 | 668 | 3,060 | 3,060 | 3,060 | 3,060 | 3,060 | 3,060 |
| R-squared | 0.28 | 0.18 | 0.27 | 0.34 | 0.05 | 0.25 | 0.34 | 0.04 |
| Country control | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Test: Equity = Debt | 0.000 | 0.001 | 0.000 | 0.000 | 0.000 | | | |
| Effect size (%) | 5.6 | 9.2 | 6.2 | 8.9 | 4.3 | | | |
| Effect size (standard deviations) | 0.35 | 0.37 | 0.35 | 0.49 | 0.15 | | | |
| Test: Equity (25%) = Equity (50%) | | | | | | 0.640 | 0.650 | 0.178 |

*Note*: In each column, the dependent variable is the expected profit of the chosen investment option in that particular round. The 3,060 observations reflect the within-design setup of the experiment, whereby each of the 765 unique microenterprise owners were assigned — in a randomly perturbed order — to each of the four treatment groups: *Control*, *Debt*, *Equity (25% sharing)* and *Equity (50% sharing)*. *Debt* and *Equity* are dummy variables for the debt and equity contracts respectively, with the reported coefficient representing the average expected profit of the investment option chosen under that particular contract relative to the average expected profit of the investment option chosen by the control group, represented by the dummy *Control* (which is the constant in the regression). In columns 3 to 8, the Pakistan and Kenya samples are pooled, and a Kenya country dummy is included. In columns 1 to 5, *Equity* pools both the 25% sharing ratio contract and the 50% sharing ratio contract, whereas columns 6 to 8 estimate impacts of each equity contract separately. Standard errors are clustered at the individual level and are reported in parentheses below each coefficient estimate. In the panel below the table, the fourth row presents $p$-values for the null hypothesis that the effect of being assigned to the equity contract is equal to the effect of being assigned to the debt contract. The fifth and sixth rows quantify the estimated treatment effect (of equity compared to debt) as a percentage of the control group mean and in standard deviations of the control group mean, respectively. The seventh row presents $p$-values from test of the null hypothesis that the effect of being assigned to the equity contract with 25% sharing ratio is equal to the effect of being assigned to the equity contract with 50% sharing ratio.

Table 3: HETEROGENEITY BY RISK PREFERENCES: INVESTMENT CHOICE

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Risk averse | -10.74*** | | -9.52*** | |
| | (2.20) | | (2.30) | |
| Loss averse | | -6.87*** | -3.69 | |
| | | (2.23) | (2.31) | |
| Probability weighting | | | | -2.31 |
| | | | | (2.25) |
| Debt * Risk averse | 1.10 | | 1.70 | |
| | (4.51) | | (4.72) | |
| Debt * Loss averse | | -1.25 | -1.82 | |
| | | (4.57) | (4.78) | |
| Debt * Probability weighting | | | | 7.38 |
| | | | | (4.50) |
| Equity * Risk averse | 10.05*** | | 8.36** | |
| | (3.83) | | (4.00) | |
| Equity * Loss averse | | 7.90** | 5.11 | |
| | | (3.89) | (4.05) | |
| Equity * Probability weighting | | | | -3.70 |
| | | | | (3.85) |
| Debt | 63.19*** | 64.50*** | 63.89*** | 60.43*** |
| | (3.33) | (3.52) | (3.92) | (3.04) |
| Equity | 69.06*** | 70.09*** | 67.09*** | 76.26*** |
| | (2.90) | (3.06) | (3.41) | (2.48) |
| Control | 113.48*** | 111.48*** | 114.90*** | 108.63*** |
| | (1.62) | (1.66) | (1.86) | (1.47) |
| Number of observations | 3,060 | 3,060 | 3,060 | 3,060 |
| Test (Risk aversion): Debt = Equity | 0.015 | | 0.091 | |
| Test (Loss aversion): Debt = Equity | | 0.013 | 0.079 | |
| Test (Probability weighting): Debt = Equity | | | | 0.003 |

*Note*: In all columns, the dependent variable is the expected profit of the investment option chosen by the microenterprise owner. The 3,060 observations are generated from the within-design experimental setup with 765 unique microenterprise owners. *Risk averse* and *Loss averse* are dummy variables for whether a microenterprise owner was measured to have above-median risk aversion or loss aversion respectively in the baseline preference elicitation exercises, and *Probability weighting* is a dummy for whether the individual has an above-median value of the non-parametric measure of non-linear probability weighting. *Equity * Risk averse* represents the expected profit of the investment option chosen by the most risk averse microenterprise owners over and above the expected profit of the investment option chosen by the most risk tolerant microenterprise owners (which is represented by the coefficient on *Equity*), with an analogous interpretation for the other interaction terms. In the panel below the table, the second, third and fourth rows present $p$-values from a test of the null hypothesis that *Equity * Risk averse* = *Debt * Risk averse*, *Equity * Loss averse* = *Debt * Loss averse*, and *Equity * Probability weighting* = *Debt * Probability weighting* respectively. *** p<0.001, ** p<0.05, * p<0.10.

Table 4: HETEROGENEITY BY RISK PREFERENCES: CONTRACT CHOICE

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Risk averse | 0.095** | | | 0.078** |
| | (0.037) | | | (0.038) |
| Loss averse | | 0.108*** | | 0.095** |
| | | (0.037) | | (0.038) |
| Probability weighting | | | -0.183*** | -0.194*** |
| | | | (0.036) | (0.036) |
| Constant | 0.404*** | 0.393*** | 0.544*** | 0.451*** |
| | (0.027) | (0.028) | (0.026) | (0.035) |
| Observations | 726 | 726 | 726 | 726 |

*Note*: In all columns, the dependent variable is a dummy for whether the microenterprise owner chose to take an equity contract over debt for the final contract choice that was implemented for real money (726 observations reflect one final unique choice from each microenterprise owner, pooling Pakistani and Kenyan data). *Risk averse* and *Loss averse* are dummy variables for whether a microenterprise owner was measured to have above-median risk aversion or loss aversion respectively in the baseline preference elicitation exercises, and *Probability weighting* is a dummy for whether the individual has an above-median value of the structurally estimated non-linear probability weighting parameter. *** p<0.001, ** p<0.05, * p<0.10.

Figure 1: STRUCTURALLY ESTIMATED RISK PREFERENCE PARAMETERS