Asset-based microfinance for microenterprises: Evidence from Pakistan*

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Abstract

We conduct a field experiment offering graduated microcredit clients the opportunity to finance a business asset worth four times their previous borrowing limit. We implement this using a hire-purchase contract; our control group is offered a zero-interest loan. We find large, significant and persistent effects from asset finance contracts: treated microenterprise owners run larger businesses and enjoy higher profits; consequently, household consumption increases, particularly on food and children's education. A dynamic structural model with non-convex capital adjustment costs rationalises our results; this highlights the potential for welfare improvements through large capital injections that are financially sustainable for microfinance institutions.

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1 Introduction

Is microfinance too 'micro'? Can larger financial products generate sustained improvements in microenterprise performance? The first wave of microfinance RCTs found modest average impacts of conventional microcredit contracts on microenterprise performance, and practically zero effects on household consumption (Duflo, 2020; Meager, 2019). Subsequent work has identified significant heterogeneity in business impacts (Banerjee, Breza, Duflo, and Kinnan, 2019), and several papers show benefits from contractual innovations designed to increase repayment flexibility (Field, Pande, Papp, and Rigol, 2013; Battaglia, Gulesci, and Madestam, 2018; Barboni and Agarwal, 2018). In their seminal review of the experimental literature, Banerjee, Karlan, and Zinman (2015) recommend that the next generation of microfinance research should explore contractual innovations and non-credit structures, while addressing the lack of evidence for the impact of larger financing amounts on graduated borrowers.

In this paper, we directly address this gap in the literature. We work with one of the most prominent microfinance institutions ('MFIs') in Pakistan; that MFI had a large pool of borrowers who had successfully completed previous loan cycles, and who wanted to expand their business through the purchase of a fixed asset that cost significantly more than the prevailing borrowing limit. To finance such a large amount in a manner that is satisfactory to the MFI's risk-reward perspective, we rely on a collateralised asset financing structure that has not previously been used in the experimental microfinance literature: namely, a 'hire-purchase' agreement, in which the client's ownership share in the asset increases as repayments are made.[1] Specifically, we conduct a field experiment in which we offer these graduated microfinance borrowers the opportunity to finance a business asset worth up to approximately two thousand US dollars,[2] which represents a large capital injection for these clients (approximately four times their previous borrowing limit, and substantially more than the loan amounts offered in most of the comparable research). We offer two variants on a hire-purchase contract, each with an 18-month duration and each allowing clients to purchase an asset of their choice. They are: (i) a fixed-repayment contract where participants are obliged to buy the asset within 18 months, and (ii) a flexible-repayment contract that provides a greater element of risk sharing by allowing either faster or slower repayment, at the client's discretion. In both contracts, clients are required to pay rent based on the MFI's proportional ownership share of the asset at the start of each month. Clients

[1] Hire-purchase agreements share features with both 'rent-to-own' structures (a more commonly used term in the United States) as well as lease agreements; the differences have implications for whether the asset is recognised on the firm's balance sheet and how payments are treated for tax purposes, which are less relevant in the context of microenterprises, but which we discuss in Section 2.2.

[2] Henceforth, we use $ to refer to US dollars, based on the actual Pakistani Rupee (PKR) amounts and the baseline USD-PKR exchange rate of 105.

who were randomly assigned to our control group were eligible for the MFI's standard cash loan with $475 borrowing limit.

We find relatively high take-up rates for our two products (57% on average), and low default rates (under 5% for both contracts).[3] Most importantly, we find large and significant effects from both treatments on business and household outcomes, using five rounds of follow-up data in the two years following our intervention. Specifically, treatment clients are more likely to remain in self-employment, have larger businesses (as measured through business assets), better business management practices (particularly in terms of inventory control and purchasing), and greater business performance (on average, an increase in monthly business profits of approximately 9% of the control group mean). This generates a significant increase in household income (on average, approximately 8% per month), and a significant increase in household monthly consumption expenditure (approximately 6%). The bulk of this increased consumption is in household educational expenditure, where we observe a 26% average increase compared to the control group. This is predominantly driven by an increase in spending on girls' education, significant across all measured subcategories: spending on school fees, books and materials, school meals, and transportation costs. We also find significant positive effects on overall purchases of food for the household. Our results are robust to winsorizing at multiple levels, to endogeneity concerns (attrition is under 5% and uncorrelated with treatment), and to mediation analysis that rules out our results merely being driven by sectoral switching. Our estimates also remain stable when we disaggregate by survey wave.

To rationalise our findings within a simple theoretical framework, and to further explore the mechanisms underlying our results, we use a calibrated dynamic structural model of microenterprise capital investment and growth. We build on the structural microfinance approaches developed by Kaboski and Townsend (2011) and Banerjee et al. (2019); we focus on the role of fixed capital and explicitly incorporate the asset-based product that we implemented in our experiment. We find that this model fits the data well – replicating patterns both of estimated treatment effects and a large number of untargeted moments – but does so only when we allow for large non-convex costs of capital adjustment. This implies that non-convex adjustment costs are crucially important for understanding our estimated treatment effects – in particular, the persistence of our estimated impacts. The model predicts that – as in the data, and as in the seminal macroeconomic work of Kaplan and Violante (2014) – households optimally spend down their low-return liquid asset, even though this precludes access to high-return illiquid investments. This framework rationalises several

[3] The average take-up rate in the existing microcredit experimental literature is approximately 40%, although this contains a mix of studies that (i) offered credit to more general populations of eligible individuals; and (ii) those that offered microcredit to people who had already expressed an interest in taking loans (which is closer to our sample). For further details, see J-PAL (2015).

key features of our data – and, more generally, key features of many microenterprise studies in the literature. Specifically, we observe little or no adjustment to enterprises' fixed capital stock over time, and most households hold minimal wealth in cash or other liquid assets; in our model, this is optimal household behaviour notwithstanding that the marginal product of fixed capital in the microenterprise is high. In sum, our model highlights the importance of financial product provision that recognises lumpiness in investment and the crucial role of large capital purchases for microenterprises. Specifically, the model implies that a microfinance intervention offering a relatively small lump-sum payment will not generate transformational change to the household's circumstances; in contrast, a large transfer can generate sustained improvements in household wealth and income, while also being financially sustainable for the MFI.

Although we find no overall difference in impact between the fixed and flexible treatments, heterogeneity analysis with pre-specified variables reveals the importance of risk preferences for differential contract take-up, use of the flexible repayment option and post-treatment impacts. Using an incentivised measure of baseline risk aversion, we find that the most risk averse individuals had 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). This suggests that the implicit insurance in the flexible-repayment contract is particularly valuable for risk-averse microenterprise owners – a result that is consistent with several recent studies finding gains from microcredit repayment flexibility (Field et al., 2013; Battaglia et al., 2018; Barboni and Agarwal, 2018).

Our paper contributes to two main strands of the microfinance literature. The first strand has used field experiments to identify the casual effect of microcredit capital injections – often targeted at microentrepreneurs – on business performance and household welfare.[4] These papers find some evidence of microcredit leading to greater business investment – but find no significant impact on profits, and no evidence for impacts on various measures of household welfare such as consumption; see, for example, the survey by Banerjee et al.

[4] There is also a long tradition of non-experimental and qualitative approaches to identifying the impact of microcredit, which has produced mixed and sometimes controversial results. For example, see Roodman and Morduch (2014) for a discussion of the earlier work by Pitt and Khandker (1998). For comprehensive surveys of the microcredit literature, see Lensink and Bulte (2019) and Cull, Demirgüç-Kunt, and Morduch (2018). For brevity we restrict our comparisons here to experimental papers.

(2015), and the Bayesian hierarchical analysis by Meager (2019).[5] Our paper builds on this evidence, and the recommendations of Banerjee et al. (2015), by working with graduated microfinance borrowers looking to purchase a business asset, and offering them a much larger financing amount (representing approximately four times their previous borrowing limit of $475).[6] Our financing offer of about $1,900 is significantly larger than the loan amounts offered in most of the existing microcredit literature; of the eight comparable microcredit field experiments, the mean loan size was approximately $650 (with a median loan of about $500). Our results demonstrate the benefits to business performance and household welfare of 'strongly backing' graduated borrowers with a significant relative increase in capital – using a financial contract structure that resulted in the MFI getting its money back, with very few defaults.

The second strand of research has offered identical capital amounts to treatment and to control in a standard debt contract, while varying the contract structure to introduce greater repayment flexibility (Field et al., 2013; Battaglia et al., 2018; Barboni and Agarwal, 2018). These studies have demonstrated benefits on business performance of allowing a 'grace period', permitting clients to defer payments in certain months (although, even in this literature, there is no evidence of the treatment leading to downstream increases in household consumption).[7] In our experiment, the flexible-repayment treatment builds on this work by taking the grace period idea to its limit: allowing clients some flexibility in every repayment period. While we do not find any average difference in treatment effects between our two contracts, we find the flexible-repayment option particularly useful for more risk-averse clients. This is consistent with the results of Field et al. (2013), who find larger benefits for clients who are more risk-averse.[8] Finally, our work also relates to a recent contribution by Jack, Kremer, De Laat, and Suri (2019), who investigate the effect of relaxing

[5] More specifically, see Augsburg, De Haas, Harmgart, and Meghir (2015) in Bosnia, Tarozzi, Desai, and Johnson (2015) in Ethiopia, Banerjee, Duflo, Glennerster, and Kinnan (2015) in India, Angelucci, Karlan, and Zinman (2015) in Mexico, Attanasio, Augsburg, De Haas, Fitzsimons, and Harmgart (2015) in Mongolia, Crépon, Devoto, Duflo, and Parienté (2015) in Morocco, Karlan and Zinman (2011) in the Philippines, and Fiala (2018) in Uganda.

[6] A separate strand of literature has attempted to use active screening methods for identifying high-potential entrepreneurs, for example using machine learning or panels of experts, and has found limited predictive success (Fafchamps and Woodruff, 2016; McKenzie and Sansone, 2019). Hussam, Rigol, and Roth (2017) do find positive results from using community-based information to predict higher-growth microentrepreneurs. In contrast, we take a relatively 'light-touch' approach, by screening only on the basis of microentrepreneurs having graduated from borrowing and successfully repaying smaller loans.

[7] A similar group of papers have used theory and lab experiments to demonstrate the benefits (and costs) of repayment flexibility in microfinance contracts: see Fischer (2013), Fischer and Ghatak (2016), Czura (2015), Barboni (2017) and Czura, John, and Spantig (2020).

[8] Battaglia et al. (2018) note that the relationship between risk aversion and flexibility is theoretically ambiguous; this result is driven by the possibility of selection into more risky or less risky projects. In our context, we find no significant difference in the average size or type of asset purchased between fixed and flexible contracts.

standard microcredit cash deposit requirements to allow for assets to be used as the deposit. While their settings is very different to ours (financing of rainwater tanks for rural farmers),[9] our results are consistent with their findings of a high take-up rate of collateralised loans, and their theoretical model that suggests the importance of loss aversion for selection into asset-based loans;[10] like us, Jack et al. (2019) find positive impacts from asset-based financing on girls' education.

In section 2, we summarise our experimental design, and in section 3, we report average treatment effects. In Section 4 we present the results from our structural estimation. Section 5 discusses heterogeneity. Section 6 concludes.

2 Experimental design

2.1 Study context

This study was conducted with clients of Akhuwat, one of the fastest growing microfinance institutions in Pakistan. Akhuwat is based in Lahore and operates in 811 branches across the country, with over 891,000 active loans and an outstanding portfolio of PKR 16.4 billion (approximately $106 million at current market rates).[11] We sampled from microenterprises that had passed the relatively simple screening process of Akhuwat, by having graduated from small-scale loans to borrowing larger amounts.

Our sample comprised 757 microenterprise owners who had successfully completed at least one loan cycle with Akhuwat, had reached the maximum permitted borrowing amount (approximately $475), and had expressed an interest in expanding their business by purchasing a fixed asset. Eligible clients were invited to a workshop, where they completed a comprehensive survey, which included questions asking about individual and household characteristics, household finances, business income, expenditures and assets, and business management practices. Following the survey, all microenterprise owners participated in a set of detailed behavioural games, designed to measure risk preferences, loss aversion, time preferences, and cognitive ability. These are explained in detail in Appendix Section B.

[9] Another recent contribution in an agricultural setting is from Burke, Bergquist, and Miguel (2018), who provide maize farmers in Kenya with a harvest-time loan that allows them to exploit an inter-temporal arbitrage opportunity in grain prices.

[10] When conducting analysis of heterogeneous take-up and post-intervention impact using an incentivised measure of baseline loss aversion, we find overall patterns that are similar to our results for risk aversion, although not as statistically significant, which is unsurprising since our elicitation process for loss aversion was much less detailed than for risk aversion.

[11] This information is correct as of November 2019.

2.2 Structure of treatment contracts

We implemented two types of hire-purchase agreement. Both were 18-month contracts that allowed clients to finance the purchase of a fixed asset up to the value of PKR 200,000 (approximately $1,900). The client was obligated to initially purchase 10% of the asset, with the MFI purchasing the remaining 90%. The difference in the contracts lay in how clients were required to purchase the MFI's share:

(i) *Fixed-repayment contract:* The client was required to purchase 5% of MFI's ownership share each month. After 18 months, the client would fully own the asset.

