Microequity and Mutuality: Experimental Evidence on Credit with Performance-Contingent Repayment*

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Abstract

A large food multinational wishes to help micro-distributors in its supply chain with the financing of a productive asset. Collaborating with the firm in Kenya, we conduct a field experiment to compare asset financing under a traditional debt contract to three alternatives that provide a greater sharing of risk and reward. We find the largest impacts from a novel hybrid contract that combines both debt- and equity-like features. The results suggest substantial mutual benefits for the multinational, its micro-distributors, and stock-points within its supply chain. These findings demonstrate the economic appeal of financing contracts that harness the improved observability of performance data in many low- and middle-income settings.

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1 Introduction

Many large multinational firms operate 'route-to-market' programmes in developing countries. To get their products to the end customer – especially in harder-to-reach rural areas and informal urban settlements – multinationals often rely on a network of 'micro-distributors': self-employed individuals, who move consumer products from the firm's stock points to customers. These micro-distributors are not formally employed by the firm, but often are highly reliant on the firm for their income. Such multinationals have access to high-quality administrative data on the performance of their distributors, and recent advances in digital technology are enabling new ways for them to manage, monitor and pay these 'dependent contractors' (Higgins, 2019; Suri, 2017). These kinds of route-to-market programmes provide opportunities for investments that mutually benefit multinationals and their micro-distributors. However, there is relatively little economic research on the effects of different financial contract arrangements for facilitating such investments within retail distribution networks and supply chains (Jack, Kremer, de Laat, & Suri, 2023).[1]

In this paper, we conduct a field experiment of a novel performance-contingent microfinance contract for microenterprises. To do so, we work within the supply chain of one of the largest manufacturers of food products in the world, leveraging novel administrative data to support lumpy capital investments by micro-distributors. We refer to this corporation pseudonymously as 'FoodCo'. FoodCo owns a large chewing gum producer in Kenya, and wishes to help its micro-distributors with the financing of a productive asset to increase their distribution activities. Traditionally, most micro-distributors travel on foot, without the help of a vehicle. In our experiment, we partner with a local microfinance institution ('MFI') to investigate the efficacy of alternative contractual structures for financing new bicycles. In doing so, we link asset finance repayments to the performance of micro-distributors, by using FoodCo's administrative data on stock purchases – from which we calculate a profit measure that is not reliant upon micro-distributors' self-reports. Our purpose is to test whether such performance-contingent financing contracts can share risk and reward more effectively than standard debt contracts. Specifically, we test four alternative contracts: a *debt* contract, an equity-like *revenue-sharing* contract, a *hybrid* contract that contains both debt- and equity-like features, and an *index insurance* contract.

Our key result is that incorporating performance-contingent features into standard microcredit contracts can encourage investment and increase profits more than under a standard rigid debt contract. In particular, we find that the most successful contract is the hybrid one, encompassing both debt- and equity-like features. This includes performance-related payments, which enhance risk-sharing by aligning contractual obligations more closely with the micro-distributor's underlying cashflows. Alongside this, there is a fixed nominal principal amount due (akin to debt) that mitigates the unrestricted sharing of upside inherent in a standard equity contract. The hybrid contract thus mitigates

[1] For related literature in other fields, see (for example) Kolk, Rivera-Santos, and Rufín (2014) and Singh, Bakshi, and Mishra (2015).

liquidity risk while avoiding the adverse incentive effects of total wealth being exposed to unlimited upside sharing. We find that the hybrid contract outperforms the debt contract in several respects. First, we find no evidence that individuals assigned to the hybrid contract move away from the activity in which they are being taxed. To the contrary, they exert significantly more effort in their business activities compared to other contracts, and we detect significant positive effects on several measures of business management practices, and on their own risk-taking. Our high-quality administrative data on profits reveals large positive impacts on micro-distributor performance. Specifically, in intent-to-treat terms, we estimate a 167% increase in monthly business profits for individuals assigned to the hybrid contract compared to the control group, and our equivalent Local Average Treatment Effect estimate implies a 214% increase in business profits. We also find large impacts of the hybrid contract on downstream household outcomes, including household consumption expenditure on food and clothing.

