Asset-based microfinance for microenterprises: Evidence from Pakistan*

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Abstract

We run a field experiment offering graduated microcredit clients the opportunity to finance a business asset worth four times their usual borrowing limit. We implement this using a hire-purchase contract; our control group is offered a zero-interest loan at the usual borrowing limit. We find large, significant and persistent effects: treated microenterprise owners run larger businesses with 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 and allows counterfactual analysis; this highlights the potential for welfare improvements through large capital injections that are financially sustainable.

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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 average effects on household consumption (Duflo, 2020; Meager, 2019). Subsequent work has identified significant heterogeneity in business impacts, particularly among the upper tail of borrowers and those with more business experience (Banerjee, Breza, Duflo, & Kinnan, 2021; Bryan, Karlan, & Osman, 2022), and several papers show benefits from contractual innovations designed to increase repayment flexibility (Barboni & Agarwal, 2018; Battaglia, Gulesci, & Madestam, 2021; Field, Pande, Papp, & Rigol, 2013). 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 from a 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. 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 US$2,000,[1] 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 do this using a hire-purchase contract structure with an 18-month duration, allowing clients to purchase a business asset of their choice; clients are then required to pay rent on the MFI's proportional ownership share of the asset at the start of each month. Clients who were randomly assigned to our control group were eligible for the MFI's standard cash loan: a zero-interest product with an 18-month duration and a borrowing limit of $475.

We find a 57% average take-up rate of assets for those assigned to any treatment, and low default rates (under 5% for both contracts). Most importantly, we find large and significant effects 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 in-

[1] 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.

ventory 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 sub-categories: 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 sample-selection 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 understand the mechanisms driving our results – and to consider plausible outcomes under alternative contractual variations – 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. (2021); 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 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.

This conclusion is supported by our analysis of benefit-cost ratios and the internal rate of return ('IRR'). We show that – under various assumptions about the long-run persistence of treatment effects – our contracts generate very high rates of return. For example, using our estimated treatment effects – and our MFI partner's actual implementation costs – we find a benefit-cost ratio of 3.9 even when assuming

zero persistence of effects after the second year of implementation. This rises to a ratio of 8.8 when assuming five years of benefits, and 11.9 when benefits persist for 10 years. The IRR is 109% even when we assume zero years of persistence, and the IRR converges to 140% when assuming five years or more of persistence. We then use estimates from our structural model to consider a scenario in which the MFI doubles the rate of interest charged, and suffers a doubling of the default rate. Even under this more conservative scenario, we obtain a benefit-cost ratio of 1.7 if we assume zero persistence of effects after the second year of implementation, rising to a ratio of 3.7 when assuming five years of benefits, and 4.9 when benefits persist for 10 years. The IRR is 9% when we assume zero years of persistence, rising to 31% with only 1 year of persistent benefits, 48% with three years of persistent benefits, and converging to between 53% and 56% when assuming five years or more of persistence.

Our paper contributes to two distinct strands of 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.[2] These papers find some evidence of microcredit leading to greater business investment, and indications of gains for upper-tail microenterprises and those with more business experience (Banerjee et al., 2021). Overall, this literature finds modest average impacts on profits, and limited evidence of impacts on various measures of household welfare such as consumption; see, for example, the survey by Banerjee, Karlan, and Zinman (2015), and the Bayesian hierarchical analysis by Meager (2019).[3] Our paper builds on this evidence, and the recommendations of Banerjee, Karlan, and Zinman (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). Our financing offer of $1,900 is significantly larger than the loan amounts offered in most of the existing microcredit literature. One notable exception is the recent work of Bryan et al. (2022), who focus on the credit allocation decision and the role of psychometric data in predicting the best performers under graduated loans; in their experiment, the control group receives twice the usual loan size, and the treatment group receives four times the usual loan size, with clients given flexibility to determine their loan duration. 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.

[2] 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), Cull, Demirgüç-Kunt, and Morduch (2018) and Cai et al. (2021). Bauchet and Morduch (2013) provide an interesting comparison of microcredit and SME borrowers from surveys in Bangladesh. For brevity we restrict our comparisons here to experimental papers.

[3] 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.

The second related strand of literature studies the impact of 'big push' asset transfers. Previous work that has provided poor individuals in low-income countries with a large capital injection (usually in the form of productive asset grants) has found substantial and persistent increases in business and household income (see, in particular, De Mel, McKenzie, and Woodruff (2008), Fafchamps, McKenzie, Quinn, and Woodruff (2014), Banerjee, Duflo, Goldberg, et al. (2015), Hussam, Rigol, and Roth (2022), Bandiera et al. (2017), Crépon, El Komi, and Osman (2022) and Balboni, Bandiera, Burgess, Ghatak, and Heil (2022)). Together, these earlier results beg an important question: *can a big-push microfinance contract generate high investment returns, while also recovering the initial capital outlay to be redeployed for future recipients?* Our results show that – for graduated borrowers, at least – asset-based financing can provide a sustainable mechanism to generate the high returns identified in the earlier capital-drop studies. In this regard, the only other field evidence we are aware of that shows the impact of asset-collateralised loans is Kremer, Jack, de Laat, and Suri (2019) – who also find very high repayment, with a repossession rate of less than 2% (and who, like us, find positive impacts on girls' education).

As in many of the asset-transfer papers, our treatment involves a bundle of related features (indeed, this is true of any microfinance experiment, where each offered product necessarily combines a set of distinct contractual components). For example, Banerjee, Karlan, and Zinman (2015) summarise six microfinance experiments using key contractual features that include (i) client selection, (ii) loan size, (iii) loan duration, (iv) interest rate, (v) repayment frequency, (vi) collateralisation and (vii) individual or group liability. In our setting, we view the key contractual features as being (i) the selection of graduated borrowers as clients,[4] (ii) the provision of a large loan for the purpose of a business investment, and (iii) same-asset collateralisation coupled with repayment according to a hire-purchase schedule. These features are mutually complementary – in the sense that microfinance institutions will typically insist upon long-standing client relationships in order to support substantially larger loan sizes (as in Bryan et al. (2022)), and will similarly require asset collateralisation or other securitisation methods to manage the increased credit risk (as in Kremer et al. (2019), Gertler, Green, and Wolfram (2021) and Carney, Kremer, Lin, and Rao (2022)). Our structural model allows us to consider variations in the key repayment terms (namely, contractual duration and the repayment structure), and these results indicate that our experimental findings are robust to a wide range of plausible contractual variations. Nonetheless – as in the asset-transfer literature (Banerjee, Karlan, Osei, Trachtman, & Udry, 2022) – we recognise that there is important scope for future experimental work to test further variations on our basic contractual structure.

Our paper proceeds as follows. In Section 2, we summarise our experimental design, and in Section 3 we report treatment effects. In Section 4 we present the results from our structural estimation, including

[4] Our selection mechanism – namely, our focus on graduated borrowers – is relatively light-touch compared to the more sophisticated screening methods attempted in the capital-drop literature; these alternative methods include the use of expert panels, machine learning methods, and methods from mechanism design theory (Fafchamps & Woodruff, 2016; Hussam et al., 2022; McKenzie & Sansone, 2019).

counterfactual analysis. Section 5 discusses rates of return, and Section 6 concludes.

2 Experimental design

2.1 Study context

We conducted our study in Pakistan in 2017 and 2018. Microfinance has grown rapidly in the country, with the number of active borrowers more than doubling from 2014 to 2019 and the total loan portfolio increasing by 400% over that period (MIX, 2019; Pakistan Microfinance Network, 2019, 2020b). The typical loan in the sector is approximately $300, to be repaid in 12 months, and at annual interest rates ranging from 0% to 40% (Basharat & Sheikh, 2019). Approximately 70% of all loans are structured as individual-liability. Prior to COVID-19, the sector had maintained very low default rates, with write-offs less than 1% of the gross loan portfolio (Pakistan Microfinance Network, 2019). As of 2019, there were 46 registered microfinance providers in Pakistan, falling into two categories (which, importantly, have quite different funding structures): microfinance banks (MFBs) and non-bank microfinance companies (NBFCs). The key distinction concerns deposits: MFBs are permitted to accept deposits, whereas NBFCs are not. For this reason, MFBs are regulated by the central bank (whereas NBFCs are regulated by the securities commission). MFBs and NBFCs each serve around half of active borrowers. MFBs' primary source of funding is public deposits, with borrowing constituting less than 10% (borrowing is mostly from local banks and development finance institutions). About 75% of funds for NBFCs come from debt, provided mainly from the apex funding agency, the Pakistan Microfinance Investment Company, which provides subsidised loans to NBFCs (Malik et al., 2020). In the two years in which we implemented our study, the average NBFC borrowing rate was around 10% in contrast, MFBs paid as much as 15% to their depositors (Basharat & Sheikh, 2019).

We worked with Akhuwat, a not-for-profit NBFC that provides Islamic microfinance services (though its lending is not restricted to Muslims). As of 2019, Akhuwat was the largest microfinance provider in the whole of Pakistan in terms of both geographical spread as well as number of borrowers – with a market share of around 13%, comprising over 891,000 active borrowers across 811 branches, and an outstanding portfolio of PKR 16.4 billion (approximately $106 million at the prevailing market rates) (Pakistan Microfinance Network, 2020a). Akhuwat receives financial subsidies from the Pakistani government, and its main product is a zero-interest loan.[5] Subsidies are a common feature of the NBFC sector in Pakistan

[5] 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.