(ii) *Flexible-repayment contract:* The client was only obliged to purchase 2.5% of the MFI's ownership share each month. The client also had the option to pay *more* than what was required in any given month. If the client purchased all of MFI's share before the 18-month period was over, the contract would terminate. If the client had not fully purchased the MFI's share at the end of 18 months, the contract gives the MFI the right to sell the asset in the market, with proceeds disbursed in proportion to the ownership shares at time of sale.[12]

Both contracts were designed to be consistent with locally accepted financial norms. The contract structure was that of *'diminishing musharakah'*, which is a declining-balance agreement that is commonly used to finance the purchase of an asset.[13] This type of contract also has strong resonance with Western legal traditions, dating back at least to the ancient Roman law of *hypotheca* (Goebel, 1961); in modern legal terms, it resembles a 'hire-purchase' contract, which shares features with both 'rent-to-own' structures (a more commonly used term in the United States) as well as lease agreements.[14]

Our contracts are based on a 'constant amortisation' structure, rather than 'constant payments': each month, clients make a fixed payment to increase their ownership share of the asset, as well as a rental payment that is based on the proportional ownership of the asset at the start of the month. The rental amount was based on a nominal annual rate of 12%, and was chosen to simplify calculations for clients (implying 1% of the initial asset value to

[12] In practice, many clients had repurchased a large share of their asset by the end of the contract (discussed further in Section 5.3), and the MFI decided to allow a few extra months for clients to fully purchase the asset (rather than exercising the sale option), which many successfully did.

[13] This type of arrangement combines two distinct Islamic legal contracts under one product: a shared ownership contract (*'musharakah'*) and a rental contract (*'ijarah'*).When communicating with participants, we were careful to use neither the Arabic words nor any terms with religious connotations; instead, we used the local equivalent terms for joint ownership (*'shirakat'*) and rent (*'kirayah'*).

[14] The exact difference between these terms is less relevant in our context, given the informal nature of most microenterprises, which are often not registered for taxes and do not file standardised accounts. Nonetheless, in Appendix Section A, we provide an example of what the accounting and tax implications of different contractual features would be for a formal firm.

be paid as rent per month), and to ensure that the MFI would break even in expectation after administrative costs (which were estimated at 7% per year, based on historical precedent for the MFI).[15] Table 1 provides an example of the required payment structure under the fixed-repayment contract for an asset costing $1,000, where the client has paid $100 to initially purchase 10% of the asset. A nominal annual rental rate of 12% implies monthly rent of 1% of the asset's value, which implies a rental payment of $9 at the end of the first month, reflecting the fact that the MFI initially owns 90% of the asset. In addition to the rent, the client is also obliged to purchase 5% of the MFI's ownership share each month, based on the initial asset value of $1,000, which implies principal payment amount of $50 per month. At the start of the second month, the MFI's ownership share is 85%, and a reduced rent of $8.50 is required at the end of the month, as well as the regular requirement of $50 to purchase 5% of the MFI's share. The contract continues in this manner until the 18th month, when the client purchases the final 5% of the MFI's ownership share, and the contract ends. Over the 18-month duration of the contract, total rental payments are $85.50, which represents a 9.5% raw return.

Appendix Table A.1 provides two repayment examples for the flexible-repayment contract, again using an initial asset value of $1,000. The first example illustrates the absolute minimum repayment requirement for the client, which is $25 per month. Since the MFI's ownership share decreases more gradually than it does under the fixed-repayment contract, the cumulative rental payments are higher than under the comparable fixed-repayment contract. The second example presents a case where the client repays more than required every month, which results in a more rapidly decreasing ownership share for the MFI (and lower rental payments), and the contract ending at the end of the ninth month.[16]

The procedure for default in both contracts is identical: if a client misses a payment, they receive a one-month grace period. If they still do not pay, the asset is repossessed and sold in the market. Proceeds are then disbursed proportional to the ownership shares at the time of the default, reflecting the shared-ownership structure. In practice, we had very few defaults (4% of clients), which we discuss further in Section 2.5.

[15] Akhuwat is a not-for-profit MFI, and our discussions with field officers and clients suggest that the rental rate could have been increased with high take-up. Even at this break-even rate, feedback that we have received suggests that this type of investment is attractive to many 'social impact investors' who are looking to invest their capital and have it returned and redeployed. In fact, following the results of this project, we received a significant amount of funding from several social impact investors to apply this asset financing model to a new project to finance houses, which is ongoing as part of a programme with Akhuwat and the government of Pakistan.

[16] It is worth noting that – unlike Barboni and Agarwal (2018) – we do not charge a higher price (rental rate) for the option of flexibility. Our flexible contract was designed so that the fixed-repayment contract is fully nested within it; a client could take up the flexible-repayment contract and perfectly recreate the repayment pattern of the fixed-repayment contract. Such a comparable design also facilitated explanation to clients, based on their initial understanding of the fixed contract, and using the same rental payment calculations.

2.3 Descriptive statistics and randomisation balance

Appendix Table A.2 presents summary statistics for the 757 microenterprise owners. 92% were male, with an average age of 38 and 7.5 years of formal education. 84% were married, and the average household size was six, of which two people were typically earning some form of income. The mean number of businesses in the household was 1.2, and the average microenterprise owner had 9.6 years of experience in their current business. The mean number of employees was 1.1, with a median of 0. 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),[17] and the average value of total fixed assets for the business was $920 (median $361).[18] This highlights the relatively large financing amount offered to our treatment group, which could triple the stock of fixed assets for the average firm (and was five times the median firm's fixed asset stock).

Average monthly household income was $353 (median $295), and average monthly household consumption expenditure was $211 (median $180), which puts our average household in the second quintile of the overall distribution for household consumption in Pakistan.[19] As a comparison to two of the most prominent studies on capital returns in microenterprises, average microenterprise profits in De Mel, McKenzie, and Woodruff (2008) and Fafchamps, McKenzie, Quinn, and Woodruff (2014) were approximately $25. The average microenterprise owner in our sample is much larger in terms of business profits, which is unsurprising given that the target population was graduated microenterprise borrowers who had successfully completed previous loans and were seeking to expand by purchasing

[17] Average monthly revenues were $728, implying what appears to be a high profit margin of approximately one third. However, our measure of profits is defined as 'net income after all expenses but *before* paying one's own wage', which would bring the true profit margin down to more conventional levels (another difference with the standard accounting measure of profit is that we do not account for depreciation expenses, which would be subtracted from net income in a conventional income statement).

[18] In all follow-up surveys (both treatment and control), enumerators took photos of both fixed and current assets, to improve reporting accuracy. In our definition of business fixed assets, we excluded buildings and land, which are notoriously difficult to value, and which were not permitted as a purchase in our project. We also measured current assets, which on average consisted of $317 of inventory, $127 accounts receivable and $188 business cash reserves. Note that the definition of business fixed assets requires ownership; at baseline, we find little expenditure on rented machinery: an average of $10 per month, with zero spend up to the 75th percentile. This rules out the possibility that our treatments are just shifting people from renting assets to owning them (and there does not appear to be a large rental market that provides access to the kind of fixed assets that microenterprises in our sample demanded).

[19] Source: Household Integrated Economic Survey (HIES) 2015-16, Pakistani Bureau of Statistics.

an asset up to the value of $1,900.[20]

2.4 Treatment assignment, take-up and assets chosen

2.4.1 Assignment mechanism

Participants were randomly assigned into one of three groups: (i) a control group, who were eligible for a $475 zero-interest loan (the standard upper borrowing limit for our MFI)[21]; (ii) treatment group 1, who were offered the fixed-repayment hire-purchase contract to purchase an asset up to the value of $1,900 (and if they rejected the offer, they were also eligible for the $475 zero-interest loan like the control group); (iii) treatment group 2, who were offered the flexible-repayment hire-purchase contract to buy an asset up to the value of $1,900, but were free to reject the offer of flexibility and take the fixed-repayment contract (and were also free to reject both contracts and take the $475 zero-interest loan). In this section, we describe the treatment assignment procedure and overall take-up patterns.

We assigned respondents to treatment using matched sextuplets (Athey and Imbens, 2017), where we stratified on gender, microenterprise business type and profits. We describe this process in Appendix Section D. Appendix Table A.2 reports normalised differences between our control group and our two treatment groups (as recommended by Imbens and Rubin (2015)), and show that our sample was well balanced.[22]

During the baseline workshop, after participants had completed their surveys and behavioural games, the fixed-repayment contract was described to everyone (i.e. before any randomisation of contracts took place) using a vignette and example calculations.[23] The flexible-repayment contract was not demonstrated at this stage; rather, we preferred

[20] The seven microcredit field experiments summarised in Banerjee, Karlan, and Zinman (2015) contained a mixture of microenterprise-targeted products and ones with no restrictions. The most relevant comparisons would be Tarozzi, Desai, and Johnson (2015), who worked with a microenterprise-targeted loan product in Ethiopia with an approximate value of $500, Karlan and Zinman (2011), who offered approximately $220 to microenterprises in the Philippines, and Angelucci, Karlan, and Zinman (2015), who offered approximately $450 to Mexican microenterprises.

[21] It should be noted that – although the MFI Akhuwat's loans are contractually zero-interest – clients often make voluntary contributions to the organisation. Mahmud and Wahhaj (2019) find that Akhuwat clients donate in the region of 4% of their loan amount, and they speculate that this may act as a mechanism for borrowers to signal their quality and obtain larger future loans. Using administrative data for our current sample, we also find evidence of voluntary contributions, in the region of 2% of loan amounts. The lower amount in our sample may relate to the fact that our clients had graduated successfully from previous loans and already had access to the maximum borrowing amount.

[22] The table also reports the results of an omnibus balance test, using all of the variables specified in our pre-analysis plan. We constructed this as a joint test of $H_0 : \beta_1 = \beta_2 = 0$ across all variables, using the following estimating equation: $y_{i0} = \beta_0 + \beta_1 \cdot \texttt{T1}_i + \beta_2 \cdot \texttt{T2}_i + \phi_{s_i} + \varepsilon_{i0}$, where $\texttt{T1}_i$ and $\texttt{T2}_i$ are respectively dummies for treatments 1 and 2, and where ϕ_{s_i} are randomisation strata dummies. The test comfortably passes ($p = 0.344$).

[23] See Appendix Section N for details of the script.

to introduce clients gradually to the calculations for principal and rent using the simpler to understand fixed repayment contract, which we later used as a reference point when explaining the flexible-repayment contract to a randomly selected sub-group. At the end of the workshop, all participants were given a one-page information sheet and allowed a few days to consider the product (the fixed-repayment contract).

Participants were subsequently visited by MFI field officers and research assistants, who were given a tablet computer, with a pre-programmed survey form that contained the treatment status of all participants. Field officers were not informed of the treatment status of the client that they were visiting. Individuals randomised into the control group were informed that they would not be offered the contract, but that they would still be eligible for the zero-interest loan of $475 from the MFI. Individuals who were randomised into and accepted the fixed-repayment contract began the contract signing and asset procurement process with the MFI.

A third group were randomly selected to be offered the flexible-repayment contract, while being given the opportunity to reject the offer and still take the fixed-repayment contract. The flexible contract was explained to them as being similar to the fixed-repayment contract, but with the added optionality that they would only be required to make a 2.5% ownership payment every month, compared to the required 5% monthly ownership payment for the fixed-repayment contract (which nests the flexible-repayment contract). All other aspects of the contract were identical.[24] Individuals were then given a one-page document with a simple summary of the structure of the flexible-repayment contract, with diagrams and tables to illustrate the repayment schedule. Participants were informed that they would be visited after a few days to take their decision on whether they would accept the flexible-repayment contract, with contract signing (for whichever of the two contracts they chose to accept, if any) and asset procurement taking place shortly after. As such, we used the same in-person visit protocol, decision elicitation procedure and "cooling-off period" as for the fixed-repayment contract.

2.4.2 Contract take-up

Figure 1 illustrates the number of individuals assigned to each of the three main treatments, as well as the number that ended up taking up each of the two asset finance contracts. 254 microenterprise owners were assigned to control, and were not offered either of the asset finance contracts (but, as discussed, were still eligible for a $475 zero-interest loan). Of the 257 individuals assigned to the fixed-repayment contract, 53% accepted the offer, successfully provided the required 10% initial payment, and proceeded with contract completion

[24] This design feature is similar to the ex-post waivers implemented by Karlan and Zinman (2009), who use it to distinguish between moral hazard and adverse selection in microcredit contracts.

and asset procurement. Of the 246 individuals assigned to the flexible-repayment contract, 50% accepted it and proceeded to contract completion and asset disbursement, 9% rejected the flexible-repayment contract but did take the fixed-repayment contract and ended up with the asset,[25] and 41% took neither contract.[26]

In total, 281 participants accepted one of the two treatment contracts (157 under the fixed-repayment schedule and 124 under the flexible-repayment contract), provided their 10% initial payment, and had their asset purchase financed. Under both the fixed and flexible contracts, microenterprise owners were permitted to purchase a business fixed asset of their choice worth up to PKR 200,000 ($1,900). The client (not the MFI) was responsible for selecting the particular asset and the asset supplier. Further, the MFI was not responsible for assisting the microenterprise owner in using their asset or in its maintenance – the role of the MFI (after some light screening to ensure that it was a self-contained fixed business asset) was simply to provide financing for 90% of the value of the asset and to collect payments.[27]

The mean asset purchase was $1,517 (median $1,666), with approximately one third of clients choosing the maximum financing amount possible.[28] Approximately another one third of clients purchased assets costing between $1,500 and $1,900, with the remaining third purchasing assets worth between $500 and $1,500 (with a spike at $1,000). A closer analysis reveals the importance of indivisible investments across a number of sectors. It is *not* the case, for example, that the upper mode of the distribution is driven by one or two of the most popular asset categories; instead, we see a high average purchase price across almost all asset categories. For example, for the most popular asset categories, mean purchases prices were: (i) $1,626 (rickshaws), (ii) $1,504 (sewing machines), (iii) $1,621 (cameras), (iv) $1,283 (manufacturing / welding machines), (v) $1,626 (leath machines), (vi) $1,476 (food

[25] Follow-up questions with microenterprise owners and discussions with MFI staff suggest that many people offered the flexible contract preferred the "discipline" of the fixed repayment schedule.