To interpret these results, we build a dynamic stochastic model – in which a risk-averse micro-distributor decides how much effort to exert on sales, and whether to accept or reject various financing contracts. The model formalises the intuition that micro-distributors are exposed to risk – and that exposure to such risk increases with the use of the fixed asset. The model illustrates that the hybrid contract breaks the traditional trade-off between implicit insurance and reduced effort: the contract offers repayment flexibility (and, with it, implicit insurance) while also incentivising additional effort in order to clear the debt. In doing so, the model matches our pattern of empirical results on distributor effort and income, and on contractual take-up.

Finally, we conduct a total return analysis, which incorporates the combined impacts of the intervention across all of the relevant actors in the supply chain: the micro-distributors, the multinational, the stockpoints from which micro-distributors source their product, and the microfinance institution. We find large mutual benefits along the supply chain, and remarkably high benefit-cost ratios across all contracts – particularly for the hybrid and revenue-sharing contracts. This is the case even when assuming minimal persistence of treatment effects beyond the three-year mark of the project. For example, we estimate a benefit-cost ratio of 29 for the hybrid contract when assuming only two years of persistence in treatment effects (with corresponding ratios of 19 for the revenue-sharing sharing contract, 9 for the debt contract, and 9 for the index insurance contract). This corresponds to internal rates of return of 605% for the hybrid contract, 391% for the revenue-sharing sharing contract, 181% for the debt contract, and 190% for the index insurance contract. Assuming ten years of benefits (a common assumption made in cost-benefit analyses in the literature), we estimate a benefit-cost ratio of 55 for the hybrid contract, 36 for the revenue-sharing sharing contract, and 17 for both the debt and index insurance contracts.

Our paper draws together two previously disparate strands of research: microfinance and supply chain finance. The first literature has identified limited impacts of the standard rigid microcredit contract on business performance and household outcomes (Banerjee, Karlan, & Zinman, 2015), notwithstanding some evidence of significant heterogeneity in business impacts (Banerjee, Breza, Duflo, &

Kinnan, 2019) and general equilibrium effects (Breza & Kinnan, 2021; Cai & Szeidl, 2022). A related body of work has demonstrated the benefits of introducing more flexibility into the standard contract through 'repayment grace periods' (Barboni & Agarwal, 2021; Battaglia, Gulesci, & Madestam, 2023; Field, Pande, Papp, & Rigol, 2013). We push the frontier in this literature by investigating a more direct way to link repayments to income – performance-contingent contracts for microenterprises. Such contracts may be more appropriate than traditional debt contracts for financing investments of risk-averse microenterprises – but, until now, have only been tested in a laboratory setting or very small pilot studies.[2] One further contribution of our paper is the homogeneity of the sample of business owners, which – along with a detailed understanding of the supply chain, administrative data, and modeling of the distributor 'production function' – provides an opportunity to more effectively explore the mechanisms through which contractual terms affect investment behaviour and effort.

We also contribute to the supply chain finance literature, on which there is relatively little work in developing countries – despite the increasing prevalence of large multinational route-to-market programs, and despite strong demand for financing at various points in the supply chain (Casaburi & Willis, 2024). In an agricultural setting, Jack, Kremer, de Laat, and Suri (2023) work within a milk supply chain (where output is also well observed, as in our context) and find large benefits to financing a productive asset for farmers (a rainwater harvest tank). Other literature in this space emphasises strong theoretical justifications for suppliers acting as financial intermediaries – due to their comparative advantage (relative to formal banks) in assessing the performance and creditworthiness of customers, and their ability to use informal means for guaranteeing repayment (such as the threat to cut off future supplies) (Beck, Pamuk, Ramrattan, & Uras, 2015; Biais & Gollier, 1997; Breitbach, 2017; Breza & Liberman, 2017; Burkart & Ellingsen, 2004; Cull, Goh, & Xu, 2023; Klapper, Laeven, & Rajan, 2012; Maksimovic & Demirgüç-Kunt, 2001; McMillan & Woodruff, 1999; Mian & Smith Jr, 1992; Petersen & Rajan, 1997; Prahalad & Hammond, 2002; Sodhi & Tang, 2014).