– as it is in many countries (for example, Cull et al. (2018) provide evidence from 1,335 microfinance institutions around the world, and show a mean subsidy of 13% and a median of 7.6%). Similarly, of the six prominent microcredit RCTs described by Banerjee, Karlan, and Zinman (2015), five of them provided products that were subsidised relative to market rates, and the average subsidy was 15.4% in APR terms.[6]

Akhuwat is based in Lahore, the second most populous city in Pakistan, and the capital of the province of Punjab. We sampled from microenterprises in and around Lahore. 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 Q.

In Appendix Table A.2, we compare the characteristics of our sample to a sample of just under 30,000 individuals, covering all of Akhuwat's first-time borrowers in Punjab during the implementation period of our study in 2017 and 2018. The average age in the two samples is very similar (37 and 38 years, respectively). The sample of graduated borrowers has a lower proportion of females (8% compared to 41% of first-time borrowers). Graduated borrowers also had higher educational attainment; 14% had post-secondary, vocational or university qualifications (compared to 7% of first-time borrowers). In contrast, 63% of first-time borrowers had a maximum education level of primary school, compared to only 31% of graduated borrowers. In terms of sectoral distribution, the most popular sector for first-time borrowers is the service sector, with a proportion higher than in our sample of graduated borrowers (22% compared to 7%). The second most popular sector among first-time borrowers was retail stores, with a proportion that is again higher than in our sample (21% compared to 10%). Unsurprisingly, our sample is more heavily tilted towards asset-heavy industries such as transportation and tailoring (with proportions of 21% and 20% respectively, compared to the comparable proportions in the sample of first-time borrowers of 6% and 6%).

2.2 Structure of control and treatment contracts

Respondents in our control group were eligible for a zero-interest loan over 18 months, up to a limit of $475 (the MFI's standard upper borrowing limit). Against this, our treatment provided 18-month hire-purchase contracts that allowed clients to finance the purchase of a fixed asset up to the value of PKR

[6] The individual differences between implemented rates and market interest rates were 5.3% (Bosnia), 12.7% (Ethiopia), 35% (Mexico), 15.7% (Mongolia), and 31.8% (Morocco). In India, the implemented product was actually higher than the market rate by 8.1 percentage points.

200,000 (approximately $1,900). The contracts charged the equivalent of a 7% nominal interest rate, and were designed using a Shariah-compliant shared ownership structure. The 7% nominal interest rate is closer to market rates than Akhuwat's standard product, while still being subsidised compared to average market rates. Nonetheless, the product was designed to break even for Akhuwat given its own cost structure.

Specifically, the contracts obliged clients initially to purchase 10% of the asset, with the MFI purchasing the remaining 90%. The contracts then require repayments of the MFI's share over the following 18 months. We tested two forms of the contract; these differed in the way that clients were required to purchase the MFI's share. The first version was a *fixed-repayment* contract – in which the client was required to purchase 5% of the asset value each month (so that, after 18 months, the client would fully own the asset). The second version was a *flexible-repayment contract*, in which (i) the client was only obliged to purchase 2.5% of the MFI's ownership share each month and (ii) the client also had the option to pay *more* than what was required in any given month.[7] 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; it combines two distinct Islamic finance contracts: a shared ownership contract (*'musharakah'*) and a rental contract (*'ijarah'*). 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.

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 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), and considering the highly subsidised nature of Akhuwat's fundning structure, as discussed in Section 2.1. 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

[7] 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. In practice, many clients had repurchased a large share of their asset by the end of the contract, 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.

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 (a raw return of 9.5%).

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.

The procedure for default in both treatment variants 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); we discuss this further in Section 2.5.

2.3 Descriptive statistics

Appendix Table A.3 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. 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 (Pakistan Bureau of Statistics, 2017). 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 sectors were: (i) transportation, primarily involving rickshaws as well as other transportation assets (and comprising 21% of the sample); (ii) tailoring and textile-related trades, including sewing of footwear and other fabric and garment related activities (20% of the sample); (iii) various forms of manufacturing and related trades (11% of the sample); (iv) food and drink businesses (10% of the sample); (v) various types of retail shops and market traders (10% of the sample); (vi) construction and related trades (9% of the sample); (vii) professional services, including telecommunications-related services (7% of the sample); and (viii) photography and other entertainment-related sectors (6% of the sample).

Average monthly baseline business profits in our sample were $245 (median $219),[8] and the average value of total fixed assets for the business was $920 (median $361).[9] This shows that the financing amount offered to our treatment group could triple the stock of fixed assets for the average firm (and was five times the median firm's fixed asset stock). In comparison, of the six microcredit field experiments summarised in Banerjee, Karlan, and Zinman (2015), five were targeted at microenterprises. In those five, the mean loan size offered in USD PPP terms was $909, with a median across the studies of $696. Our product therefore represents a sizeable capital injection relative to most of the literature, and importantly provides a large multiple of the prevailing borrowing limit for the microenterprises in our sample.

2.4 Treatment assignment, take-up and assets chosen

2.4.1 Assignment mechanism

Participants were randomly assigned into one of three groups: (i) the control group; (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); and (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 & Imbens, 2017), where we stratified on gender, microenterprise business type and profits. We describe this process in Appendix Section B. Appendix Table A.3 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.

During the baseline workshop, after participants had completed their surveys and behavioural games

[8] 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).

[9] The value of business assets was based on the response to the question *'How much it would cost you to replace the assets with ones in similar condition?'*. In all baseline and follow-up surveys (for 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).

– but before any randomisation of contracts had taken place – the fixed-repayment contract was described to everyone, using a vignette and example calculations (see Appendix Section R for details of the script). The flexible-repayment contract was not demonstrated at this stage; rather, we preferred 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. 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.

When describing the products to participants, we were careful not to use Arabic terms, nor any other words that might carry religious connotations; instead, we used the local Urdu terms for joint ownership (*'shirakat'*, rather than the Arabic *'musharakah'*) and rent (*'kirayah'*, rather than the Arabic *'ijarah'*). We took this approach in order to avoid potential complications that might otherwise arise from religious-moral incentives to repay (an issue explored in detail in a consumer finance context by Bursztyn, Fiorin,

Gottlieb, and Kanz (2019)).[10]

2.4.2 Contract take-up

We assigned 254 microenterprise owners to control. 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 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, and 41% took neither contract.[11]

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.

The mean asset value was $1,517 (median $1,666), and approximately one third of clients chose the maximum financing amount possible. The maximum treatment financing amount available was decided in advance by the MFI, based on their risk appetite and their assessment of typical fixed asset prices. The MFI did allow respondents to purchase up to three assets, provided that the assets formed a complementary

[10] Bursztyn et al. (2019) explore the role of morality in debt repayment using an experiment with an Islamic bank in Indonesia; the authors work with a sample of customers who had missed their repayment date, and send them various text messages to encourage repayment. In their main treatment, the authors find that a religiously-framed message – highlighting that failure to repay (when one is able to do so) violates a moral norm – significantly increases debt repayment. Through several follow-up experiments, the authors conclude that it is actually the moral statement – rather than the religious language, and/or the use of Arabic words – that drives the main effect.

[11] We collected information on reasons for refusal among those who refused at the time of the contract offer. However, most of those who were assigned to treatment but did not take up had actually notionally accepted the treatment when offered, but they then declined by being unwilling or unable to produce the necessary deposit. We did not directly collect information on reasons for refusal for these respondents (though, of course, one can reasonably presume that being unwilling or unable to produce the necessary deposit would be a primary reason for many of these respondents; this is also consistent with the results in Table 3 that we discuss shortly and which show that individuals who took the contract were wealthier than those assigned to treatment but did not take up). Nonetheless, we do have some data from loan officers, some of whom collected information on reasons for clients not taking up at the point that the loan officers tried to collect the deposit and sign the final contract. Specifically, we have this data for 40% of the 222 respondents who were assigned to treatment but did not take up the contract. Often the reasoning given is not much more than them stating that they decided not to continue. Some of the common (non-generic) reasons include: (i) an inability to gather the funds for the 10% initial payment required; (ii) a decision – after considering the required monthly payments – that it was too high for them; (iii) a decision that what they needed for their business was actually working capital or a combination of working capital and fixed asset (which we were not providing in this project, which was limited to fixed assets).

bundle. Individuals who chose the maximum financing amount possible were more likely to choose a bundle of assets rather than a single asset.[12] 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 machines). 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.[13]

In Table 3, we compare the characteristics of individuals who took up an asset finance contract with those who were assigned to either of the treatment contracts but did not take up the product. There is no significant difference in average age or gender; nor is there any difference in terms of cognitive ability (measured using a series of mathematical questions) or from an index of business management practices. There is also no difference in the proportion who work in the two most popular sectors, transportation and tailoring (which jointly account for 40% of our sample). We *do* find that contract takers have larger and more profitable businesses. On average, they have 6% higher revenues, 18% higher profits, 38% greater fixed assets, and 34% higher business cash holdings. They also have 80% greater household savings and 12% greater monthly consumption expenditure.[14]

In Table 2, we report on total borrowing for all individuals in the sample within the first three months

[12] One way to see this is by analysing the most popular asset, a rickshaws – only 4% of those who chose the maximum financing amount purchased a standalone rickshaw, while 47% of the sample who didn't "max out" the financing amount chose a rickshaw. More generally, typical combinations of assets includes: (i) in the tailoring and textile-related sector, a 'Juki' machine (that produces specialised stitches for a variety of items including clothing, shoes, and bags), an 'Overlock' machine (that sews over the edge of one or two pieces of cloth for edging, hemming, or seaming, and is also used for inserting zippers), and a 'Picot' machine that does more decorative types of stitches; (ii) in the food and drink sector, cookers / ovens combined with food counters; (iii) in manufacturing, a combination of welding tools, metal cutting machines, and a lathe machine for shaping metal and wood; (iv) a combination of computer-related items, including laptops, printers, photocopying machines, and scanners. The MFI required that each funded asset should be a standalone 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).