[26] Administrative data suggests that 30% of individuals assigned to the control group ended up taking the $475 zero-interest loan in the 18 months following our intervention. This may reflect their previously stated need for a large capital investment, for which the conventional loan amount is insufficient.

[27] The MFI allowed respondents to purchase up to three assets, provided they formed a complementary bundle – for example, some tailors wanted a standard sewing machine along with a complementary "overlocker" machine that provides a professional-looking finish when joining the edges of multiple pieces of cloth, which is especially important for the often intricate garments worn in South Asia. Separately, the MFI required that each funded asset should be a stand-alone object; for example, a small number of clients were refused permission to purchase building materials, which would have been incorporated into a larger structure (and thus almost impossible to repossess in case of default).

[28] The maximum financing amount available in this project (four times the previous maximum loan size), was decided by the MFI based on their risk appetite and their assessment of typical fixed asset prices.

machines).[29] Appendix Figure A.2 illustrates the distribution in the value of assets financed for clients who took up one of our treatment contracts. Appendix Section F presents results from regressions that investigate the relationship between contract assignment and the value and type of asset chosen by microenterprise owners. The average value of asset financed for those assigned to the fixed-repayment contract was $1,471, while those assigned to the flexible-repayment contract chose assets with an average value of $1,530.[30]

Appendix Table A.3 presents the characteristics of those who took up either of our asset finance contracts, compared to those who were assigned to a treatment contract but did not take up the product. There is no difference in characteristics of takers and non-takers in terms of gender, age, household size, number of household earners, the number of businesses in the household or whether they run a rickshaw business (the most popular sector in our data). Those who took up appear to run slightly younger businesses. Perhaps unsurprisingly – given the relatively large deposit required to purchase the initial 10% of the asset (approximately $150 on average) – we find that contract takers have slightly larger and more profitable businesses: $39 higher revenues per month (compared to $706 for non-takers), $42 higher monthly profits (compared to $228), $297 greater fixed assets (compared to $789), and $56 greater current assets in the form of cash (compared to $164), with all differences statistically significant as per the t-test reported in the table. They also appear to come from slightly wealthier households in terms of net household assets and monthly consumption expenditure. Where we do not see any difference is in their math scores, business management practices, or incentivised measures of risk aversion, loss aversion or time preferences. In section 5 we unpack heterogeneous take-up separately for each contract, using these pre-specified behavioural characteristics.

2.4.3 Asset choice and usage

In this section, we provide further details on the assets chosen by microenterprise owners and how they used them, as well as their understanding of, and satisfaction with, the financing contract that they received.

Appendix Figure A.1 illustrates the types of assets funded. The most popular as-

[29] It may appear surprising that the average sewing machine purchase was $1,504 and the average camera purchase was $1,621, however the items purchased were of high quality and very specialised (for example, the microenterprises purchasing cameras were often involved in high-quality photography for weddings and other events, as well as the entertainment industry, and the sewing machines were often used for very specific garments, requiring specialised parts.).

[30] The difference in means is not significant when controlling for stratification dummies in a regression ($p = 0.233$). Column 2 of the table in Appendix Section F provides some suggestive evidence of more risk-averse individuals choosing higher asset values when offered the flexible contract. The remaining columns show that – for the five most popular assets – there is no clear difference by treatment assignment in the proportion of microenterprise owners choosing that asset.

sets selected were rickshaws (33%), followed by sewing machines (14%), cameras (10%), and manufacturing or welding machines (7%).[31] In most cases, the choice of asset maps intuitively onto the baseline business sector of microenterprises, especially for the most specialised business sectors. For example, 81% of people who bought cameras were working in photography (and 7% in the entertainment sector), 80% of those who purchased a food-related machine were working in the food business, and approximately two thirds of those who purchased manufacturing or welding machines came from similar sectors. For sewing machines, there appears to be a little more 'diversification' at play with asset choice, but still within similar sectors: 51% of those who purchased sewing machines were tailors, 28% were fabric and garment retailers, while 8% were involved in the footwear business. With rickshaws, half of the purchases were from those already in the rickshaw business at baseline, and half were from sectors for which a rickshaw can conceivably function as a complementary business asset (for example, food and drink businesses that might be using the asset for deliveries, as well as retailers in the garment business). As we describe in Section 3, our results suggest a large and persistent expansion in the fixed capital stock for treatment clients, but no large expansion in the number of business employees. As such, the offer of asset financing appears to have induced what appears to be, on average, a profitable change in the 'production technology' for businesses with a large expansion in fixed assets, and in some cases a diversification in the mix of fixed assets.[32]

We also asked detailed questions in all follow-up surveys to ascertain how clients actually used the asset. Over the two years post-disbursal, microenterprise owners report frequent usage: on average, six days per week, and eight hours per day.[33] The numbers are almost exactly the same at all follow-up waves, indicating that – at least in the two years of our project – there is no evidence of severe deterioration in the assets and their usability (this was also documented with enumerator photographs). Further, as discussed in Appendix Section O, we explicitly measured depreciation rates using an incentivised belief elicitation task, and estimated them at only 5% per quarter. These positive suggested results relating to the life cycle of the asset coincide with the persistent treatment effects that we show in Section 3.

[31] The remaining assets included other machines for light manufacturing, food production machines, computers, photocopiers and printers.

[32] In Section 3, we also explore whether our treatments induced more sectoral switching than the control group, and find little evidence for this; we also confirm using mediation analysis that sectoral switching for the biggest sector is not explaining a large part of our estimated positive effects on profits.

[33] 96% of respondents reported that the asset was regularly used for the business. In terms of *who* was using the asset, 84% of the time it was the microenterprise owner themselves, 16% of the time it was business employees and 7% of the time it was some other household member.

2.5 Repayment patterns for the asset finance contracts

In left panel of Figure 2, we show the trend in asset ownership over the life of the contract.[34] Specifically, we show the average ownership share and its interquartile range; we superimpose dotted lines showing (i) the ownership share formally required by the fixed-repayment contract, and (ii) the minimum ownership share required by the flexible-repayment contract.

The figure shows that, from an administrative perspective, the contracts performed well. For clients in the fixed-repayment contract, ownership shares are very close to those formally required (though, as one would expect, loan officers tolerated some occasional repayment delays, particularly towards the end of the 18 month period). Clients in the flexible-repayment contract generally paid substantially more than the minimum required; at the 18-month mark, the average ownership share for clients under the flexible-repayment contract was 80%.[35] In the right panel of Figure 2, we see that there is significant month-to-month variation in repayments made under the flexible contract, mostly lying in between what entrepreneurs were required to pay and what the equivalent required payment under the fixed contract would have been. This is consistent with the results of Battaglia et al. (2018) who find that the grace periods they offered were used across the loan cycle and sometimes not used at all. In Section 5 we investigate these repayments in more detail, exploring the relationship between usage of the flexible repayment option and shocks faced by the microenterprise, and how the repayment response varies based on baseline risk preferences and volatility of their business income.

The MFI experienced relatively few defaults (fewer than 4% of clients), with no significant difference in default between the fixed and flexible contracts. For defaulting clients, the assets were repossessed and sold in the market, as agreed in the original contract. The MFI reported to us that asset repossession and sales were conducted in a straightforward manner in almost all cases, with no reports of clients running away with assets or disputing the contractual terms. At the two-year market, we conducted a survey with all those who took the asset to explore clients' experience with the product.[36] 90% of clients stated that they understood how the contract worked (specifically, how ownership and rental payments were calculated). Reported understanding was not significantly different across the two contracts. 68% of clients stated that the contract helped them to grow their business (with 22% strongly agreeing with that statement).

[34] This is based on administrative data provided to us by the MFI. All contracts were individual-liability loans that required clients to pay instalments at a branch.

[35] While the original agreement was that the asset would be sold in the market and proceeds disbursed in proportion to the ownership shares, in practice – since many clients had repurchased a large share of their asset – by the end of the contract the MFI allowed them a few extra months to fully purchase the asset (which many clients successfully did).

[36] This survey was conducted by enumerators from the independent survey company, and not in the presence of MFI loan officers, with clients aware that all data was kept private.

3 Treatment effects

In this section, we show the average treatment effects of our two interventions. In doing so, we follow our pre-analysis plan (available at www.socialscienceregistry.org/trials/3886); we note explicitly in a few places where, to understand mechanisms, we run estimations that were not pre-specified. Throughout this analysis, our results follow an intent-to-treat specification. We report equivalent LATE estimations in Appendix Section L.[37]

3.1 Pooled results

We begin by pooling our two treatment arms. Specifically, we denote $\texttt{T}_i$ as a dummy for whether the respondent was assigned either to treatment 1 or to treatment 2, and we use an ANCOVA specification with strata dummies:

$$y_{it} = \beta_0 + \beta_1 \cdot \texttt{T}_i + \beta_2 \cdot y_{i0} + \phi_{s_i} + \varepsilon_{it}. \tag{1}$$

In doing so, we pool observations from follow-up surveys conducted three months, six months, 12 months, 18 months and 24 months after the time of treatment; we cluster errors at the individual level. In each regression table, we report estimated average treatment effects ($\hat{\beta}_1$, in equation 1), standard errors, p-values, and sharpened q-values (Benjamini, Krieger, and Yekutieli, 2006).

3.1.1 The business

We begin, in Table 2, by testing effects on key business outcomes for the primary business in the household.[38] We find large and significant effects across a range of key outcomes. Specifically, treated respondents are, on average, nine percentage points more likely to be running a business (compared to 80% of the control group).[39] Average business assets are larger by 40% of the control group mean (on average, an increase of about $401 compared to

[37] As one would expect, the LATE estimates are larger in magnitude than the ITT estimates, but almost identical in their general pattern and implications.

[38] This is defined as the business that the participant spends most time on. Most households only operate one business.

[39] In Appendix Table A.4, we test the effect of treatment on wage employment. Consistent with this result on self-employment, we find that treated respondents are, on average, seven percentage points less likely to be working in wage employment; as a result treated respondents work fewer wage jobs, fewer wage hours, and earn less wage income. For analogous results, see Breza and Kinnan (2018).

$1,003 in the control group).[40] This generates an increase in profits of about 11%; an average increase of about $27 on a control group mean of about $249. We find no effect on employment; this is unsurprising, given the traditional difficulty of encouraging microenterprises to increase employment (see, in particular, De Mel, McKenzie, and Woodruff (2019)).

In Table 3, we disaggregate this capital effects into its constituent parts: fixed assets, cash, accounts receivable and inventory. Our results are stark and unsurprising: all of the effect on total assets is driven by the effect on fixed assets. The magnitude of the increase in fixed assets is intuitive, once one accounts for reasonable rates of depreciation.[41]

We find no effect, in Table 2, on business revenue – despite finding a significant effect on profits. In part, this difference may reflect the inherent noisiness of measuring microenterprise revenue as opposed to profits (see, for example, De Mel, McKenzie, and Woodruff (2009)); it is possible, given the standard errors on business revenue, that the increase in revenue is actually larger than the increase in profits that we observe.[42] In Appendix Table A.5, we test treatment effects on business costs.[43] We find that the treatment caused a large and significant reduction in business costs – in particular, a reduction of 17% in expenditure on raw materials. That is, our profit result is primarily explained by a reduction in business expenses, rather than an increase in revenues.[44]

In Appendix Table A.7, we investigate if there is any impact of the treatment on the sector of business operation. We find that there is some sectoral change over time, but find no evidence that this is greater in the treatment group. Specifically, in the control group,

[40] 'Business assets' refers to assets *in* the business, regardless of whether the business fully owns them; for example, treated respondents who accepted the contract would report the full market value of the asset, even if they only partially owned it at the time of the follow-up survey. This follows standard accounting practice for capital leases as assets on the balance sheet (provided that there is a transfer of ownership or the option of ownership transfer at the end of the term) as per the Generally Accepted Accounting Principles (US GAAP) and the International Financial Reporting Standards (IFRS), most of which Pakistan has adopted.