By conducting an experiment with a large multinational, we shed light on the exciting potential for multinationals to help finance productive assets for dependent contractors. In doing so, we leverage advancements in digital technology that improve the observability of microenterprise performance – mitigating the classic problems of costly state verification that traditionally limit the viability of performance-contingent financing contracts (Townsend, 1979). The rapid adoption of digital payments technologies – including in many low-income settings (Annan, Cheung, & Giné, 2024) – opens many possibilities for innovative performance-based financing contracts in the years ahead. For this reason, we view this paper as an important proof of concept for a new class of financing contracts for small

[2] See Fischer (2013) and De Mel, McKenzie, and Woodruff (2019). Separately, there is a long tradition of research in agricultural settings exploring the role of implicit insurance through share-cropping and other insurance-like arrangements bundled into loans to farmers (Burchardi, Gulesci, Lerva, & Sulaiman, 2019; Giné & Yang, 2009; Karlan, Kutsoati, McMillan, & Udry, 2011; Stiglitz, 1974). In particular, the benefits of revenue-sharing contracts for the risk averse was central to Udry's (1994) analysis of informal state-contingent loans in northern Nigeria (see also Udry (1990)). Our paper contributes to the limited non-agricultural literature, with a focus on more formal actors within a multinational supply chain.

firms operating within a supply chain that permits observability of their performance.

The paper proceeds as follows. Section 2 explains the context of the study and the design and implementation of the experiment; in doing so, the section also outlines our conceptual framework. Section 3 reports our treatment effects. We provide a cost-benefit analysis in section 4, and conclude in section 5.

2 Experimental design

2.1 Study context

In 2013, FoodCo developed a route-to-market micro-distribution program using self-employed micro-distributors in Kenya. The distribution system is built around small warehouses (called 'stockpoints'), which are located in both rural and urban areas. Stockpoints receive deliveries of FoodCo chewing gum, which they sell alongside various non-FoodCo products. Micro-distributors purchase chewing gum (as well as other products) from stockpoints, before selling to customers. They initially purchase the gum from the stockpoints with an up-front discount to the market price, which must be paid in full (i.e. there is very little trade credit provided). They additionally receive performance-related pay in the form of an end-of-month bonus via mobile money (M-Pesa) for every bag of gum sold. There is no obligation for distributors to sell gum exclusively, but selling FoodCo's product is relatively profitable, and they have a strong incentive to stay in the program. This setting is common to many route-to-market distribution programs run by multinational corporations around the world (Prahalad & Hammond, 2002). On the basis of feedback from FoodCo and qualitative work that we conducted with micro-distributors, we hypothesised that bicycle access could substantially improve distributors' profits. However, bicycles are often prohibitively expensive, costing approximately \$100 for a mid-market model.

2.2 Contract variants

Our sample consists of micro-distributors who had been in the FoodCo program for at least three months and who had expressed an interest in purchasing a bicycle to expand their distribution activities. Interested micro-distributors were invited to a baseline workshop where they completed a survey and conducted behavioural games, and were randomly offered one of four microfinance contracts (designed in collaboration with FoodCo and our partner MFI). All contracts required the micro-distributor to pay an initial deposit of 10%, with the remaining 90% of the bicycle price financed by the local MFI; the MFI bore all of the credit risk, and maintained ownership of the bicycles until completion of each contract. All finance provided in this project was 'digital finance'. No cash changed hands, either in disbursing funds to clients (payments were sent via mobile money to procure bikes), or in repayments (which were again made by mobile money). The contracts were as follows:

(i). *Debt*: A contract requiring a total repayment amount equal to the asset financing amount plus a 15% mark-up, spread evenly over 12 fixed monthly payments.