[13] 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.

[14] In Appendix Table A.39 we explore heterogeneous take-up separately for each contract using some pre-specified behavioural characteristics.

of the experiment, including both cash- and asset-based loans. In short, the intervention significantly increases total borrowing. Specifically, column 1 shows that assignment to treatment (being offered the asset-based loan, pooling both the fixed- and flexible-repayment contract offers) led to a 48 percentage point increase in the likelihood of any borrowing from Akhuwat (compared to a control mean of 13%). Columns 3 and 5 respectively show that this is composed of an 8 percentage point decrease in the likelihood of taking a cash loan from Akhuwat (compared to a control mean of 13% taking cash loans) and a 56 percentage point increase in the likelihood of taking an asset-based loan (compared to a control mean of zero). Column 10 shows that the amount of extra borrowing in the treatment group is very large: US$821 greater borrowing from Akhuwat, compared to a control mean of only $40.[15]

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 assets selected were rickshaws (33%), followed by sewing machines (14%), cameras (10%), and manufacturing or welding machines (7%). Other popular assets included manufacturing machines, food production machines, computers, photocopiers and printers. Choice of asset often mapped in a very intuitive way onto baseline business sector. For example, 88% of people who bought cameras were working in photography or entertainment, 87% of those who purchased sewing machines were in tailoring and its related sectors, 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 that sector. In other sectors, there appeared to be a little more diversification at play with asset choice, but still within similar sectors. For example, while half of those who purchased rickshaws were already in the transportation sector, and many others were from sectors for which a transportation asset could conceivably function as a complementary business asset (for example, food and drink businesses that might be using the asset for

[15] In Table 2, we defined the short run as any loan taken within three months of participants entering the experiment. In Appendix Section E, we provide a more detailed breakdown of cash borrowing from Akhuwat administrative data (Panel A of Table A.4) as well as cash borrowing from all sources as obtained from the survey data (Panel B of Table A.4), at different time periods. Column 1 of Panel A of Table A.4 shows that, one month after the start of the project, 5% of the control group had taken a cash loan from Akhuwat. Columns 2 to 4 show that this increases to 13% by the 3-month stage (which is the figure that corresponds to Table 2), 17% by the 6-month mark, and 31% by the 18-month mark (which is the duration of the asset finance contract). In terms of the dollar amount of cash borrowing (again, using administrative data from Akhuwat), at the 6-month mark the average for the control group was $53.88. This can be compared with column 2 of Panel B of Table A.4, which reports from the survey-based data that outstanding loans in the control group rose from $33.90 at baseline to $81.32 by the 6-month mark, a difference of $47, which is quite close to the aforementioned value inferred from Akhuwat's administrative data. This is reassuring in terms of the accuracy of our data, more generally. Finally, the numbers in Panel B of Table A.4 also reveal that we are not seeing any significant crowding in- or crowding-out of borrowing; there are a few people who borrow from other MFIs and family / friends, but after winsorising the survey data the differences between total borrowing from Akhuwat and total borrowing from all sources are very small.

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, our asset financing appears to have induced 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. In Section 3.2.2, we also explore whether our treatments increase the rate of sectoral switching; we find little evidence for this. We also confirm, using mediation analysis, that sectoral switching explains very little of our estimated positive effects on profits.

We also asked detailed questions in all follow-up surveys to understand how clients actually used the asset. Respondents report frequent usage: on average, six days per week, and eight hours per day. 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. 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 (something supported by photographs of the assets, taken by our enumerators). Further, as discussed in Appendix Section O, we directly measured respondents' perceptions of depreciation rates using an incentivised task; we estimate this at 5% per quarter.

2.5 Repayment patterns for the asset finance contracts

All repayments were made in-person at a branch. In Figure 1, we illustrate the repayment patterns. Panel A illustrates the trend in actual asset ownership per quarter over the duration of the contract, compared to what was required. The left-hand graph of Panel A presents data for clients under the fixed-repayment contract, and the right-hand graph of Panel A presents data for clients under the flexible-repayment contract. The mean and median ownership shares are represented by the triangles and circles respectively, and the inter-quartile range is represented by the grey-filled bar. The dotted lines illustrate (i) the ownership share required by the fixed-repayment contract (blue), and (ii) the minimum ownership share required by the flexible-repayment contract (green). (We also add a blue dotted line to the right-hand graph of Panel A to illustrate what the flexible-repayment clients would have been required to pay under the fixed contract.)

Panel A 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). The solid blue circle shows that the median client was up to date with required payments. 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%. 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).

Panel B explores in further detail the variation in absolute monthly payment among flexible-contract clients; as in Panel A, the green dotted line represents what clients were actually required to pay under the flexible contract, and the blue dotted line illustrates what they hypothetically would have been required to pay under the fixed contract (5% of the ownership share each month: twice the required amount under the actual flexible contract). A non-trivial proportion of clients decided to pay monthly amounts that were close to what would have been required under the fixed contract, while some did use the flexibility allowed. 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 payment would have been under the fixed contract. This is consistent with the results of Battaglia et al. (2021) who find that the grace periods they offered were used across the loan cycle and sometimes not used at all. (In Appendix Table A.50 we explore the relationship between usage of the flexible repayment option and shocks faced by the microenterprise; there we also test how the repayment response varies with baseline risk preferences and volatility of 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 mark, we included in our survey a module just for those who took the asset, to explore their experience with the product. 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).

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 (ITT) specification. We report equivalent local average treatment effect (LATE) estimations in Appendix Section H.

3.1 Pooled results

Our primary analysis pools 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, & Yekutieli, 2006).

3.1.1 The business

We begin, in Table 4, by testing effects on key business outcomes for the primary business in the household. 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).[16] Average business assets are larger by 40% of the control group mean (on average, an increase of about \$401 compared to \$1,003 in the control group).[17] 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 hire workers (see, in particular, De Mel, McKenzie, and Woodruff (2019)).

In Table 5, 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 we account for reasonable rates of depreciation (discussed shortly).

We find no effect 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

[16] In Appendix Table A.5, 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 (2021).

[17] '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.

business revenue, that the increase in revenue is actually larger than the increase in profits that we observe. In Appendix Table A.6, we test treatment effects on business costs.[18] 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.[19]

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. 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 Appendix Table A.33, we show that only about 1% of this estimated ATE is mediated through the switch into running rickshaws. 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.

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 and savings; we show results in Table 6. 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

[18] 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.

[19] Appendix Table A.6 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).

effect on total household savings (column (3)).[20]

When we disaggregate the increase in household consumption (Table 7), 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. Table 8 provides a further disaggregation of household educational expenditure into its constituent sub-categories (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). In the top panel of that table, we show 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. The bottom panel of the table 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.

Following these results, we went back to the field to get a better insight into the mechanisms driving these effects on education. We called clients from the take-up group who had experienced the biggest increase in schooling expenditure between baseline and follow-up; we did this in order to obtain descriptive evidence on the primary motivations of those individuals driving the education treatment effects. We used a structured survey that allowed for long-text responses. We received a high response rate (89%), with 100 surveys completed. Around half of respondents mentioned that they increased the number of hours that they sent children to school (for example, extra tuition centres or summer schools). Over a third mentioned that they switched to a different school. Some of the most popular reasons given by respondents for why they believed that educational expenditure will pay off in terms of their children's future earnings was that it would enable their children to (i) find a good job, (ii) become financially independent, (iii) achieve financial stability, (iv) "break the poverty cycle", and (v) improve health. Many respondents also mentioned confidence, self-respect and social recognition.

Our education results are consistent with the recent work of Agte, Bernhardt, Field, Pande, and Rigol (2021) – following up the earlier work of Field et al. (2013) on flexible-repayment microcredit (whose original intervention, like ours, successfully led to greater microenterprise investment, assets and income). Agte et al. (2021) find that economic benefits persisted and spilled over to the next generation. Specifically, treatment households spend more on private secondary schooling and after-school tutoring on children – and, subsequently, children who were school-aged at baseline were more likely to attend college. Our result is also consistent with Kremer et al. (2019) – who, like us, offer asset-based microfinance (in their

[20] In our pre-analysis plan we had included total household borrowing in this table of outcomes, but we now report a much more detailed analysis of total borrowing in Table 2 and Appendix Table A.4.

case, rainwater-harvest tanks in an agricultural setting), and who find positive treatment effects on girls' school enrolment.

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 7 also shows a significant increase in expenditure on food, of about 5% of the control group mean (from about $53 to $56 per 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.7, 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 Disaggregation

3.2.1 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. We find no robust differences in average outcomes between these treatments. In Appendix Table A.45, 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.

3.2.2 Separating by survey wave

In Appendix Section J we reproduce all of our main previous results, disaggregating by each survey wave. We present estimates individually for follow-up surveys at the three-month, six-month, 12-month, 18-month and 24-month points. Our results are very 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. We note that there is suggestive evidence that the fixed capital effect declines slightly over time; in Appendix Section K, we show that this is consistent with reasonable assumptions about depreciation.

As Appendix Section J illustrates, there is suggestive evidence of an increasing treatment effect on business profits over time. In Appendix Section L, we explore whether this effect might be related to a change in business activities; we conclude that, overall, there is little in the way of sectoral switching.

In Appendix Section M, we explore whether sectoral switching might explain some of our estimated positive effects on profits. 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 (the main asset in the most popular business sector in our sample, transportation). 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.