[41] As mentioned, enumerators took pictures of the assets, and valuation was based on the cost of replacing the asset with one of a similar condition. The valuation was automatically checked in the tablet to flag unrealistically large values or when responses changed significantly from the previous survey round. Focusing on the magnitude in the LATE specification (Appendix Section L), we estimate a treatment effect of $794. This average effect (which comes from pooling follow-up surveys in the two years post-intervention) would be consistent, for example, with an average asset purchase of $1,500 (approximately the average value of asset purchases in our sample), devalued by 30% at the point of sale and experiencing a 30% annual depreciation rate. We discuss in the appendix the incentivised elicitation of beliefs about asset depreciation and partial irreversibility.

[42] In our analysis of outliers in Appendix Section K, we find that the coefficient on revenue becomes positive (though still insignificant) when we increase the level of winsorization.

[43] The analysis in this table was not pre-specified; we have conducted these regressions in order to shed further light on our results on business revenues and business profits.

[44] Appendix Table A.5 also allows us to rule out the possibility that our finding of greater profits is mechanically driven by microenterprise owners receiving a new asset and subsequently reducing their previous expenditure on asset rental and / or old asset repairs; although there is a significant negative effect of the treatment on machine rent expenses, the magnitude is small (a $3 decrease per month), and machine repair costs actually marginally increase (by $1 per month).

there is a statistically significant change in the post-treatment period in the proportion of microenterprises in five out of the 13 sectors, while in the treatment group there is also a significant change in five sectors. In only two sectors there is a significant change between treatment and control, with the magnitude relatively small.[45] In Appendix Table A.13, we use the method of Acharya, Blackwell, and Sen (2016) to calculate the Average Controlled Direct Effect, using as a mediator a dummy variable for whether the respondent runs a rickshaw. We find that this mediator explains about 30% of the estimated ATE on raw materials and on bills; however, the mediator explains only about 8% of the estimated effect on profits.

Finally, we test for treatment effects on management practices in the microenterprise. To do this, we administered a modified version of the questions used by McKenzie and Woodruff (2016). In Appendix Table A.8, we find a large and significant effect on management practices concerning inventory purchasing and management. It is possible that some part of this impact might be 'mechanical' – for example, a larger asset might require more sophisticated management of inputs. However, the positive effect on purchasing and control of inventories is driven by all three components of that measure – namely, treated respondents are more likely to attempt to negotiate with suppliers on the price of raw materials, more likely to compare prices from alternative suppliers, and they run out of inventories less frequently.[46] Further, we also find some evidence of better marketing practices. Note that our two treatments did not include any assistance with management of the asset, nor any training on – for example – market access or general business management practices. This finding of better inventory management is also consistent with the earlier results that the increase in overall profits is primarily driven by a reduction in business expenditure on raw materials.[47]

3.1.2 The household

Our hire purchase contracts clearly improved the performance of the microenterprise – but what are the consequences of this for household welfare? To answer this question, we test effects of our treatment on household income, expenditure, savings and loans; we show

[45] Specifically, there is a two percentage point greater proportion of rickshaw drivers in the treatment group, and a three percentage point greater proportion of those doing drilling / cutting work.

[46] We also rule out the possibility that the improvement in management practices is a mechanical result of encouraging some respondents to switch into running rickshaws. In Table A.13, we show that only about 1% of this estimated ATE is mediated through the switch into running rickshaws.

[47] The reduction in expenditure on raw materials may also partially reflect some diversification in enterprise activities towards those that are less inventory heavy. For example, a closer inspection of the data reveals that a number of owners of retail shops, in particular food retailers and garment stores, purchased rickshaws; this may have allowed them to diversify activities by delivering to customers, as well as utilising the vehicle to assist in sourcing inputs on a more frequent basis and thereby reducing stockpiling of raw materials.

results in Table 4. In column (1), we find a large and significant treatment effect on total household monthly income, which increases by about 9% relative to the control group. (This effect is driven solely by the treatment effect on business profits; in separate regressions, we find no significant effect on other sources of household income.) In column (2), we find a significant effect on total monthly household consumption expenditure (an increase of 6% relative to the control group). Although the coefficient is positive and relatively large, we find no statistically significant effect on total household savings (column (3)), but do find a large and significant reduction in total household debt (column (4): a reduction of about 50% compared to the control group).[48]

When we disaggregate the increase in household consumption (Appendix Table A.9), we find a striking result: our treatment caused a large and significant effect on households' expenditure on schooling. Specifically, we find an increase of 26% on the control group mean – from about $22 per month to about $28. Tables A.10 and A.11 provide a further disaggregation of household educational expenditure into its constituent sub-categories.[49] We observe significantly greater overall schooling expenditure on both girls and boys (an increase of 25% and 17% respectively, relative to the control mean), with both effects highly significant even after multiple hypothesis corrections. Appendix Table A.11 reveals that the increased spending on children's education is evident across all the measured sub-categories of spending: the treatment effects on school fees, spending on books, stationary and other materials, spending on school meals, as well as school transportation costs. Coefficients are again highly significant even after correction for multiple hypothesis testing across expenditure categories. The effects are positive and significant for both girls and boys, although the estimated effects are generally greater for girls. Our findings on children's educational expenditure are surprising given the muted impacts in the rest of the microfinance literature. As a consistency check, in Appendix Table A.12, we investigate the cross-sectional correlation between business characteristics and household educational expenditure. Using several different specifications, we find a robust and statistically significant conditional correlation between total fixed assets and educational expenditure.[50]

In Figure 3, we show two empirical CDFs – one for total consumption, and one for consumption on schooling. Each graph shows a clear separation of CDFs: a general shift of the distribution to the right. Appendix Table A.9 also shows a significant increase in expenditure on food, of about 5% of the control group mean (from about $53 to $56 per

[48] A regression with an outcome variable constructed as total household savings minus total household loans (which was not pre-specified, but is the sum of the two pre-specified variables) reveals a large and statistically significant positive effect of treatment assignment on net household savings.

[49] We collected these measures in the 24-month endline survey, prompted by having found significant effects on schooling expenditure in the previous follow-up rounds.

[50] Note that our results are also consistent with the only other asset-based microfinance paper we are aware of: in a rural setting, Jack et al. (2019) also find positive outcomes on girls' schooling.

month). This result stands in clear contrast to previous research on microfinance; it suggests that financing the purchase of a productive asset may generate sustained improvements in household welfare as well as improving microenterprise performance, specifically in terms of households' investment in their children's human capital.

Finally, in Appendix Table A.6, we test for effects on respondents' attitudes towards saving (including respondents' reports of savings problems, making of unnecessary purchases, feeling pressure to share, and similar outcomes). We find no effect on any of these measures.

3.2 Separating treatment 1 and treatment 2

In Appendix Section I, we repeat our earlier analysis, splitting by whether respondents were assigned to treatment 1 or treatment 2.[51] We find no robust differences in average outcomes between these treatments.[52] In Section 5, we show that the difference between treatment 1 and treatment 2 matters when considering heterogeneity in risk aversion; however, there is no robust difference in average effects of the two treatments across the sample as a whole.

3.3 Separating by survey wave

Appendix Section J repeats our earlier ITT analysis, disaggregating by survey wave. Specifically, we show estimates individually for follow-up surveys at the three-month, six-month, 12-month, 18-month and 24-month points. Our results are remarkably stable across waves: we see no large differences in coefficients for any of our pre-specified outcome variables across time. In particular, we note that the majority of our estimated effects remain large even at the 24-month follow-up; this is itself an important aspect of our results (that is, the fact that our control group does not catch up over time), and one that we explore shortly with our structural model.

3.4 Robustness

We test robustness both to outliers and to endogenous attrition. Appendix Section K considers outliers: there, we take the main treatment effects of interest from our previous analysis, and subject them to increasing degrees of winsorization. Specifically, we report winsorizing

[51] Following our pre-analysis plan, we estimate: $y_{it} = \beta_0 + \beta_1 \cdot \texttt{T1}_i + \beta_2 \cdot \texttt{T2}_i + \beta_3 \cdot y_{i0} + \tau_{s_i} + \varepsilon_{it}$. Recall that some individuals who were offered the flexible contract ($\texttt{T2}_i$) decided to take up the fixed-repayment contract.

[52] We do see some individually significant differences in some outcome variables; compared to respondents assigned to treatment 1, those assigned to treatment 2 have higher business management practices on (i) purchasing and stock control, and (ii) on costing and record keeping. However, these differences are not robust to corrections for multiple hypothesis testing.

(top and bottom) at 2.5% (used for our original analysis), 1%, 5% and 10%. Our results remain remarkably stable across specifications, including their statistical significance. This is entirely consistent with the empirical CDFs (for example, in Figure 3), which show that our treatment effects apply across the distribution (rather than, for example, only appearing in the tails).

Attrition is very low for this sample: the overall attrition rate is just under 4%.[53] Further, attrition is uncorrelated with treatment.[54] For these reasons, we conclude that our analysis is robust to concerns about endogenous attrition.

4 Structural analysis: Adjustment costs, wealth dynamics and contractual design

To help understand these results, we now specify and calibrate a dynamic structural model. The purpose of this model is to understand how a large capital injection, financed through a hire-purchase contract, can generate large and sustained improvements in household wealth and income. Further, the model helps us to characterise microenterprise dynamics, and to understand how our treatments affected those dynamics. In these regards, our approach is broadly similar to two seminal structural models of microfinance: those of Kaboski and Townsend (2011) and of Banerjee et al. (2019). Our model builds on these earlier contributions by incorporating explicitly an asset-based financing product of the form implemented in our experiment.

Specifically, our structural estimates describe a world in which there is a low return to holding cash or other liquid assets. This means that households choose to hold only minimal liquid assets over time. Credit-constrained households are therefore unwilling to accumulate sufficient liquid wealth to overcome substantial non-convex capital adjustment costs (costs that are driven, for example, by the indivisibility of fixed assets) – even though, if purchased, such assets would have a high productive value to the household microenterprise. This kind of juxtaposition – between high-return illiquid assets and low-return liquid assets – has been noted in several recent empirical contexts; in particular, it is central to Kaboski and Townsend's (2011) structural analysis of the 'Million Baht' program in

[53] As one would expect, this rate increases with the time since baseline survey – but the wave-by-wave attrition rates remain low for all waves: for the three-month follow-up, attrition is 2.4%, for the six-month follow-up, it is 2.6%, for the 12-month follow-up, it is 4.6%, for the 12-month follow-up, it is 5.9%, and for the 24-month follow-up, it is 7.8%.

[54] When we estimate equation 1, using a dummy for attrition as the outcome variable (and, of course, omitting the ANCOVA term), we obtain a treatment effect of just 0.7 percentage points, with $p = 0.55$.

Thailand.[55] The same juxtaposition has also recently been applied to household behaviour in Heterogeneous-Agent New Keynesian macroeconomic models, where it is described as generating a 'wealthy hand-to-mouth' phenomenon (see, in particular, Kaplan and Violante (2014), and the discussion in Kaplan, Violante, and Weidner (2014)). Our model implies that household wealth levels are likely to be highly persistent, and that there are profitable and persistent gains from microfinance products that provide large capital injections.

4.1 Model specification

The no-contract case: Our basic model describes a credit-constrained household that runs a microenterprise and optimises on an infinite horizon in discrete time:

$$V_n(k_t, f_t, \varepsilon_t, \psi_t) = \max_{k_{t+1}, f_{t+1}} \mathbb{E}_{(\varepsilon_{t+1}, \psi_{t+1}) \,|\, (\varepsilon_t, \psi_t)} \left[\frac{c_t^{1-1/\gamma}}{1-1/\gamma} + \beta \cdot V_n \left(k_{t+1}, f_{t+1}, \varepsilon_{t+1}, \psi_{t+1} \right) \right] \tag{2}$$

subject to

$$c_t = (1-\tau) \cdot \exp(\mu + \varepsilon_t) \cdot k_t^{\alpha} - \Delta k_t - \delta \cdot k_t - s_t - a_t > 0; \tag{3}$$

$$s_t = f_{t+1} - (1+r) \cdot f_t; \tag{4}$$

$$\varepsilon_{t+1} \,|\, \varepsilon_t \sim \mathcal{N}\left(\rho \cdot \varepsilon_t, \sigma^2 \right). \tag{5}$$

Here, the state space comprises fixed capital (k_t), a liquid financial asset (f_t), a productivity shock (ε_t), and a dummy for whether the household has an investment opportunity (ψ_t). The Bellman equation (2) is formed by assuming that the household maximises the expected discounted future utility of consumption. Equation 3 explains that the household obtains income through the microenterprise (where we assume a value-added production function that is Cobb-Douglas in fixed capital, having total factor productivity of $\exp(\mu + \varepsilon_t)$). We allow for an ad-valorem kinship tax on microenterprise income (τ); this is intended primarily to reflect community 'sharing norms', by which the respondent household is expected to contribute to poorer households in the extended family and broader community (Jakiela and Ozier, 2016; Squires, 2018). We define Δk_t as the change in fixed capital ($\Delta k_t \equiv k_{t+1} - k_t$); capital depreciation is $\delta \cdot k_t$. We use a_t for capital adjustment costs, defined shortly (Equation 7). Equation 4 is a standard savings equation (in which we allow a slightly negative real interest rate, r, on the assumption that savings are largely held in cash, and often without effective savings devices (Dupas and Robinson, 2013). Equation 5 allows both for productivity shocks and for persistent entrepreneurial ability.