(ii). *RevShare*: A 12-month contract that required clients to pay half of the fixed monthly payment of the debt contract (calculated in the equivalent way), as well as paying a 10% share of their monthly profits (calculated from administrative data). Relative to the debt contract, the RevShare contract is particularly attractive for insuring downside risk: if the micro-distributor has a bad month, the RevShare contract reduces the payments required.[3]

(iii). *Hybrid*: A contract in which monthly payments were calculated in exactly the same manner as the RevShare contract, but with a flexible contract duration: repayments end when the cumulative payments reach the level required under the debt contract (i.e. the asset financing amount plus a 15% mark-up). The hybrid contract thus provides the advantages of insuring against downside risk, but without the disadvantage of the taxation of high performance. Further, if micro-distributors experience an endowment effect (Carney, Kremer, Lin, & Rao, 2022) – such that they would prefer to bring forward the day on which they own the bicycle outright – then this contract directly incentivises effort.[4]

(iv). *IndexShare*: An index insurance contract, which had a similar repayment structure to the RevShare contract, with the difference being how the profit-sharing is calculated: the 10% sharing payments were based on an index constructed from the profits of other micro-distributors in their region (again, calculated using administrative data). This contract shares a similar advantage to the RevShare contract – namely, that it insures the micro-distributor against common shocks – but it does not penalize high effort as the RevShare contract does. This contract is similar in spirit to index insurance contracts in agriculture. These are commonly used to mitigate asymmetric information and adverse incentive issues by basing crop insurance payouts on average yields over a clearly defined area, rather than on own reported yield (Carter, Galarza, & Boucher, 2007).[5]

Finally, respondents in the *control* group were not offered the opportunity to finance a bicycle using any contract, but maintained full 'business as usual' access to the FoodCo micro-distribution program. Similarly, individuals who had rejected the contract for which they drew a ball were not offered any contract for bike financing.

[3] Conversely, it is possible for the micro-distributor to owe substantially more under the RevShare contract than under the debt contract, if monthly profits are high.

[4] The flexible duration of our hybrid contract shares similarities with relationship-based bank lending contracts traditionally implemented in Germany with small and medium sized enterprises ('Mittelstand'), in which for example any unpaid amounts from a one-year debt contract would roll over to a second year, providing a type of risk-sharing over time (Behr & Schmidt, 2015).

[5] In our study, the index is aggregated at the regional level, encompassing Nairobi, Central Kenya, Kisumu, Eastern Kenya, and Mombasa. The index that we calculate for each treated individual excludes their profits and the profits of other distributors at their stockpoint.

Profit-sharing payments under the RevShare, Hybrid and IndexShare contracts were calculated using administrative data on stock purchases and a profit margin given to us by FoodCo, based on the retail price at which the micro-distributors were requested to sell their products. We designed the contracts to be similar in terms of expected net present value for the median micro-distributor, given (i) the baseline distribution of micro-distributor profits in the broader route-to-market program and (ii) estimates, based on qualitative interviews, of the expected impact of the bicycles on profits.

2.3 Conceptual framework

To fix ideas, we now discuss the trade-offs facing a stylised micro-distributor. Specifically, we consider a micro-distributor who is credit-constrained, and whose productivity will increase if she makes a lumpy purchase of a bicycle. The micro-distributor, faced with our menu of financing contracts, needs to answer two questions. First, the *incentive compatibility* question: "under each available contract, how much effort shall I invest in sales for FoodCo ('on contract')?". Second, the *individual rationality* question: "given a take-it-or-leave-it decision, which contracts should I accept?".

Risk plays two important roles in our conceptual framework – each of which, in our view, reflects important features of the actual experience of micro-distributors in our experiment. First – as our incentivised baseline behavioural games show – micro-distributors are risk averse.[6] This implies that, *ceteris paribus*, micro-distributors value a contract that bundles some degree of risk-sharing. Second, micro-distributors operate in a risky environment – with the risk increasing along with the micro-distributors' use of the lumpy asset. This feature, too, is closely grounded in the real experience of our respondents. For example, a micro-distributor who cycles her bicycle further to serve new markets may increase and diversify her sales – but is also putting that bicycle at more risk of being stolen, or destroyed in an accident; similarly, new markets themselves are intrinsically likely to be more uncertain (Roll, Dolan, & Rajak, 2021).