3.3 Robustness

We test robustness both to outliers and to endogenous attrition. Appendix Section N 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 (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%.[21] Further, attrition is uncorrelated with treatment: 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 $p = 0.55$. 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

We now specify and calibrate a dynamic structural model. We do this for three related reasons. First, the model helps us to to understand how a large capital injection, financed through a hire-purchase contract, can generate large and sustained improvements in household wealth and income. Second, in doing so, the model helps us to characterise microenterprise dynamics, and to understand how our treatments affected those dynamics. Third, we then extend the model to allow for counterfactual scenarios.

Our general approach here is broadly similar to two seminal structural models of microfinance: those of Kaboski and Townsend (2011) and of Banerjee et al. (2021). Our model builds on these earlier contributions by incorporating explicitly an asset-based financing product of the form implemented in

[21] 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%.

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 Thailand.[22] 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

[22] 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 poorer households in the extended family and broader community (Jakiela & Ozier, 2016; Squires, 2021). 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 r represents the real return on saving; as discussed shortly, 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 & Robinson, 2013). Equation 5 allows both for productivity shocks and for persistent entrepreneurial ability.

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. (2021), 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, Karlan, and Zinman (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 (2022)). 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.[23] 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

[23] 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.

fixed capital; we require a minimum sale of size κ.[24] 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' (see also Caballero and Engel (1999) and Cooper and Haltiwanger (2006)). 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 chooses to repair some share of the depreciation.[25]

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)):

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

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. (2021) and Balboni et al. (2022) – this combination opens the possibility that the effects of large capital shocks are highly persistent.[26]

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 fixed-repayment hire-purchase agreement. 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

[24] 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. In Appendix Section O.9, we consider an alternative specification in which the minimum transaction size applies to capital expansions but not to capital reductions; we show that this alternative specification barely changes the model behaviour in this context.

[25] 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 corresponds to a situation where the household buys fixed capital but allows the existing capital to depreciate.

[26] 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'.

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.

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 induction 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 baseline joint distributions of (k_t, f_t) (and implementing the asset-finance contract for the treatment group). Our model does not endogenise contract take-up; instead, we simulate take-up using the observed empirical proportions who respectively took each contract type (independent of the simulated point in the state space).

We use several different methods to calibrate the model parameters; these are summarised in Table 9, 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 & Bond, 2000; Cooper & 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: that is, $\omega = 0.52$. We assume a quarterly discount factor of $\beta = 0.9$ and we use $\gamma = 0.35$ as the intertemporal elasticity.[27] Finally, we choose a negative quarterly real interest rate, $r = -1.25\%$; this would approximate a setting with an annual inflation rate of 5% and a zero nominal interest on saving. (We show shortly that our estimates are robust to a very wide range of plausible assumptions about r.) 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

We find that 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; we illustrate this in Appendix

[27] 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.

Figure A.7, where we show how the Indirect Inference loss function varies with κ. In this context, we view the purpose of this structural exercise *not* as identifying a single κ that should be taken 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. (Based on Appendix Figure A.7, we choose $\kappa = 1500$.)

The model with large non-convex costs fits the observed data 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 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.

It is worth noting that – even under $\kappa = 1500$ – the structural treatment effects on fixed capital decline noticeably faster than the experimental estimates suggest (though the structural effects remain within the experimental confidence intervals). This suggests that the actual capital adjustment costs are more intricate than our (very stylised) representation allows; in particular, there may be an important role for permanent heterogeneity, which our model ignores in the interests of simplicity and tractability.[28] Similarly, 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 graphical comparisons for

[28] In particular, we note that – in Appendix Figure A.10 – the deterioration in the capital fit is driven by the model predicting that, in the control group, some firms will accumulate substantial capital through realisation of high productivity draws. One could – at substantial cost to tractability and interpretability – generalise the current model by allowing permanent heterogeneity in μ and in κ.

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, indeed, 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 it was at 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.[29] *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 (Atkin, Khandelwal, & Osman, 2017; Janes, Koelle, & Quinn, 2022), and – for the firm sizes in our dataset – implies a high marginal return to fixed capital. 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%. *Third*, most households in our data hold minimal wealth in cash or other liquid assets (Dupas & Robinson, 2013).

Appendix Figure A.12 shows policy functions, both for fixed capital k (in the left panel) and financial capital f (in the right panel). (We illustrate the policy functions for the no-credit case, in order to highlight the underlying tension between the choice of the two different forms of capital.) 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.[30] 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. Appendix Figure A.13 illustrates this stability using a phase diagram in (k, f) space. 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

[29] Similarly, Balboni et al. (2022) 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.

[30] 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 A.12 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).

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' innovation of Field et al. (2013) – can generate persistent improvements in both wealth and welfare.

4.4 Counterfactual scenarios

We now use the structural model to run two sets of counterfactual analyses. We view each set of counterfactual analyses as serving two related purposes: (i) the analysis allows us to explore further the mechanisms driving the structural results, and (ii) the analysis helps us to think about policy alternatives.

4.4.1 Variation in the real interest rate

Our first counterfactual analysis considers variation in the real interest rate. In our main specification, we used a quarterly real interest rate of $r = -1.25\%$. As equation 4 showed, this is the rate earned on the liquid financial asset. We can, therefore, think of counterfactual increases in r literally as representing improvements in the interest rate on savings; more generally, this can describe changes in the attractiveness of other outside investment options. We implement this counterfactual by re-running our main model specification (using the parameters in Table 9, and $\kappa = 1500$), across a grid of values for r: from $r = -1.25\%$ to $r = 10\%$ (that is, an annual interest rate over 40%). We show counterfactual 12-month treatment effects on fixed capital in the left panel of Figure 4 (with counterfactual treatment effects on value-added and consumption in Appendix Section O.7).

As one would expect, the general slope with respect to the real interest rate is negative: as the value of holding cash increases, the household optimally chooses less fixed capital. However, what is striking about the left panel of Figure 4 is how gentle is the decline: the increase in real interest rate only has an appreciable impact on the capital treatment effect once the quarterly real interest reaches about 8% (and, even then, it remains within the 95% confidence interval of the actual experimental treatment effect). This result – that the structural predictions are robust to a very wide range of plausible values for the real interest rate – makes strong intuitive sense given the key mechanism just described in Section 4.3. In a model without adjustment costs, household behaviour would be highly sensitive to the relative return to fixed capital and the real interest rate (indeed, this comparison would determine firm size). Under large non-convex adjustment costs, the marginal product of fixed capital can already far exceed the real interest rate (as noted in section 4.3) – so it makes intuitive sense that even relatively large changes in that real interest rate have only limited implications for model behaviour.

More generally, this counterfactual highlights the central relevance of capital adjustment costs for a range of alternative policy initiatives. In different ways, various policies seek to improve the real return on liquid savings in low-income settings – for example, through improved savings technologies, business training programs, through insulating entrepreneurs from sharing pressures, and so on. Our model results

– though necessarily stylised – suggest that such policies are unlikely to generate persistent gains if the marginal propensity to consume from liquid savings is high.

4.4.2 Variation in the contractual terms

Our second counterfactual exercise considers plausible variations in the contractual terms. Recall that – as Table 1 illustrates – our contract requires a 10% deposit, with the remaining 90% amortised across the 18 months. To this obligation, we add a 1% nominal monthly interest payment. Under our counterfactual contracts, we keep the 10% deposit requirement and vary both (i) the contract duration (in each case, amortising the 90% loan over the entire period of the contract) and (ii) the nominal contractual interest rate. To run these counterfactuals, we re-run our main model specification (again, using the parameters in Table 9 and $\kappa = 1500$), adjusting the repayment terms and the duration of the contract (and, therefore, of the finite-horizon backward induction). As we do so, we hold fixed both take-up rates and default rates (neither of which our model endogenises); this simplification assists the clarity and transparency of the exercise (and is an assumption that we relax in the following section when considering benefit-cost ratios).

The right panel of Figure 4 illustrates the counterfactual 12-month treatment effects on fixed capital (the equivalent graphs for value-added and consumption are provided in Appendix Section O.8). As one would expect, clients are wealthier when the interest rate is lower, and when the contract duration is longer: in both cases, the MFI is charging less, in return for the same capital injection. More interesting – and more relevant for policy – is the magnitude of the change. First, the simulations indicate that gains remain substantial for monthly nominal interest rates up to and including 5% (though, as noted, one might expect take-up to drop substantially under such high rates). Second, the simulations indicate that gains are likely to be about 25% larger if the contract were offered over 30 months rather than 18 months (with smaller gains anticipated when moving from 30 months to 45 months). We explore these counterfactuals further in the following section, when considering benefit-cost ratios under higher interest rates.

5 Benefit-cost analysis

We now explore benefit-cost ratios and internal rates of return (IRR). In doing so, we build upon the methodology of Banerjee, Duflo, Goldberg, et al. (2015) and Bandiera et al. (2017). To do this, we use actual implementation costs and estimated treatment effects; we then follow Alfonsi et al. (2020) in using our model-based counterfactuals to calculate benefit-cost ratios and IRR under alternative contract structures that may be relevant for potential future scale-up.

In Table 10, we present the key elements of the analysis (all in USD). Costs are comprised of: (i) capital disbursed for the initial purchase of the assets for take-up clients, subtracted from total capital recovered (i.e. building in all non-payment of contractual obligations); (ii) staff salaries; and (iii) all other

implementation costs. Total costs are then compounded to the two-year mark using a social discount rate of 10%, which is on the conservative side of the range of social discount rates recommended by the World Bank (Lopez, 2008). We provide two estimates for each cost: (i) a 'lower bound', where we take the total amount that was reported to us as project costs by the MFI and divide it by the 503 individuals *assigned* to treatment (giving an average total cost of $168 per client); and (ii) an 'upper bound', where the total cost is divided by the smaller number of 281 who actually took up the contract (giving an average cost of $301).