[55] Kaboski and Townsend (2011) provide for lumpy investments with complete irreversibility; they allow such investments to have a return 'higher than the interest rate on liquid savings, r, and sufficiently high to induce investment for households with high enough liquidity' (p.1373)

To this basic setup we add four important constraints, which we view as important realities of running a microenterprise in a low-income country. First, like Banerjee et al. (2019), we assume that – absent formal microfinance contracts – households are credit-constrained: $f_t \geq 0$. Second, fixed capital is lumpy: a household cannot, for example, buy or sell a rickshaw one wheel at a time. The assumption of lumpiness is a common feature of several key models of microfinance (see, for example, Besley, Coate, and Loury (1993), Kaboski and Townsend (2011), Field et al. (2013) and Banerjee et al. (2015)). This assumption reflects the reality that respondents do not have access to liquid rental markets for fixed capital (nor, indeed, to sophisticated norms or contractual forms to allow for time-sharing in fixed capital usage, as in Bassi, Muoio, Porzio, Sen, and Tugume (2020)). Empirically, it reflects the observation that a large number of enterprises in our data do not adjust their fixed capital from one period to the next. It also reflects the observation that many enterprises who make such capital adjustments do so by making a discrete switch from one line of business into another.[56] Formally, we follow Field et al. (2013) by modelling such lumpiness through imposing a minimum investment size (κ); we view this assumption as a useful way of capturing non-convex adjustment costs more generally. Third, like Kaboski and Townsend (2011), we allow investment opportunities to be stochastic; we do this by allowing ψ_t to be drawn independently each period from a Bernoulli distribution having parameter $\omega < 1$. Formally, we require that Δk_t belongs to one of three line segments:

$$\Delta k_t \in \begin{cases} \{[-(1-\delta)\cdot k_t, -\kappa],\ [-\delta \cdot k_t, 0]\} & \text{if } \psi_t = 0; \\ \{\underbrace{[-(1-\delta)\cdot k_t, -\kappa]}_{\text{sell}},\ \underbrace{[-\delta \cdot k_t, 0]}_{\text{repair}},\ \underbrace{[\kappa - \delta \cdot k_t, \infty)}_{\text{buy}}\} & \text{if } \psi_t = 1. \end{cases} \tag{6}$$

Here, the segment $[-(1-\delta)\cdot k_t, -\kappa]$ correspondents to a situation where the household is selling fixed capital; we require a minimum sale of size κ.[57] The segment $[\kappa - \delta \cdot k_t, \infty)$ corresponds to a situation where the household purchases fixed capital; here, we require a minimum purchase of value κ. Together, when $\kappa > 0$, these two line segments imply a non-convex adjustment cost in capital: what Bloom (2009) describes as 'a central region of inaction'. Note that this investment segment is unavailable to the household when $\psi_t = 0$. To this we add a small intermediate segment for replacement investment, $[-\delta \cdot k_t, 0]$, which corresponds to a situation in which the household neither buys nor sells fixed capital, but

[56] Previous empirical work shows that business start-up costs for urban microenterprises can be substantial. In particular, Fafchamps and Quinn (2017) study aspiring entrepreneurs in Ethiopia, Tanzania and Zambia, and show large effects on business start-up from cash grants of $1,000. Klinger and Schündeln (2011) show large effects for grants between $6,000 and $15,000; McKenzie (2017) shows large effects from grants with a median size of $57,000.

[57] Of course, the household cannot sell more fixed capital than it owns. Note that, for households having $k_t < \kappa \cdot (1-\delta)^{-1}$, this first segment is a null set; in that case, asset sales are not possible.

chooses to repair some share of the depreciation.[58]

Fourth, we assume that fixed capital is partially irreversible – in the sense that sales of fixed capital incur a proportionate mark-down in capital value, $\phi \in [0, 1]$ (as in, for example, Ramey and Shapiro (2001) and Cooper and Haltiwanger (2006)):[59]

$$a_t = \begin{cases} -\phi \cdot (\Delta k_t + \delta \cdot k_t) & \text{if } \Delta k_t + \delta \cdot k_t < 0; \\ 0 & \text{otherwise.} \end{cases} \tag{7}$$

Our model therefore combines both nonconvexities (in the form of the capital adjustment costs) and financial market frictions (in the form of household credit constraints). As many authors have noted – including, recently, Ghatak (2015), Banerjee et al. (2019) and Balboni, Bandiera, Burgess, Ghatak, and Heil (2020) – this combination opens the possibility that the effects of large capital shocks are highly persistent.[60]

Introducing microfinance: This basic setup can be adjusted to allow for microfinance – first in the form of a standard unconditional loan of \$475 and then in the form of a \$1,500 asset-finance contract that mimics our hire-purchase agreement.[61] To model the standard loan, we introduce a new state variable, x_t; this is an integer count of the household's point in a loan cycle (such that $x_t = 0$ reflects the start of the cycle, $x_t = X$ is the final period of repayment, and x_t increments by one each period). We then write a new value function, incorporating this state variable; we also assume that the household is lent some lump-sum F to be repaid in X periods (with zero interest); we do this by relaxing the lower bound on the financial asset, such that $f_t \geq -F + x_t \cdot F/X$. Alternatively, to model the fixed-repayment asset financing contract described earlier, we retain the assumption $f_t \geq 0$, and adjust Equation 4 to account for the repayment structure required by that contract. We explain these amendments in detail in Appendix Section O.

[58] Thus, for example, a household can sell a rickshaw, or buy a rickshaw, or add a new coat of paint to repair general wear and tear on the rickshaw. But no amount of new paint will turn one rickshaw into two. For this reason, note that the upper bound of the first segment corresponds to a situation in which the household sells fixed capital but pays the depreciation on the existing capital; the lower bound of the third segment correspondents to a situation where the household buys fixed capital but allows the existing capital to depreciate.

[59] Kaboski and Townsend (2011) assume that investment is completely irreversible. In our model, this corresponds to the limiting case $\phi = 1$.

[60] As Kaboski and Townsend (2011, pp.1360-1361) put it, 'given the lumpiness of projects, small amounts of credit are relatively unlikely to change investment decisions on large projects'.

[61] For tractability, we do not consider our flexible-repayment asset-financing contract in this structural section.

4.2 Solution and calibration

We solve the model in two steps. First, we solve for V_n (the no-contract case); this is a stationary infinite-horizon problem (by equation 2), and can be solved by standard numerical contraction. Second, with the solution to V_n in hand, we solve for the two separate microfinance cases using backward over the fixed number of repayment periods. We then obtain relevant moments (described shortly) by simulating forwards through the model solution, starting from the observed joint distributions of (k_t, f_t) (and implementing the asset-finance contract for the treatment group). For each group, we simulate some proportion of individuals taking no contract, some proportion taking the loan contract, and some proportion taking the asset-based contract; we do this using the observed empirical proportions who respectively took each contract type.

We use several different methods to calibrate the model parameters; these are summarised in Table 5, and described in detail in Appendix Section O. We obtain the production function parameters (μ and α) and the productivity persistence and variance (ρ and σ^2) by using a quasi-differenced GMM estimator (Blundell and Bond, 2000; Cooper and Haltiwanger, 2006). We rely on an incentivised belief-elicitation exercise to obtain values for δ and ϕ. We back out τ by an accounting exercise using baseline household control group averages for consumption, business profits, asset sales and net saving. To pin down the probability of having an investment opportunity, we use the take-up rate under treatment 1: we use $\omega = 0.52$. Finally, we assume a quarterly discount factor of $\beta = 0.9$ and we use $\gamma = 0.35$ as the intertemporal elasticity.[62] With these parameter values in hand, we then search over a grid of possible values for κ, in order to understand the importance of non-convex adjustment costs. We evaluate these different values using an Indirect Inference loss function, in which we target treatment effects on fixed capital, value-added, and household consumption; we target these effects at the three-month, six-month, 12-month, 18-month and 24-month follow-ups.

4.3 Results: Household behaviour under non-convex adjustment costs

Figure 4 shows the key result of our structural model: our treatment effects are rationalised much more effectively by a model with large non-convex capital adjustment costs than a more standard model with no such costs; as the figure shows, the model loss under $\kappa = 0$ is approximately double the loss with (for example) κ of 1400 or above.[63] In this context, we view the purpose of this structural exercise *not* as identifying a single κ that should be taken

[62] We chose $\gamma = 0.35$ to match the estimate for India in Ogaki, Ostry, and Reinhart (1996). We chose $\beta = 0.9$ to reflect the stylised observation – from low-stakes incentivised baseline games – that the respondent pool has relatively high impatience over cash.

[63] This pattern is robust to allowing for a wide range of alternative values of (β, γ).

very literally as a minimum investment size; as noted earlier, κ serves here as a stylised device to capture non-convex adjustment costs through capital lumpiness, and our results here indicate that such costs are economically large and meaningful. Indeed, our estimate of large non-convex capital adjustment costs is consistent with treated respondents' decision to purchase very valuable assets; as noted earlier, the median asset purchase was $1,666, and approximately one-third of respondents chose the maximum financing amount possible.

The model with large non-convex costs fits the observed data remarkably well, in several respects. First, the model replicates closely the pattern of *targeted moments*. We show this in Appendix Figure A.8; this figure shows both the real treatment effects (for fixed capital, value-added and consumption, at all follow-up waves), and we superimpose simulated treatment effects under both the $\kappa = 1500$ and $\kappa = 0$ model variants. Our preferred model replicates large and persistent treatment effects on both fixed capital and enterprise value-added. (The fit on consumption is close to the observed treatment effect, though nonetheless smaller in absolute terms. As we discussed earlier, our reported consumption treatment effects include spending on children's education – which is, in many respects, more of an investment in human capital than the kind of consumption that the model describes.) In contrast, the treatment effects cannot be replicated by the $\kappa = 0$ version of the model; in that version, the control group is able to catch up quickly, both in terms of fixed capital and value-added.

Second, the model also replicates well a large number of *untargeted moments*. Specifically, we compare model predictions to data for fixed capital (both in levels and in first differences), for value-added (in levels and in differences) for household consumption (in levels and in differences) and for financial assets (in levels); we do this both for control and treatment groups, at the three-month, six-month, 12-month, 18-month and 24-month marks, and we map the 25th, 50th and 75th percentiles. In Appendix Figure A.9, we compare real and simulated moments, and show that the fit for our preferred model is remarkably close to the 45-degree line (in Appendix Section O, we provide a graphical comparisons for each of these moments, separately for the control and treatment groups). Again, the model fit is much better under $\kappa = 1500$ than $\kappa = 0$. In particular, under $\kappa = 0$, the model predicts substantially more capital accumulation – both in control and treatment groups – than is actually observed.

More generally, our preferred model framework rationalises three key features of our data – and, more generally, data from many microenterprise studies in the literature. *First*, most microenterprises in our sample make little or no adjustment to their fixed capital stock over time; it is *not* the case, for example, that households steadily build their wealth by multiple incremental investments in fixed capital. Indeed, our data on period-to-period changes in fixed assets reveals that the median six-monthly change for the control group

was zero (as was the 75th percentile); even at the 90th percentile the change in capital is only $300, and we only observe increases in total fixed capital of $1,000 or more in 7% of our follow-up data for the control group.[64] *Second*, notwithstanding this fact, the marginal product of fixed capital in the microenterprise is high (De Mel et al., 2008; Fafchamps et al., 2014)). Specifically, we estimate $\alpha = 0.16$; this is similar to other microenterprise production function estimates in other contexts (Janes, Koelle, and Quinn, 2020; Atkin, Khandelwal, and Osman, 2017), and – for the firm sizes in our dataset – implies a high marginal return to fixed capital.[65] *Third*, most households in our data hold minimal wealth in cash or other liquid assets (Dupas and Robinson, 2013).

Finally, Figure 5 illustrates the key implication of our model for contract design; this figure shows the policy functions, both for fixed capital k (in the left panel) and financial capital f (in the right panel). Specifically, the figure illustrates the stark implications for household capital accumulation in our preferred model: given both the opportunity and the cash, households would willingly invest in fixed capital. However, large non-convex adjustment costs mean that these high returns to capital lie beyond the reach of most households; instead, those same households rationally consume their available cash.[66] Rather, interventions that facilitate the acquisition of productive indivisible assets can have highly-persistent impacts, by shifting the household to a new point within what is essentially a stable *range* of states.[67] In short, our model implies that a microfinance intervention offering a relatively small lump-sum payment will not generate transformational change to the household's circumstances. The household will rationally spend such a payment to increase consumption in the short run; in our model, such a payment will not suffice for investment in fixed capital, and will prove too costly to be held in cash. As a consequence, microfinance interventions that allow the household to accumulate a larger lump sum – such as the intervention described in this paper, and the 'grace period' innovations of Field et al. (2013) – can generate persistent improvements in both wealth and welfare.

[64] Similarly, Balboni et al. (2020) argue that the opportunity for individuals to significantly increase their productive assets would not have arisen without the program that they study: only 5.6% of their control group experience a change of log assets of the same magnitude as their average asset injection.

[65] For example, for a firm having fixed capital of $500 and with $\varepsilon_t = 0$, this implies a marginal product of capital of $\alpha \cdot \exp(\mu) \cdot 500^{\alpha-1}$: a return of about 33%.