On the benefits side, we use the estimated treatment effects from our ITT regressions, as well as an estimate of future benefits beyond the period of the project. For benefits during the project period, we sum the treatment effects estimated on business profits in the first and second year after asset disbursement, as well as the year-2 treatment effect on business assets. This gives a total benefit of $1,165 during the project period. To this, we add the estimated net present value of all future benefits from year 3 onward, by taking the year-2 ITT on business profits as the annual value of future benefits. We conduct our analysis of benefit-cost ratios and IRR under various assumptions for the persistence of benefits, ranging from zero years of future benefit to persistence for 20 years (implying an NPV of future benefits of $3,371).

We present the results of the analysis graphically in Figure 5, both as a benefit-cost ratio and an IRR. In each graph, the horizontal axis represents the number of years the benefits are assumed to persist, and we show results using both the lower- and upper-bound cost estimates. Panel A represents the analysis using the actual implementation costs and the estimated treatment effects (described in Table 10), with the top graph illustrating the benefit-cost ratio, and the bottom graph illustrating the IRR. We estimate very high benefit-cost ratios, even under very conservative assumptions. For example, using the upper-bound cost estimates, we find a benefit-cost ratio of 3.9 even when assuming zero persistence of effects after the second year of implementation. This rises to a ratio of 8.8 when assuming five years of benefits, and 11.9 when benefits persist for 10 years. The IRR is 109% even when we assume zero years of persistence, and the IRR converges to about 140% when assuming five years or more of persistence.

In Panel B, we take the model-based estimates for treatment effects at year-1 and at year-2, under the actual implemented contract cost (1% per month); note that this imposes slightly conservative figures for treatment effects relative to the experimental point estimates. Nevertheless, estimated benefit-cost ratios remain very high. Using the upper-bound cost estimates, we find a benefit-cost ratio of 2.7 even when assuming zero persistence of effects, which rises to 5.8 when assuming five years of benefits, and 7.7 with 10 years of persistence. The IRR is 51% when we assume zero years of persistence, and the IRR converges to approximately 88% when assuming five years or more of persistence.

Finally, in Panel C, we use model-based estimates for treatment effects using a counterfactual cost of 2% per month. This reduces the estimated treatment effects, to which we also add a conservative estimate of a doubling of losses to the MFI from additional defaults under the more expensive contract (see Appendix Table A.38 for the extent to which we increase costs and reduce benefits). Even with these

conservative assumptions, we continue to find high rates of return. We find a benefit-cost ratio of 1.7 if we assume zero persistence of effects, rising to a ratio of 3.7 when assuming five years of benefits, and 4.9 when benefits persist for 10 years. The IRR is 9% when we assume zero years of persistence, rising to 31% with only one year of persistent benefits, 48% with three years of persistent benefits, and converging to about 55% when assuming five years or more of persistence.

6 Conclusions

In this paper, we test the effects of a hire-purchase contract, which facilitates large capital injections for experienced microfinance clients. We find large and significant gains in microenterprise assets and profits – and, in turn, increases in household income and consumption. We show that our results can be rationalised by a structural model that allows for large non-convex adjustment costs in fixed capital. We then use this model to consider counterfactual scenarios, including potential variations on some key contractual terms. In this concluding section, we now discuss the scope for scaling such a product in different settings.

Our IRR analysis indicates that the product was highly cost-effective, under a range of plausible assumptions about the persistence of treatment effects. In practical terms, there are several related reasons why our large treatment effects generate a large IRR. Most fundamentally, our capital injection was provided as a loan – rather than as a grant – which very substantially reduces the net cost to the provider. Put differently, our partner MFI recovered almost all of its initial outlay – allowing it to redeploy those funds to other borrowers. Further, we observed a high repayment rate – though we also note that our IRR would remain very large even if (for example) the interest rate were set to more traditional market rates, and if the default rate were to double. Finally, we note that all of the financing was used to purchase productive assets: we did not include any spending on (for example) training on asset use, or business mentoring. Such additions would have increased substantially the cost and the complexity of the program; we speculate that these add-ons were unnecessary in this context given that we selected experienced clients who had successfully repaid previous business loans (and who had identified a specific asset that would benefit their business).

Nonetheless, when considering the scaling up of any intervention like ours, credible enforcement mechanisms are obviously important. In our setting, the MFI used a combination of quite traditional approaches. First, the MFI screened clients to be graduated borrowers, who had showed a willingness and an ability to repay at least one previous loan – and who had specifically identified a profitable investment opportunity through the acquisition of a fixed asset. Second, like most lenders, the MFI relies on dynamic incentives as part of its ongoing relationship with borrowers – including a clear and credible threat to refuse future lending in the case of a client's strategic default. Third, as our results showed, the capital investments themselves were highly profitable on average – providing clients with the ability to repay, and

perhaps further strengthening clients' sense of obligation to do so. Further, the MFI also used traditional in-person methods for asset procurement and for repayment collection. In different contexts, recent technological changes might substantially reduce implementation costs and improve credit risk management and enforcement mechanisms, and could form part of any potential scaling up; indeed, many MFIs have dramatically accelerated their digital transformation process in the wake of COVID-19.

More generally, there are a range of related asset-based financing options that deserve further attention from both research and policy angles. In this paper, we use a lease-based structure – but the substance of the contract is very similar to other asset-financing contracts used for SMEs in high-income countries. In an extensive survey of asset financing models across the globe, Kumaraswamy, Mattern, and Hernandez (2020) recommend that lease-based contracts are used for financing higher-value, 'productive' (income-generating) assets. Within the category of lease-based models, the authors recommend 'rent-to-own' structures (very similar to our hire-purchase agreement) since the collateralisation possibilities improve credit risk management. There is also increasing interest and work by the World Bank on collateral registries for movable assets (Love, Pería, & Singh, 2016).[31] Several start-ups are now experimenting with such rent-to-own models for productive asset financing; for example, financing for vehicles such as motorcycle taxis, solar water pumps, heaters and purifiers, farm equipment and other business assets.

To understand our respondents' recommendations for potential scale-up, we added a series of questions to our final interview round – in which we asked clients their opinions regarding the 'optimal contract structure' if the MFI were to offer this product to others in future. First, we asked about the optimal initial payment. The average was 10% (with minimal variation): the figure we had implemented. Second, we asked clients what the maximum level of financing should be. The average response was approximately double the amount that we permitted in the current project: \$3,500 (with the 75th percentile at \$5,000). Third, we asked clients their views on optimal contract duration: the average response was 33 months, with the 75th percentile at 36 months. Finally, we were interested to know how clients would have used the financing if it had been offered in the form of cash rather than a direct injection of a fixed asset (a question for which we allowed multiple categories of answer). 95% of clients reported that they would have used at least some of the funds to purchase a fixed asset, 42% said that would have used some of the funds on working capital, and 8% said that they would have used some funds for construction or repairs to their business premises. Among those reporting that they would have purchased a fixed asset, clients reported – on average – that 80% of the funds would have been used for that asset. This highlights the importance of financing that provides fixed assets as well as complementary working capital for graduated borrowers.

Together, our results show that large asset-based microfinance contracts have the potential to stimulate microenterprise growth among graduated borrowers. Of course, large asset-based financing is not for

[31] See also Campello and Larrain (2016) for evidence that expanding the menu of assets that may be used as loan collateral (to include movable assets) can lead to an increase in firms' access to credit, investment and productivity.

everyone: for many microenterprise owners, smaller and more standard loans may be more appropriate given their risk profile and investment requirements. As the microfinance sector matures, with a growing focus on 'financial inclusion', it is increasingly important that MFIs are able to expand the suite of products they offer in their portfolio, to allow clients to obtain products that are well suited to their individual requirements. Given their Shariah-compliant contractual form, asset-based contracts are likely to have particular appeal to Muslim entrepreneurs – who face disproportionately high levels of financial exclusion (Demirguc-Kunt, Klapper, & Randall, 2014; El-Gamal, El-Komi, Karlan, & Osman, 2014; Karim, Tarazi, & Reille, 2008; Karlan, Osman, & Shammout, 2021). 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.

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Tables and Figures

Table 1: **Contract repayment schedule**

MONTH	MFI	PAYMENT		TOTAL
	OWNERSHIP	RENT	OWNERSHIP	PAYMENT
1	90.0%	9.00	50.00	59.00
2	85.0%	8.50	50.00	58.50
3	80.0%	8.00	50.00	58.00
4	75.0%	7.50	50.00	57.50
5	70.0%	7.00	50.00	57.00
6	65.0%	6.50	50.00	56.50
7	60.0%	6.00	50.00	56.00
8	55.0%	5.50	50.00	55.50
9	50.0%	5.00	50.00	55.00
10	45.0%	4.50	50.00	54.50
11	40.0%	4.00	50.00	54.00
12	35.0%	3.50	50.00	53.50
13	30.0%	3.00	50.00	53.00
14	25.0%	2.50	50.00	52.50
15	20.0%	2.00	50.00	52.00
16	15.0%	1.50	50.00	51.50
17	10.0%	1.00	50.00	51.00
18	5.0%	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. The table shows monthly rent payments of 1% of the asset's value; in addition, the client is also obliged to purchase 5% of the MFI's ownership share each month. Over the 18-month duration of the contract, total rental payments are $85.50 (a raw return of 9.5%).