[66] We noted earlier that the general behaviour described by our model mirrors that of the 'wealthy hand-to-mouth' model of Kaplan and Violante (2014). The right panel of Figure 5 shows that our model replicates one of the key implications of that earlier literature: namely, a very high marginal propensity to consume out of shocks to cash (observed in our model at least for households with relatively low levels of physical capital).

[67] Appendix Figure A.12 illustrates this stability using a phase diagram in (k, f) space.

5 Heterogeneity

Our earlier analysis pools the two treatments; when disaggregating (in section 3.2) we found no significant difference in average treatment effects between fixed and flexible contracts. This motivated our focus in the structural analysis on the fixed-repayment contract. In this section, we think more explicitly about heterogeneity, both in outcomes and in take-up. This also follows an increasing recent focus on heterogeneous treatment effects in the microfinance literature (Meager, 2019; Banerjee et al., 2019; Crépon, El Komi, and Osman, 2020).

In our pre-analysis plan, we committed to testing for outcome heterogeneity across terciles in five dimensions, including risk risk aversion and loss aversion (both measured at baseline using the incentivised elicitation tasks).[68] In this section, we summarise heterogeneity in take-up, usage of the flexible repayment contract, and in follow-up business and household outcomes.

5.1 Heterogeneity in take-up

In Appendix Table A.38, we report regressions of take-up, where the dependent variable is a dummy for whether the respondent took up our asset financing contract.[69] In each column, we test heterogeneity based on a tercile-split for the aforementioned heterogeneity variables.[70] We find striking heterogeneity by baseline risk aversion, with a similar but less significant pattern by baseline loss aversion.[71] Specifically, those individuals in the highest tercile of risk aversion (the most risk averse) had a take-up rate of 43% when offered the fixed-repayment contract, whereas take-up rates for the most risk averse group when assigned to the flexible-repayment contract was 24 percentage points higher ($p = 0.001$ for a test of the difference). Figure 6 visually illustrates the stark result that – for those assigned to the fixed-repayment contract – take-up rates are lowest for the most risk averse

[68] The other (baseline) dimensions were: time preferences (measured using an incentivised elicitation task), management practices (measured using an index of the questions proposed by McKenzie and Woodruff (2016)) and numeracy (measured using an index combining a digitspan and numerical calculation exercises).

[69] The variable is coded as a 1 whether the take-up was of the flexible-repayment contract or the fixed-repayment contract – recalling that those assigned to the flexible-repayment contract were alternatively permitted to take the fixed-repayment contract (9% chose to do this).

[70] We conducted this analysis of heterogenous take-up before we had collected follow-up data for the study (and before we had submitted our pre-analysis plan), although we used the same pre-specified heterogeneity variables as a related lab-in-the-field experiment that was conducted with the same participants during the baseline workshop (see https://www.socialscienceregistry.org/trials/2224). In that plan, and our subsequent plan that included outcome heterogeneity regressions, a tercile split was pre-specified, rather than a median split, based on the recommendations of Gelman and Park (2009).

[71] This is unsurprising, given that measures of loss aversion often correlate with measures of risk aversion (we also find a highly significant correlation between the two) and that our baseline exercises for measuring risk aversion involved substantially more time and elicitation effort than those for loss aversion.

people, for those assigned to the flexible-repayment contract we actually observe the highest take-up rates among the risk averse. In the table, we also confirm the significant of this result when tested as a 'difference-in-difference': the take-up differential between the least and most risk averse group (when offered the fixed-repayment contract), compared to the difference in take-up rates for the least and most risk averse who were offered the flexible-repayment contract ($p = 0.002$ for a test of the difference). We also find that the most loss-averse microenterprise owners had a take-up rate of 48% when offered the fixed-repayment contract, increasing to 65% for take-up of the most loss averse who were offered the flexible contract ($p = 0.029$ for a test of the difference).[72]

These results suggest that the insurance-like benefit of the flexible-repayment contract may have been particularly valued by the most risk and loss averse microenterprise owners (who may value the option to make lower payments when their business profits are low, and visa versa). We explore this further when investigating contract repayment patterns in Section 5.3.

5.2 Heterogeneity in outcomes

We now explore heterogeneity in outcomes, focusing once again on risk aversion. Table 6 displays estimates in which we again interact each of the two treatment assignment dummies (representing the offer of the fixed- or flexible-repayment contract) with dummies for each of the three baseline risk terciles (low, medium and high risk aversion). Each column present heterogeneous intent-to-treat effects for one of the following major outcome variables: number of businesses managed (which largely captures the extensive margin), business profits, total business assets, total business fixed assets, household income, household consumption and household savings.

We find clear evidence of heterogeneity by risk aversion, for many outcomes. In each case, results follow the same general pattern: when assigned to the fixed contract, the least risk averse individuals have significantly greater impacts than the most risk averse; however, this difference is reduced (and sometimes even reversed) when assignment is to the flexible contract. Specifically, this 'closing of the gap' between the least and most risk averse under the flexible contract is observed for the estimated effects on: (i) number of businesses managed, (ii) business profits, (iii) total business assets, (iv) total business fixed assets, (v) total household consumption expenditure and (vi) total household savings. The effect is particularly striking, for example, when considering total household consumption expenditure

[72] This result is also consistent with recent work showing the importance of loss aversion for take-up of collateralised microfinance (Jack et al., 2019; Carney, Lin, Kremer, and Rao, 2018). For the other three dimensions of heterogeneity – time preferences, management practices and mathematical ability – the evidence overwhelmingly suggests that there is no heterogeneity in take-up by those variables.

(column 6). In this case, the fixed and flexible treatments each have heterogeneous effects across terciles ($p = 0.027$ and $p = 0.063$ respectively). However, the effects are heterogeneous in *opposite* directions: the fixed contract treatment has the largest effect for respondents who are least risk averse, whereas the flexible treatment has the largest effect for respondents who are most risk averse. We report similar analysis for the other four pre-specified dimensions of heterogeneity in Appendix Section M.[73] For heterogeneity by loss aversion, there are similar general patterns, though not as clear and not significant; this is unsurprising, given that measures of loss aversion often correlate with measures of risk aversion.

Considering our results on heterogeneous selection, this provides further evidence suggesting that the implicit insurance in the flexible-repayment contract is particularly valuable for risk averse respondents. This is consistent with the risk-heterogeneity result in Field et al. (2013) (on the effect of a fixed grace period).[74]

5.3 Heterogeneity in usage of the flexible repayment option

As illustrated in the right panel of Figure 2, there is significant month-to-month variation in repayments made under the flexible contract, mostly lying in between what entrepreneurs were required to pay and what the equivalent required payment under the fixed contract would have been. In Appendix Table A.39, we formally explore how clients utilise the flexible repayment option, particularly when they experience business shocks. Business shocks are defined as the percentage change in monthly business profits, compared to the value six months prior. In each column, the dependent variable is total payments made in the previous six month period for individuals under the flexible repayment contract.[75] In column 1, we see that clients who faced a positive shock in their business profits in the previous six months were more likely to exercise their flexible repayment option by making higher payments, while those that faced negative shocks made lower payments (compared to the mean of 20% payment over the six month period).[76] This is an intuitive result that demonstrates usage of the flexible repayment option for its insurance value, and is consistent with results in Battaglia et al. (2018).

In the remaining columns of the table, we explore heterogeneity in this response to business shocks, focusing on the interaction between shocks and risk. We follow Battaglia

[73] We do not observe strong patterns of heterogeneous outcomes by baseline management practices, time preferences or mathematical ability.

[74] Note that this is different to the results found in Battaglia, Gulesci, and Madestam (2018) – however, as those authors note, the relationship between risk aversion and flexibility is theoretically ambiguous due to the possibility of selection into more risky or less risky projects. In our context, we found no significant difference in the average size or type of asset purchased between fixed and flexible contracts.

[75] The flexible contract allowed payments greater than the required 2.5% of the asset value each month.

[76] Recall that the minimum permitted payment over a six-month period would be 15% (2.5% per month).

et al. (2018) in focusing on two types of risk that are important for business performance and contract repayment: (i) personal risk aversion of the microenterprise owner, and (ii) risk exposure of the business. For business risk exposure, we use the volatility of business profits, measured using the standard deviation of the previous three months of business profits (at baseline). Both risk variables are captured using a tercile split, with 'medium risk' and 'high risk' referring to the middle and highest tercile of the respective variable. To begin, column 2 presents the simple correlation between contract payments and business risk exposure, revealing that the most risk-exposed businesses (both high and medium risk) are less likely to make extra payments on average (compared to the least risk-exposed businesses, the omitted category). In column 3, we add business profit shocks to the analysis, interacting shocks with risk exposure measures. Results reveal that the most risk-exposed businesses – when faced with a positive shock – are much more likely to make higher excess payments (significant at the 1% level, with no other interaction terms significantly different from zero). In columns 4 and 5, we turn to the measure of risk aversion for the microenterprise owner. While column 4 indicates that there is no general relationship between repayments and risk aversion, when shocks are interacted with the measure of risk aversion in column 5 we see that the most risk-averse individuals were more likely to make additional payments when faced with a positive business shock (significant at the 1% level, with no other interaction terms significantly different from zero).

In summary, the flexible-repayment contract appears to provide some insurance-like benefit to the most risk averse (and risk-exposed) microenterprise owners in dealing with shocks; this is consistent with our previous analysis of heterogeneity, where we found that the most risk-averse microenterprise owners had higher selection into the flexible contract and greater post-treatment impacts, compared to similarly risk averse individuals who were only offered the fixed repayment contract.

6 Conclusions

Can microfinance institutions better serve graduated borrowers through creative variations on the standard microcredit contract? In this paper, we have tested the effects of a hire-purchase contract, which serves to facilitate large capital injections for experienced microfinance clients. We see high take-up, and find large and significant gains in microenterprise assets and profits, for household income and for household consumption. For more risk-averse clients, the gains are particularly pronounced when the contract structure incorporates repayment flexibility. We show that our results can be rationalised by a structural model that allows for large non-convex adjustment costs in fixed capital.

Previous studies that have provided poor individuals in low-income countries with a

large capital injection (usually in the form of productive asset grants) have found substantial and persistent increases in business and household income (see, in particular, De Mel et al. (2008), Fafchamps et al. (2014), Banerjee, Duflo, Goldberg, Karlan, Osei, Parienté, Shapiro, Thuysbaert, and Udry (2015), Hussam et al. (2017), Bandiera, Burgess, Das, Gulesci, Rasul, and Sulaiman (2017) and Crépon et al. (2020)).[77] Of course, that literature is not directly comparable to our current paper, since our capital injection is provided as a loan, and the MFI recovers its finances. Nonetheless, our results suggest that – for graduated borrowers, at least – asset-based financing may provide a sustainable mechanism to generate the high returns identified in the earlier capital drop studies.

In the wake of COVID-19, many governments in low-income countries and development finance institutions are under significant financial pressure, and there is a growing interest amongst the financial inclusion and policy community in developing innovative and financially sustainable asset-based microfinance products that can achieve some of the benefits of the earlier studies while recovering and redeploying the capital (Kumaraswamy, Mattern, and Hernandez, 2020).[78] Our results show that an asset-based microfinance product can work – both from an administrative perspective (high repayment rates, active and intuitive use of the flexible-repayment option), and in terms of positive outcomes at the client level (both business performance and household welfare).

Together, our results suggest that large asset-based microfinance contracts have the potential to stimulate microenterprise growth among graduated borrowers. Given their Shariah-compliant contractual form, such contracts are likely to have particular appeal for many Muslim clients – a group disproportionately represented among the world's poor and among the financially excluded (El-Gamal, El-Komi, Karlan, and Osman, 2014). There is also no reason for these advantages to be limited to Islamic contexts; indeed, asset-based financing is an important source of credit for small businesses around the world, and a form of contract that could readily be extended to many microenterprises.

[77] In recent work, Karlan, Banerjee, Osei, Trachtman, and Udry (2020) find that just giving ultra-poor people a productive asset, without any training on how to use it, was not as effective as the whole package. One major difference in our context is that we worked with graduated microenterprise owners, who did not need any training or continued mentoring on how to use the business asset.

[78] To quote CGAP, a partnership of 30 leading development organisations focusing on financial inclusion (housed at the World Bank), "Asset transfer programs have demonstrated enormous impact but are expensive...with the SDGs facing an estimated annual investment gap of $2.5 trillion, financing offers a more sustainable alternative to transfers, with potential to drive asset ownership at scale...but the terms of traditional microfinance loans often are poorly suited to financing assets..New innovations in asset-finance models promise to overcome challenges reaching low-income households" (CGAP, 2020).

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Tables

Table 1: **Contract structure: Fixed-repayment contract**

MONTH	MFI	PAYMENT		TOTAL
	OWNERSHIP	RENT	OWNERSHIP	PAYMENT
1	9.00%	9.00	50.00	59.00
2	8.50%	8.50	50.00	58.50
3	8.00%	8.00	50.00	58.00
4	7.50%	7.50	50.00	57.50
5	7.00%	7.00	50.00	57.00
6	6.50%	6.50	50.00	56.50
7	6.00%	6.00	50.00	56.00
8	5.50%	5.50	50.00	55.50
9	5.00%	5.00	50.00	55.00
10	4.50%	4.50	50.00	54.50
11	4.00%	4.00	50.00	54.00
12	3.50%	3.50	50.00	53.50
13	3.00%	3.00	50.00	53.00
14	2.50%	2.50	50.00	52.50
15	2.00%	2.00	50.00	52.00
16	1.50%	1.50	50.00	51.50
17	1.00%	1.00	50.00	51.00
18	0.50%	0.50	50.00	50.50
TOTAL		85.50	900.00	985.50

Note: This table provides an example of the required payment structure under the fixed-repayment contract for an asset costing $1,000, where the client has paid $100 to initially purchase 10% of the asset. A nominal annual rental rate of 12% implies monthly rent of 1% of the asset's value, which is $100. In addition to the rent, the client is also obliged to purchase 5% of the MFI's ownership share each month, based on the initial asset value of $1,000, which implies an amount of $50.

Table 2: **Treatment effects: Overall business outcomes**

	(1) Runs a buiness	(2) Number of businesses	(3) Business total assets	(4) Business revenue	(5) Business profits	(6) Business employees
Assignment	0.09	0.10	401.22	1.82	26.93	0.04
	(0.02)	(0.02)	(89.94)	(39.65)	(9.93)	(0.06)
	[0.00]***	[0.00]***	[0.00]***	[0.96]	[0.01]***	[0.54]
	{0.00}***	{0.00}***	{0.00}***	{0.47}	{0.01}***	{0.28}
Control mean (follow-up)	0.80	0.82	1003.34	689.65	249.31	0.56
Observations	3,608	3,608	3,608	3,608	3,608	3,608

Note: In this table we report the *intent-to-treat* estimates of the combined treatment on primary outcomes, obtained by least-squares estimation. Below each coefficient, we report a standard error in parenthesis, a p-value in brackets, and a q-value in curly braces. Standard errors allow for clustering at the level of the individual. q-values are obtained using the sharpened procedure of (Benjamini et al., 2006). We denote significance using $*$ for 10%, $**$ for 5% and $***$ for 1%.

Table 3: **Treatment effects: Effect on business assets**

	(1) Total fixed assets	(2) Current assets: cash	(3) Current assets: accounts receivable	(4) Current assets: inventory
Assignment	438.05	2.68	-0.59	-29.76
	(67.15)	(1.77)	(1.47)	(34.53)
	[0.00]***	[0.13]	[0.69]	[0.39]
	{0.00}***	{0.25}	{0.53}	{0.36}
Control mean (follow-up)	660.19	31.38	9.93	250.77
Observations	3,608	3,608	3,608	3,608

Note: In this table we report the *intent-to-treat* estimates of the combined treatment on primary outcomes, obtained by least-squares estimation. Below each coefficient, we report a standard error in parenthesis, a p-value in brackets, and a q-value in curly braces. Standard errors allow for clustering at the level of the individual. q-values are obtained using the sharpened procedure of (Benjamini et al., 2006). We denote significance using $*$ for 10%, $**$ for 5% and $***$ for 1%.

Table 4: **Treatment effects: Effect on the household**

	(1) Household income	(2) Household consumption expenditure	(3) Household savings	(4) Household loans	(5) Household assets
Assignment	31.47	12.95	16.44	-22.81	20.33
	(12.66)	(3.37)	(19.16)	(3.65)	(14.03)
	[0.01]**	[0.00]***	[0.39]	[0.00]***	[0.15]
	{0.01}**	{0.00}***	{0.19}	{0.00}***	{0.08}*
Control mean (follow-up)	357.35	220.40	113.03	46.05	681.79
Observations	3,608	3,608	3,608	3,608	1,410

Note: In this table we report the *intent-to-treat* estimates of the combined treatment on primary outcomes, obtained by least-squares estimation. Below each coefficient, we report a standard error in parenthesis, a p-value in brackets, and a q-value in curly braces. Standard errors allow for clustering at the level of the individual. q-values are obtained using the sharpened procedure of (Benjamini et al., 2006). We denote significance using $*$ for 10%, $**$ for 5% and $***$ for 1%.

Table 5: **Calibrated structural parameters**

PARAMETER	DESCRIPTION	VALUE	SOURCE
μ	mean of log productivity	5.93	Panel GMM
ρ	quarterly autocorrelation of productivity	0.62	Panel GMM
σ	standard deviation of productivity	0.30	Panel GMM
α	curvature of production	0.16	Panel GMM
δ	quarterly depreciation rate	0.05	Incentivised measure
ϕ	partial irreversibility cost	0.25	Incentivised measure
τ	ad-valorem sharing tax	0.15	Baseline accounting
ω	probability of investment opportunity	0.52	Take-up under treatment 1
γ	intertemporal elasticity of substitution	0.35	Assumed
β	quarterly discount factor	0.90	Assumed

Note: This table reports a series of structural parameter values used for our calibration exercise. 'Panel GMM' refers to a quasi-differenced GMM panel estimator; 'incentivised measure' refers to a series of incentivised lab-in-field games conducted at baseline; 'baseline accounting' refers to an accounting exercise using baseline data. We provide further detail in Appendix Section O.

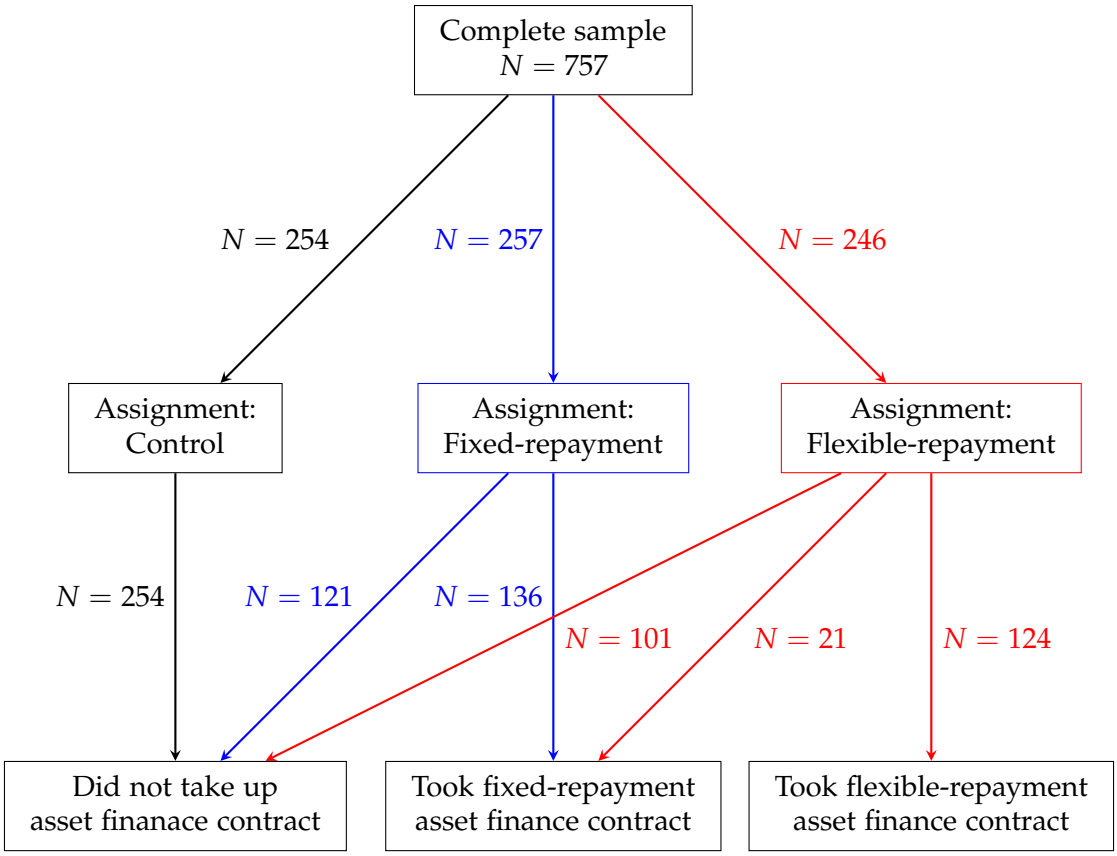
Table 6: **Outcome heterogeneity by baseline risk aversion**

	(1) Number of businesses	(2) Business profits	(3) Business assets	(4) Fixed assets	(5) Household income	(6) Household consumption	(7) Household savings
Medium risk aversion	0.09*	15.17	38.04	-60.39	23.32	-7.75	29.44
	(0.051)	(19.665)	(178.653)	(137.505)	(26.041)	(6.911)	(37.350)
High risk aversion	0.08	24.77	446.05**	132.99	4.48	-7.00	-16.33
	(0.054)	(21.905)	(190.518)	(138.098)	(27.950)	(7.649)	(41.448)
Fixed * Low risk aversion	0.24***	64.70***	786.39***	662.95***	58.06**	23.33***	17.56
	(0.047)	(18.964)	(190.271)	(154.605)	(25.193)	(7.111)	(46.865)
Fixed * Medium risk aversion	0.02	19.35	479.70**	553.07***	7.56	18.77***	-9.51
	(0.050)	(19.480)	(190.599)	(155.550)	(25.771)	(6.293)	(38.187)
Fixed * High risk aversion	0.02	-2.13	-40.42	202.81*	14.93	-2.66	-5.92
	(0.051)	(20.935)	(168.028)	(113.828)	(26.660)	(7.191)	(34.780)
Flexible * Low risk aversion	0.17***	41.35**	417.38**	339.18**	41.31	-0.50	-0.69
	(0.052)	(20.034)	(172.690)	(138.106)	(25.695)	(6.808)	(34.277)
Flexible * Medium risk aversion	0.04	17.10	543.31***	431.66***	20.52	16.53**	23.40
	(0.047)	(19.138)	(192.387)	(150.049)	(25.725)	(7.043)	(48.686)
Flexible * High risk aversion	0.07	15.43	116.33	390.03***	46.73*	22.59***	84.88*
	(0.047)	(19.857)	(167.939)	(124.516)	(26.499)	(7.834)	(44.377)
Observations	3608	3608	3608	3608	3608	3608	3608
Test: Fixed coefficients equal	0.001	0.050	0.005	0.034	0.326	0.027	0.899
Test: Flexible coefficients equal	0.177	0.586	0.241	0.903	0.759	0.063	0.347
Test: Diff-in-diff (high vs low risk aversion)	0.044	0.113	0.026	0.011	0.183	0.000	0.071

Note: In this table we investigate heterogeneous treatment effects by interacting each of the two treatment dummies (assignment to the fixed or flexible contract) with dummies for each of the three baseline risk terciles (where low, medium and high risk aversion refers to individuals who were in the bottom, middle and highest terciles of measured risk aversion using the baseline risk preference elicitation task). The omitted category represents individuals in the control group from the lowest tercile of risk aversion. Standard errors, reported below each coefficient in parenthesis, allow for clustering at the level of the individual. We denote significance using $*$ for 10%, $**$ for 5% and $***$ for 1%. In the bottom three rows of the table, we report p-values for two null hypotheses: (i) the null hypothesis that the effect of assignment to the fixed contract is equal across three terciles of risk aversion; (ii) the null hypothesis that the effect of assignment to the flexible contract is equal across risk terciles; and (iii) a difference-in-difference test: testing the null that the difference in outcomes between the least risk averse and the most risk averse was the same across the two assignment groups.

Figures

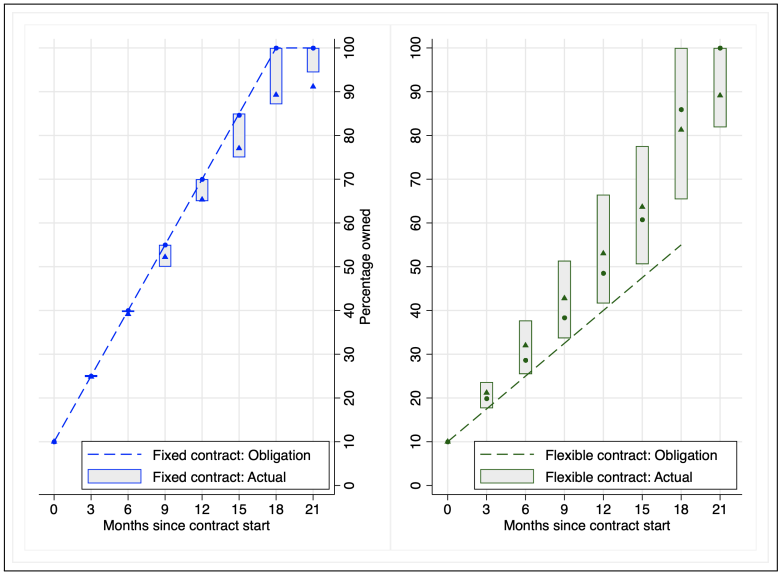
Figure 1: **Experimental flow diagram**



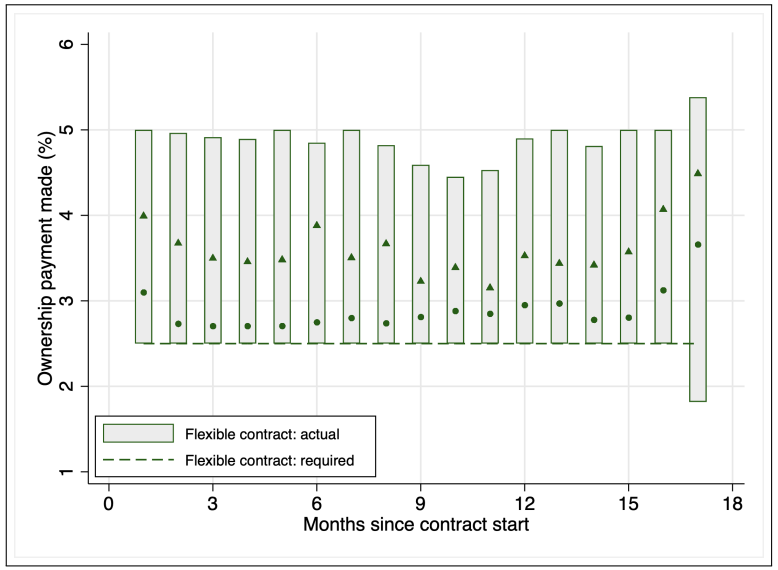
Note: This figure shows the division of our sample into (i) those in the control group, (ii) those offered the fixed-repayment contract and (iii) those offered the option of both fixed-repayment or flexible-repayment contracts; it then shows the resulting take-up of asset-based contracts.