Table 2: **Take-up and borrowing**

	(1) Any loan	(2) Any loan	(3) Cash Loan	(4) Cash Loan	(5) Asset loan	(6) Asset loan	(7) Fixed-repayment	(8) Flexible-repayment	(9) Total borrowing	(10) Total borrowing
Assignment	0.48***		-0.08***		0.56***				821.42***	
	(0.030)		(0.023)		(0.022)				(36.947)	
Assignment: Fixed		0.44***		-0.09***		0.53***	0.53***			748.87***
		(0.038)		(0.024)		(0.031)	(0.031)			(50.440)
Assignment: Flexible		0.52***		-0.07***		0.59***	0.09***	0.50***		897.21***
		(0.037)		(0.025)		(0.031)	(0.018)	(0.032)		(52.714)
Control mean	0.13	0.13	0.13	0.13	0.00	0.00	0.00	0.00	40.46	40.46
Observations	757	757	757	757	757	757	757	757	757	757

Note: We report take-up indicators and borrowing amounts for any type of loan (cash or asset-based) from all participants within the first three months of them entering the experiment, using administrative data from the MFI. In Appendix Table A.4, we conduct a similar exercise without restricting the time period to be the first three months of the experiment (i.e. using administrative data on borrowing throughout the project). *Assignment* refers to assignment to either of the two asset finance contracts (fixed- or flexible-repayment). In columns 1 and 2, the dependent variable equals one if participants took up any new loan, in columns 3 and 4 the dependent variable is a dummy for taking up any cash loan, and in columns 5 and 6 it is take-up of an asset-based loan. In column 7, the dependent variable is a dummy for take-up of the fixed-repayment contract, and in column 8 it is a dummy for take-up of the flexible-repayment contract. In columns 9 and 10, the dependent variable is the total borrowing amount, combining both loan types, in USD. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 3: **Characteristics of take-up group**

Variable	(1) Take-up = 0 Mean/SE	(2) Take-up = 1 Mean/SE	(3) Total Mean/SE	T-test Difference (1)-(2)	Normalized difference (1)-(2)
Age	38.81	37.90	38.30	0.91	0.09
	(0.64)	(0.63)	(0.45)		
Female	0.12	0.08	0.10	0.04	0.12
	(0.02)	(0.02)	(0.01)		
Math score (above median)	0.55	0.53	0.53	0.02	0.04
	(0.03)	(0.03)	(0.02)		
Management practices (above median)	0.50	0.51	0.50	-0.01	-0.03
	(0.03)	(0.03)	(0.02)		
Sector: Transportation	0.21	0.20	0.20	0.01	0.03
	(0.03)	(0.02)	(0.02)		
Sector: Tailoring	0.19	0.21	0.20	-0.02	-0.06
	(0.03)	(0.02)	(0.02)		
Business revenue	706.09	744.87	727.75	-38.78*	-0.05
	(49.47)	(46.65)	(33.97)		
Business profits	227.65	269.11	250.82	-41.46**	-0.26
	(9.80)	(10.17)	(7.19)		
Total fixed assets	789.16	1,086.29	955.15	-297.13*	-0.18
	(98.33)	(103.36)	(72.46)		
Current assets: cash	163.65	219.81	195.02	-56.16*	-0.20
	(18.09)	(17.72)	(12.77)		
Household savings	308.61	557.42	447.61	-248.80*	-0.28
	(49.07)	(58.30)	(39.46)		
Household loans	55.98	25.44	38.92	30.54***	0.39
	(6.30)	(3.50)	(3.46)		
Household consumption expenditure	203.13	227.66	216.84	-24.53*	-0.20
	(7.62)	(7.58)	(5.43)		
Observations	222	281	503		

Notes: In this table, we present the characteristics of whose who took up either of the asset finance contracts, compared to those who were assigned to a treatment contract but did not take the product. Standard errors are clustered at the individual level. All flow variables are for the last month, and all currency values are in US$ equivalent based on the prevailing exchange rate during implementation of the projects (USDPKR of approximately 105). Normalized differences are computed as the difference in means divided by the square root of half of the sum of the variances. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. (In A.2, we provide a similar compairson, but comparing our full experimental sample with the broader population of just under 30,000 first-time borrowers.)

Table 4: **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: 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. Business total assets is defined as the sum of total fixed assets and total current assets in the form of cash, accounts receivable, and inventory. 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: **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: 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 6: **Household outcomes**

	(1) Total household income	(2) Household consumption expenditure	(3) Total household savings	(4) Household assets
Assignment	31.47	12.95	16.44	20.33
	(12.66)	(3.37)	(19.16)	(14.03)
	[0.01]**	[0.00]***	[0.39]	[0.15]
	{0.02}**	{0.00}***	{0.24}	{0.11}
Control mean (follow-up)	357.35	220.40	113.03	681.79
Observations	3,608	3,608	3,608	1,410

Note: 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 7: **Disaggregating household consumption**

	(1) Food	(2) Clothing	(3) Bills	(4) Schooling	(5) Health	(6) Special occasions	(7) Household items
Assignment	2.61	1.54	0.67	5.70	0.09	0.04	1.91
	(0.90)	(1.82)	(0.31)	(1.30)	(0.30)	(0.29)	(1.39)
	[0.00]***	[0.40]	[0.03]**	[0.00]***	[0.78]	[0.89]	[0.17]
	{0.01}**	{0.42}	{0.05}*	{0.00}***	{0.61}	{0.61}	{0.20}
Control mean (follow-up)	52.80	34.71	24.54	22.05	2.24	7.30	67.54
Observations	3,608	3,608	3,608	3,608	3,608	3,608	3,608

Note: 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 8: **Impacts on children's education**

PANEL A: EXTENSIVE MARGIN AND TOTAL SCHOOLING EXPENDITURES

	(1) In school: girls	(2) In school: boys	(3) Expenditure: girls	(4) Expenditure: boys
Assignment	0.04	0.04	4.83	3.13
	(0.03)	(0.03)	(1.31)	(1.32)
	[0.16]	[0.24]	[0.00]***	[0.02]**
	{0.12}	{0.14}	{0.00}***	{0.03}**
Control mean (follow-up)	0.83	0.85	19.55	18.81
Observations	549	487	549	487

PANEL B: SCHOOLING EXPENDITURE CATEGORIES

	(1) School fees: girls	(2) School fees: boys	(3) Books & materials: girls	(4) Books & materials: boys	(5) Food expenditure: girls	(6) Food expenditure: boys	(7) Transport costs: girls	(8) Transport costs: boys
Assignment	1.53	0.89	0.81	0.50	0.99	1.23	1.46	0.67
	(0.80)	(0.77)	(0.25)	(0.26)	(0.34)	(0.35)	(0.39)	(0.35)
	[0.06]*	[0.25]	[0.00]***	[0.06]*	[0.00]***	[0.00]***	[0.00]***	[0.06]*
	{0.03}**	{0.07}*	{0.00}***	{0.03}**	{0.00}***	{0.00}***	{0.00}***	{0.03}**
Control mean (follow-up)	11.43	10.34	3.25	3.56	2.69	2.97	2.83	2.77
Observations	553	493	553	493	553	493	553	493

Note: We report the ITT estimates of the combined treatment on outcomes related to children's education, 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%.

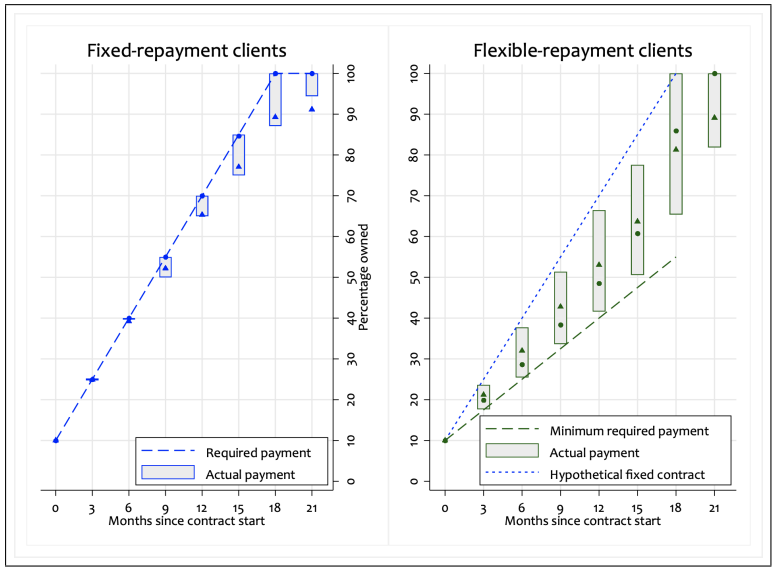
Table 9: **Calibrated structural parameters**

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
r	quarterly real return on saving	-0.0125	Implied by inflation
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
κ	minimum investment size	1500	See Appendix Figure A.7