Figure 2: **Administrative data on contract repayments**

MICROENTERPRISE ASSET OWNERSHIP SHARE

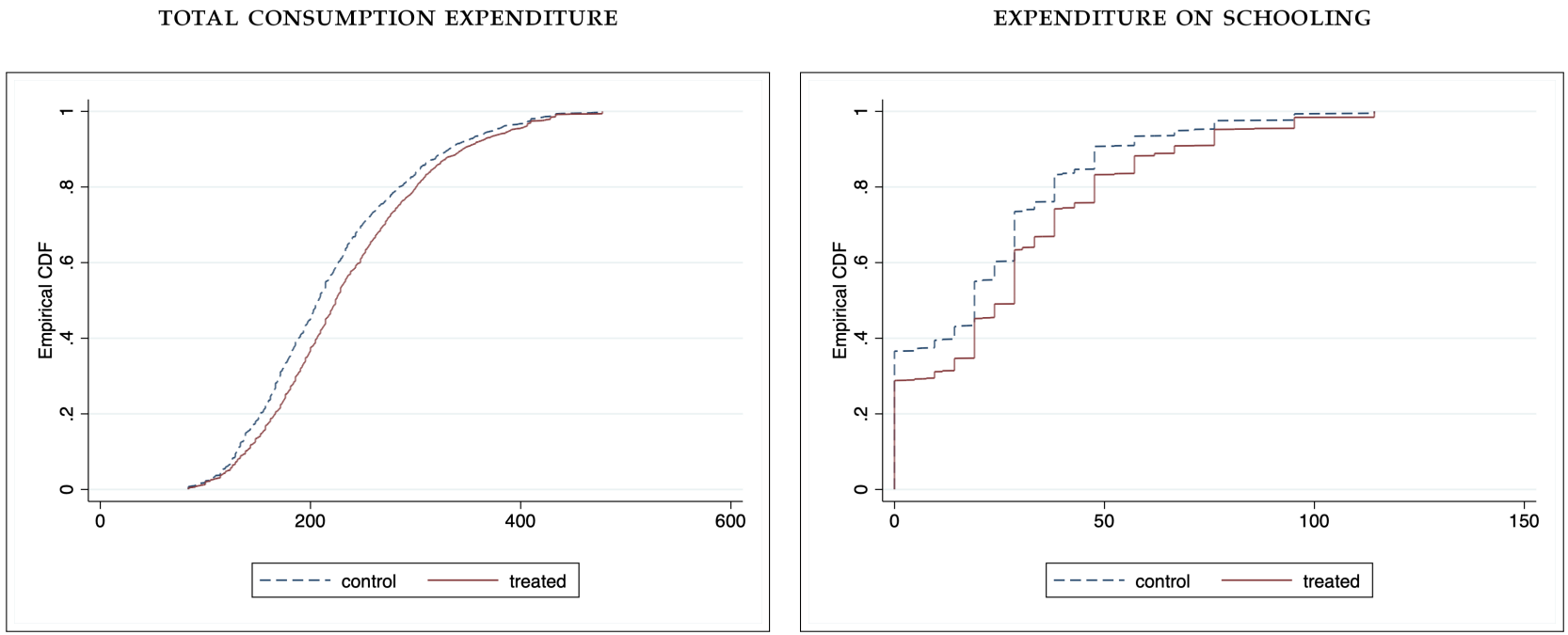


PAYMENTS UNDER THE FLEXIBLE CONTRACT



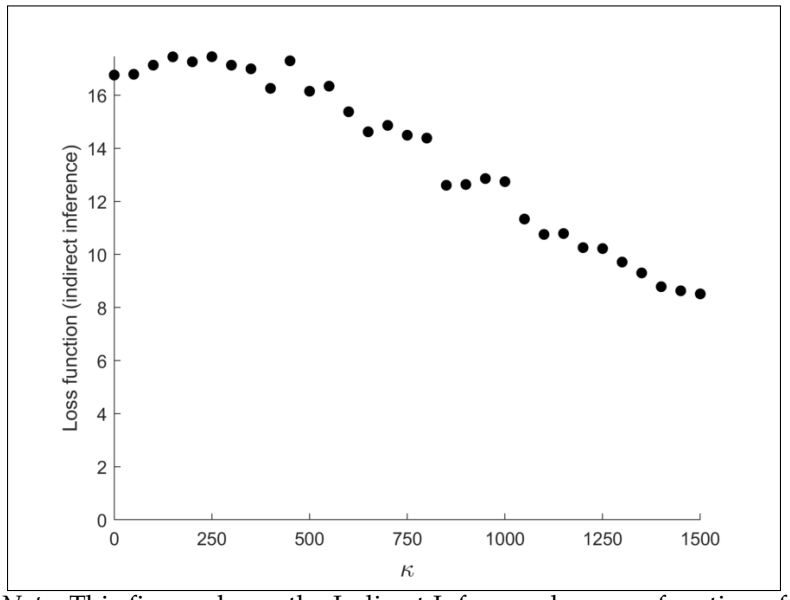
Note: The left panel illustrates the trend in actual asset ownership over the life of the contract, compared to what was obligated under each contract. The mean and median ownership shares are represented by the triangles and circles respectively, with the inter-quartile range represented by the grey-filled bar. The dotted lines represent (i) the ownership share formally required by the fixed-repayment contract (blue), and (ii) the minimum ownership share required by the flexible-repayment contract (green). The right panel focuses specifically on individuals under the flexible contract and illustrates the variation in absolute monthly payment made, with the dotted line again representing what entrepreneurs were required to pay under the flexible contract, with the mean, median and inter-quartile range for monthly payments similarly displayed.

Figure 3: **Treatment effects on consumption**



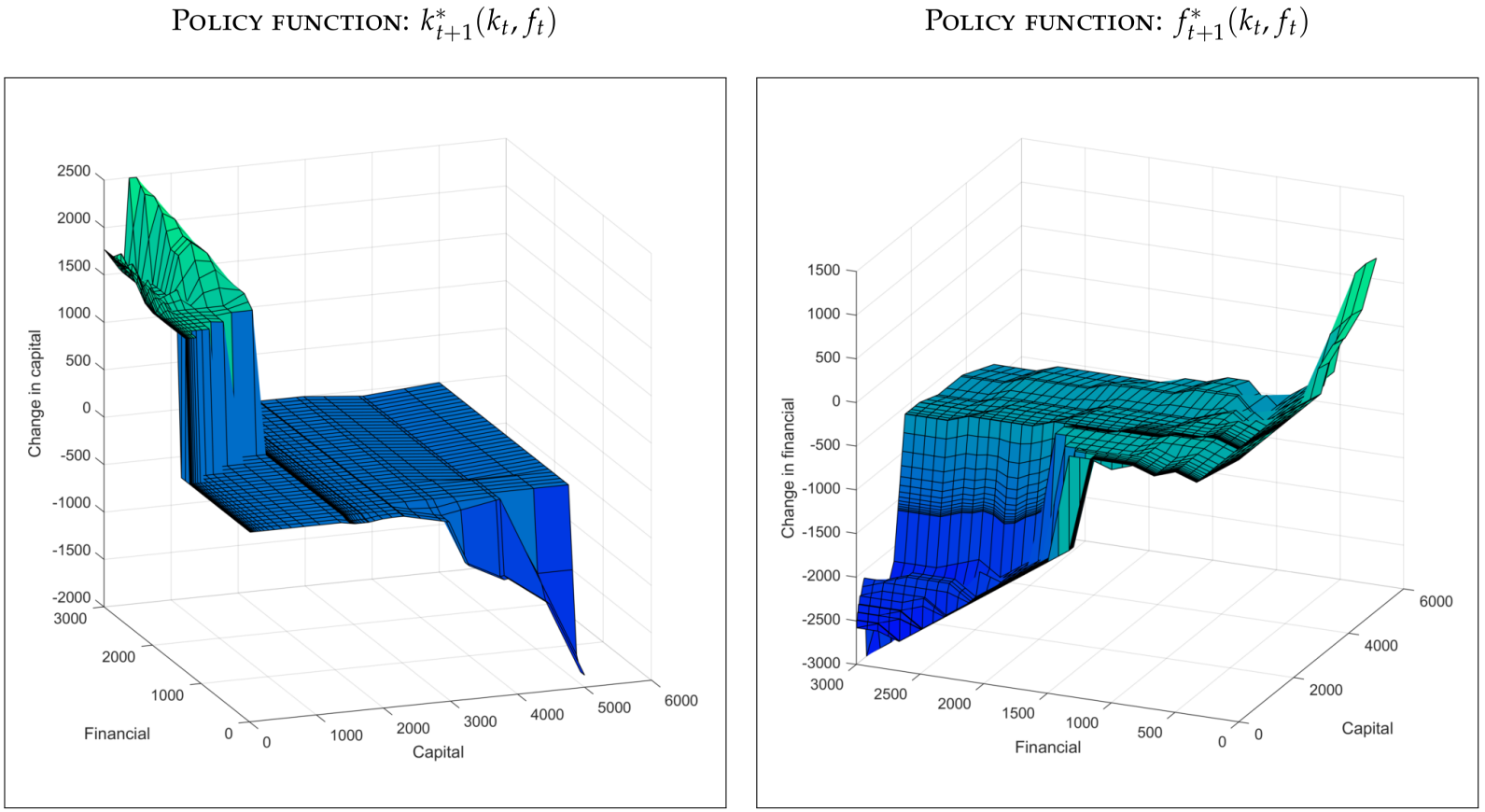
Note: The left panel presents the empirical CDF for total household consumption expenditure, and the right panel shows the empirical CDF for the sub-component representing total household expenditure on schooling (including spending on school fees, books and other materials, food and transportation).

Figure 4: **Model fit and non-convex adjustment costs**



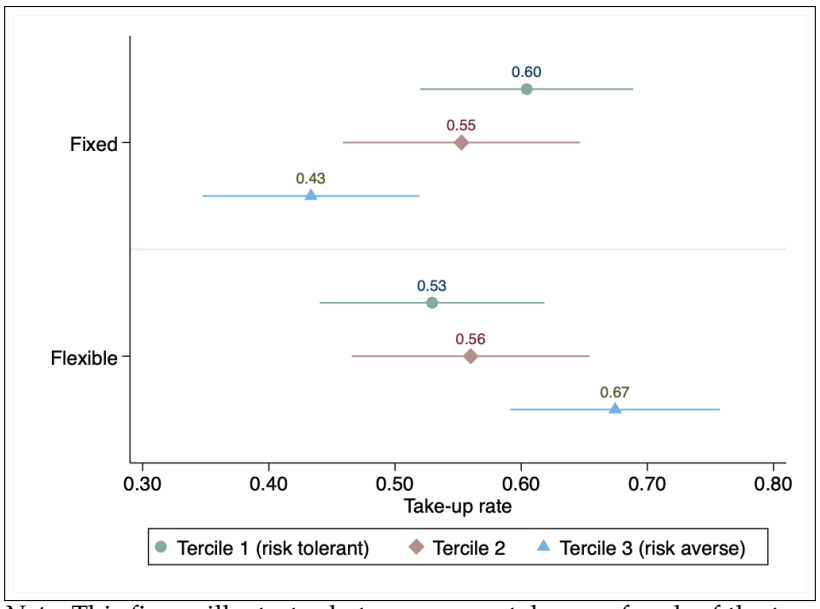
Note: This figure shows the Indirect Inference loss as a function of the magnitude of the non-convex capital adjustment cost, κ.

Figure 5: **Policy functions: Illiquid and liquid wealth**



Note: This figure shows the policy functions for fixed capital (left panel, $k^*_{t+1}(k_t, f_t)$) and for financial capital (right panel, $f^*_{t+1}(k_t, f_t)$). We show these functions for the case $(\varepsilon, \psi) = (0, 1)$.

Figure 6: **Take-up heterogeneity by baseline risk aversion**



Note: This figure illustrates heterogeneous take-up of each of the two treatment contracts by baseline risk aversion, using a tercile split. Take-up rates are displayed along with 90% confidence intervals.