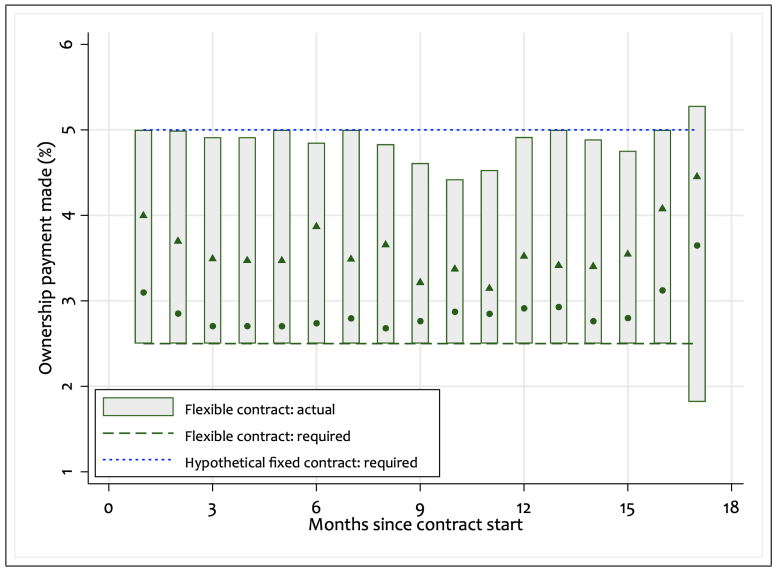
Note: This table reports a series of structural parameter values used for our calibration exercise. 'Panel GMM' refers to a quasi-differenced GMM panel estimator; 'incentivised measure' refers to a series of incentivised lab-in-field games conducted at baseline; 'baseline accounting' refers to an accounting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

Figure 1: **Administrative data on contract repayments**

PANEL A: MICROENTERPRISE ASSET OWNERSHIP SHARE

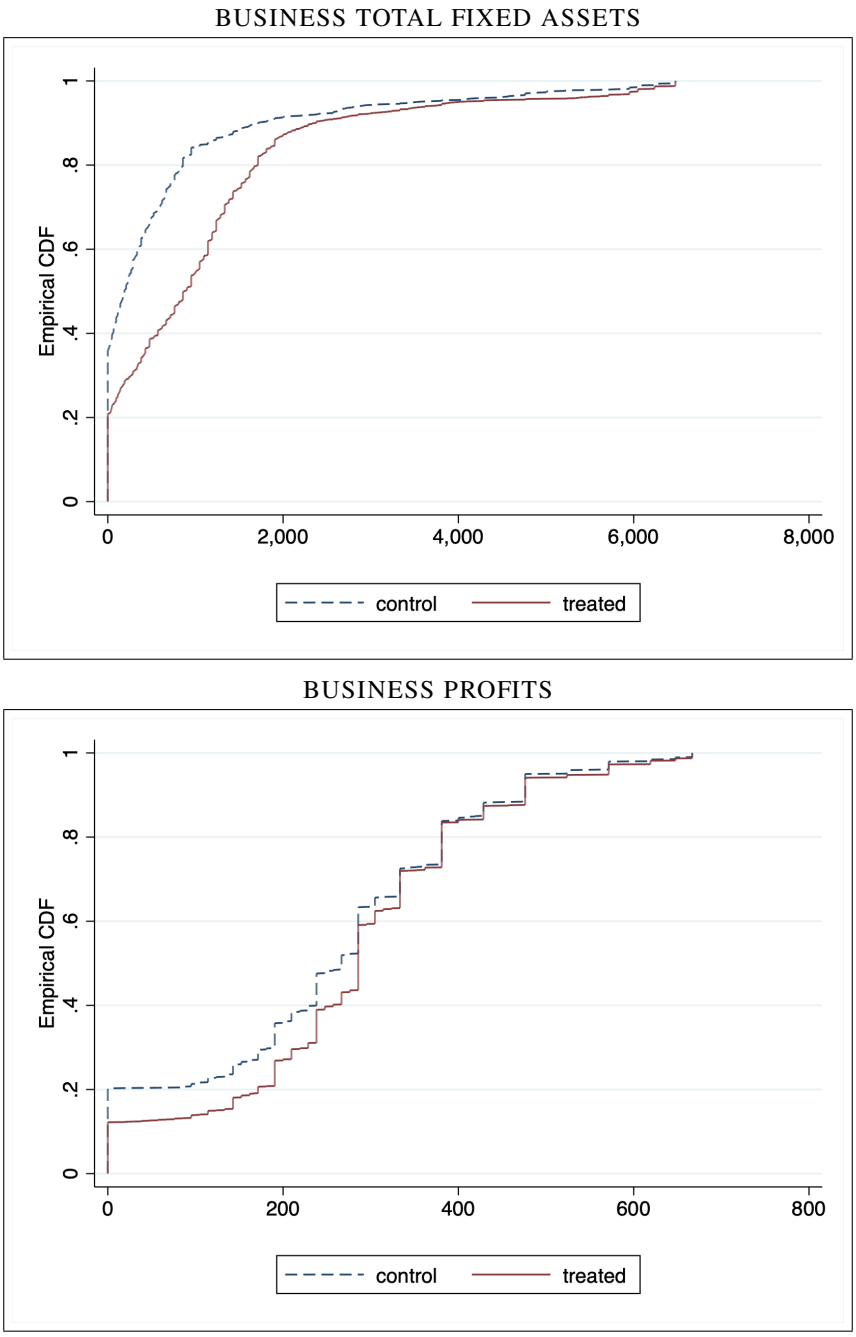


PANEL B: PAYMENTS UNDER THE FLEXIBLE CONTRACT



Note: Panel A illustrates the trend in actual asset ownership over the life of the contract, compared to what was obligated under each contract. The left-hand side graph of Panel A presents data for clients under the fixed-repayment contract, and the right-hand side graph of Panel A presents data for clients under the flexible-repayment contract. The mean and median ownership shares are represented by the triangles and circles respectively, and the inter-quartile range is represented by the grey-filled bar. The dotted lines illustrate (i) the ownership share required by the fixed-repayment contract (blue), and (ii) the minimum ownership share required by the flexible-repayment contract (green). In the right-hand side figure of Panel B, the blue dotted line illustrates what the flexible-repayment clients hypothetically would have been required to pay under the fixed contract. Panel B explores in further detail the variation in absolute monthly payment among flexible-contract clients; the green dotted line represents what clients were actually required to pay under the flexible contract, and the blue dotted line illustrates what they hypothetically would have been required to pay under the fixed 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.

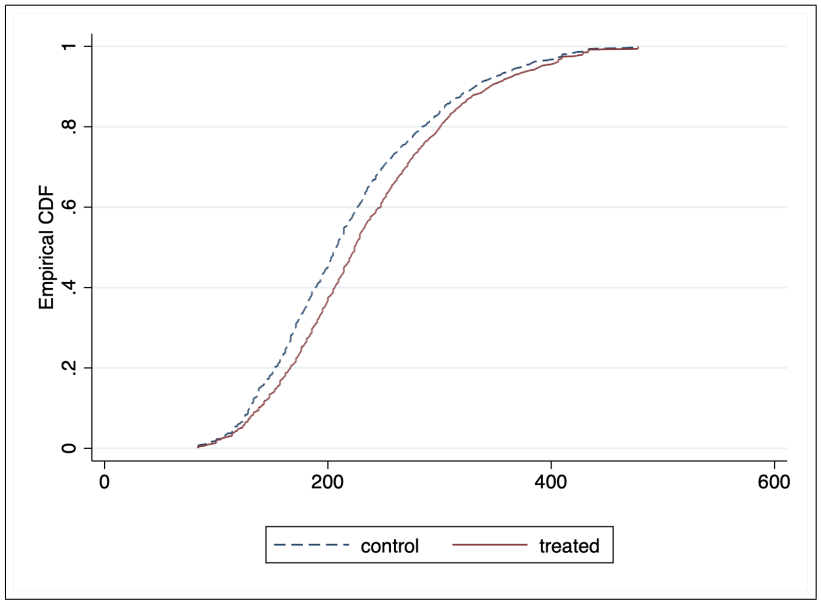
Figure 2: **Empirical CDFs for business total fixed assets and business profits**



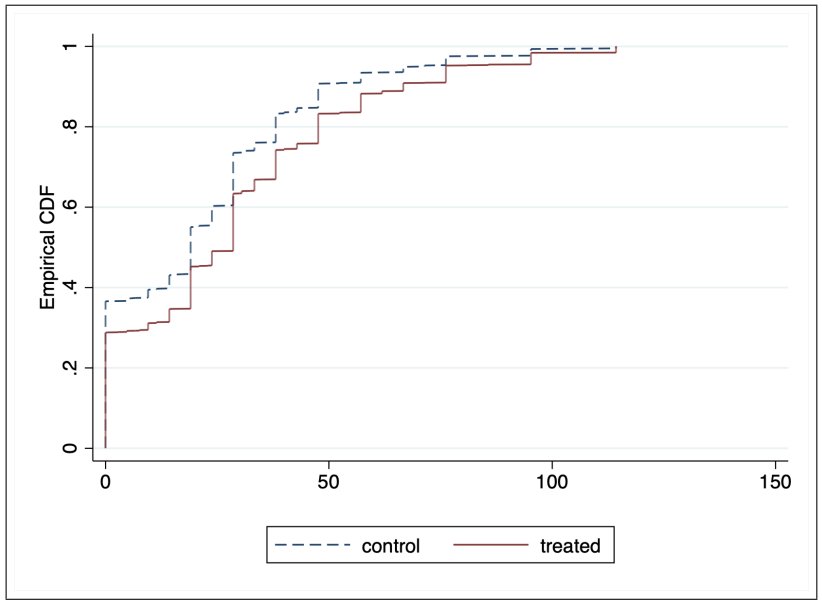
Note: In the above empirical CDFs for business total fixed assets and business profits, we pool all follow-up survey waves.

Figure 3: **Treatment effects on consumption**

TOTAL CONSUMPTION EXPENDITURE



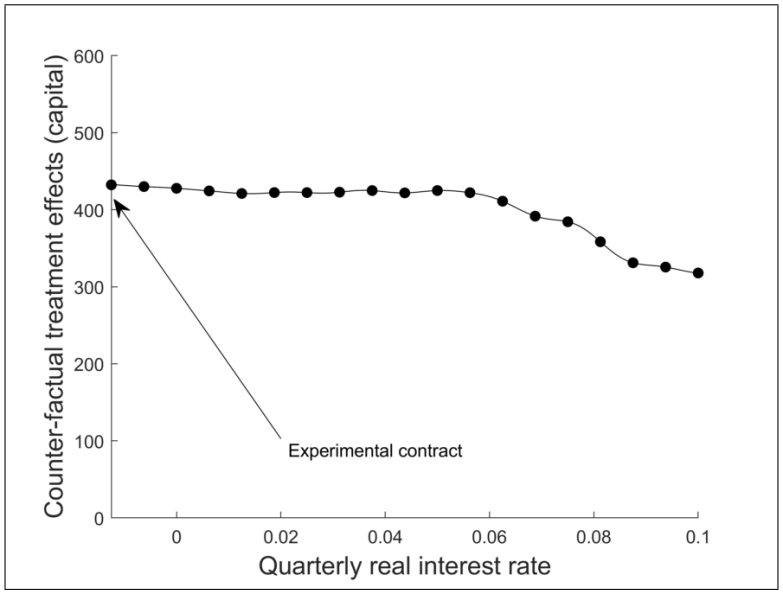
EXPENDITURE ON SCHOOLING



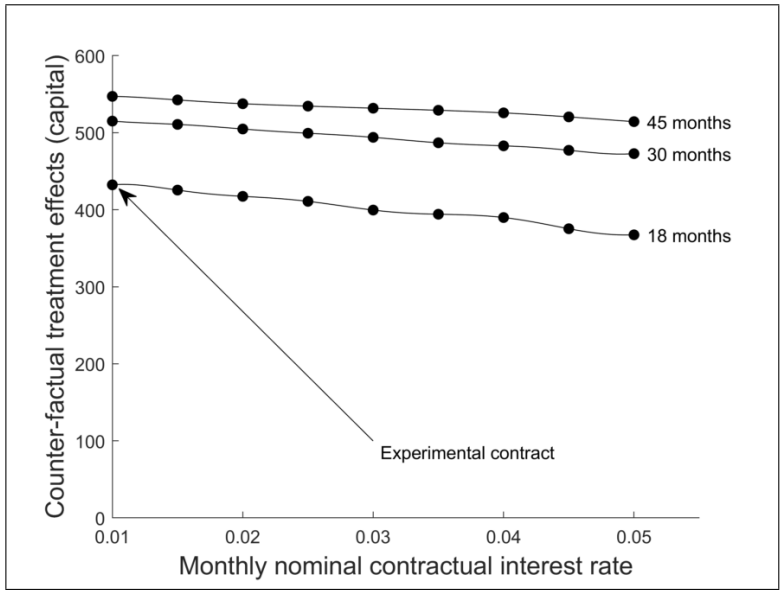
Note: The left panel presents the empirical CDF for total household consumption expenditure, and the right panel shows the empirical CDF for the sub-component representing total household expenditure on schooling (including spending on school fees, books and other materials, food and transportation).

Figure 4: **Counterfactual structural analysis**

COUNTERFACTUAL 12M CAPITAL EFFECTS: ALTERNATIVE REAL INTEREST RATE



COUNTERFACTUAL 12M CAPITAL EFFECTS: ALTERNATIVE CONTRACTUAL TERMS



Note: These panels show 12-month counterfactual treatment effects on fixed capital. In both cases, we re-run our main model specification using the parameters in Table 9 and $\kappa = 1500$. In the left panel, we consider alternative values for the real interest rate, r. In the right panel, we consider alternative contractual interest rates and contractual durations; in each case, we keep the 10% deposit (amortising the 90% loan over the period of the contract).

Table 10: **Benefit-cost analysis: Key elements**

Costs

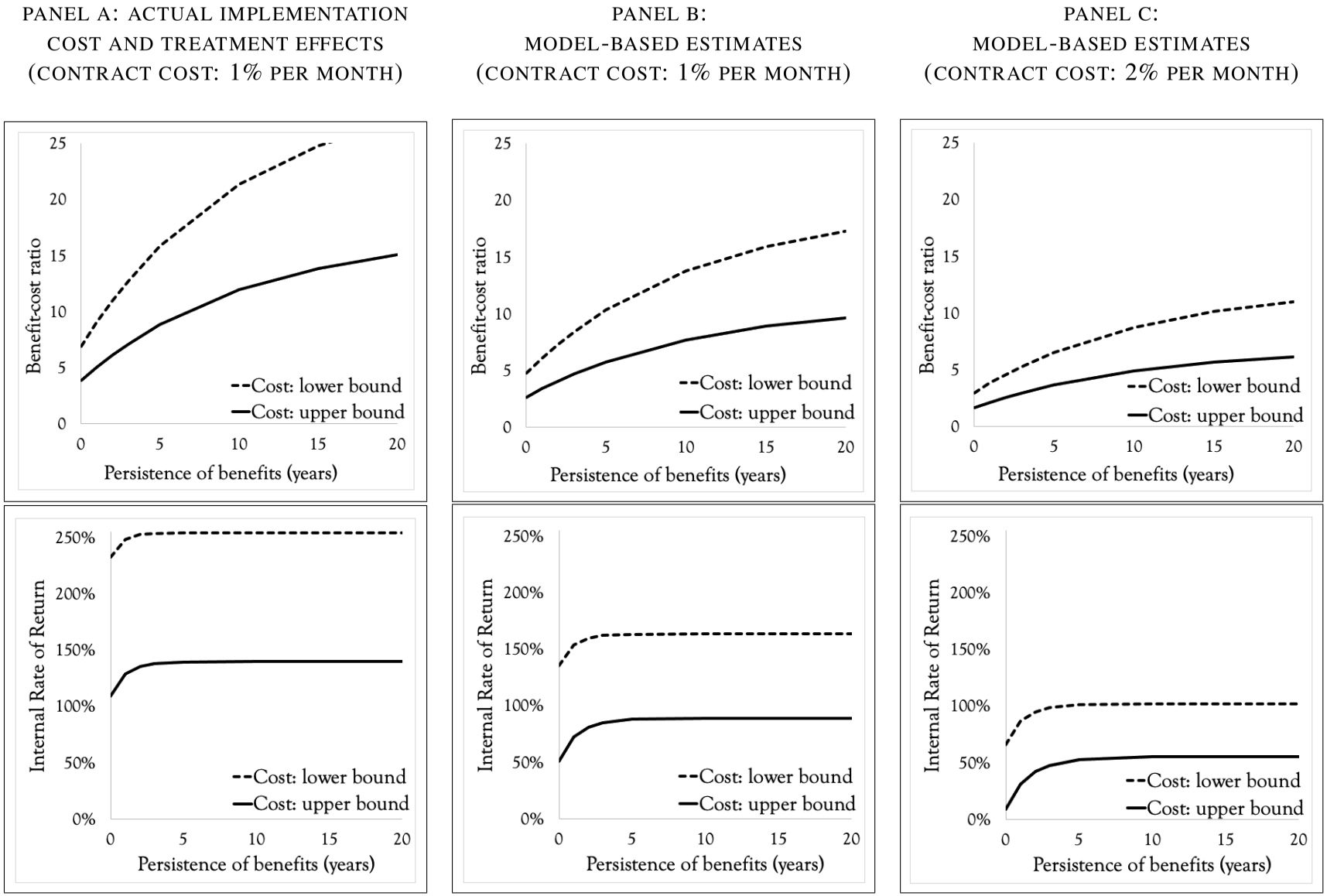
	Project total	Cost lower bound: per treatment client (N=503)	Cost upper bound: per take-up client (N=281)
Capital disbursed for initial purchase of assets	388,571	773	1,383
Total capital recovered from clients (including defaults)	-385,524	-766	-1,372
Total capital disbursed minus capital recovered (discounted to year 0)	38,095	76	136
Staff salaries (calculated as if all incurred at start of year 0)	30,076	60	107
Other implementation costs (calculated as if all incurred at start of year 0)	1,810	4	6
Total cost (calculated as of year 0)	69,981	139	249
Total costs compounded to year 2 at 10% social discount rate		**168**	**301**

Benefits

	Average (ITT)
Year 1 business profit treatment effect	440
Year 2 business profit treatment effect	396
Year 2 business assets treatment effect	329
Total benefits at year 2	**1,165**
NPV of future business profits, assuming that benefits last:	
1 year	360
2 years	687
3 years	985
5 years	1,501
10 years	2,433
15 years	3,012
20 years	3,371

Note: In this table, we provide the key elements for our analysis of benefit-cost ratios and internal rates of return (IRR), the final output of which is presented in Figure 5. All values are in USD. Costs are reported to us by the MFI. For benefits, we use the estimated treatment effects from our ITT regressions, as well as an estimate of future benefits beyond the period of the project (the net present value of all future benefits from year 3 onward, by taking the year-2 ITT on business profits as the annual value of future benefits, and showing the result under various assumptions for persistence).

Figure 5: **Benefit-cost ratios and internal rates of return**



Note: In this figure, we present benefit-cost ratios and internal rates of return. In Panel A, we use the actual estimated treatment effects and project implementation costs. In Panel B, model-based estimates are used, based on a 1% per month contract cost (which is the actual contract implemented in the experiment). In Panel C, model-based counterfactual treatment effect estimates are used, based on a contract cost of 2% per month, which affects both the benefits (impacts of the product on business and household income) as well as the costs (a higher rate of return for the MFI from the higher price of the contract, to which we also add a higher risk of default – twice the actual loss faced by the MFI during the project).