To formalise these ideas, we assume that the micro-distributor has an exponential utility function with r being the coefficient of absolute risk aversion. We model the micro-distributor's net income as the sum of income that does not depend upon the bicycle at all ('sure thing' sales: a constant, π_0), and income that depends upon a Cobb-Douglas form in on-contract labour effort (e) and capital (where $k \equiv 1$ for no bicycle, and $k >> 1$ for a bicycle): $\pi_1(e, k, \eta_t) = \eta_t \cdot e \cdot k$. For tractability, we assume $\log(\eta_t) \sim \mathcal{N}(\mu, \sigma^2)$. Further, for simplicity, we assume that the micro-distributor has neither any credit nor any savings technology; this accords approximately with the empirical reality (in which the respondent micro-distributors were unable to accumulate sufficient funds to purchase the bicycle

[6] For example, using incentivised risk preference elicitation activities that we describe in more detail in Appendix Section A6, we find that – for a binary outcome lottery with expected payment of 500 KES – the average certainty equivalent was 374 KES; for a lottery with expected payment of 750 KES, the average certainty equivalent was 478 KES. A structural estimation of $u(x; \alpha) = x^\alpha$ using all the data from our incentivised games returns $\hat{\alpha} = 0.69$.

without a financing contract), and allows the model to focus clearly upon the consequences of the experimental contracts.

Suppose that, each month, the micro-distributor must pay a fixed sum F and then a proportion $(1-\omega)$ of her total net income. We assume that, each month (in advance of the realisation of η_t), the micro-distributor chooses her effort. We allow a quadratic effort cost (in currency-equivalent terms); this reflects both the psychic cost of effort and the opportunity cost of the distributor's time on other projects (including, in particular, sales off-contract). This is a stationary problem; with monthly discount factor β, the distributor's infinite-horizon value is:

$$V(\kappa, F, \omega) = \frac{1}{1-\beta} \cdot \max_{e \geq 0} \ \mathbb{E}_\eta \left(u \left\{ \omega \cdot \left[\pi_0 + \pi_1(e, \kappa, \eta) \right] - 0.5e^2 - F \right\} \right). \tag{1}$$

Equation 1 can be used to describe four important cases. First, the value of refusing any financing contract; in this case, the distributor has no bicycle ($\kappa = 1$), and keeps all of her own income ($\omega = 1$; $F = 0$). The value can therefore be written as $V(1, 0, 1)$. Second, the value of completing a financing contract; in this case, the distributor owes nothing further, but has a bicycle: $V(\kappa, 0, 1)$. Third, the debt contract involves 12 months of fixed repayments of F_d, after which the client owns the bicycle; the initial value of taking that contract is therefore $\left(1-\beta^{12}\right) \cdot V(\kappa, F_d, 1) + \beta^{12} \cdot V(\kappa, 0, 1)$. Fourth, by analogous logic, the initial value of taking the revenue-sharing contract is $\left(1-\beta^{12}\right) \cdot V(\kappa, 0.5F_d, \omega) + \beta^{12} \cdot V(\kappa, 0, 1)$.

Three insights flow immediately from this setup for the distributor's effort with the bicycle. First, since the marginal product of effort is increasing in κ, the model predicts greater effort with the bicycle than without. Second, because of the assumption of constant absolute risk aversion, the model predicts identical effort for a micro-distributor on the Debt contract as for a micro-distributor who owns the bicycle outright (because, in both cases, the micro-distributor receives all of the income – and the fixed repayments F_d do not affect the marginal return to effort under constant absolute risk aversion). Third, for reasonable values of risk aversion, the RevShare contract reduces effort by 'taxing' the micro-distributor's returns; as Angrist, Caldwell, and Hall (2021) elegantly put it, output sharing 'inserts a wedge between effort and income'.[7]

Together, these results indicate that performance-contingent repayment structures require a trade-off: they are valued for their implicit insurance, but this comes at the cost of reduced effort. Indeed, this is a familiar trade-off from many studies of performance-continent remuneration (Holmström, 1979; Lazear, 2000), including in the famous case of sharecropping: Burchardi et al. (2019); Stiglitz (1975); Stiglitz and Weiss (1981). The Hybrid contract, however, provides a way of breaking this trade-off: by offering repayment flexibility (and, thus, some implicit insurance), while also incentivising

[7] In appendix Section A1, we use a second-order approximation to argue that this result need not be universal; a distributor who is extremely risk averse – indeed, probably implausibly risk averse, in this context – might increase effort as ω decreases, because of an implicit-insurance channel.

additional effort in order to clear the micro-distributor's debt. Under the Hybrid contract, increased on-contract effort in any given month can bring forward the date at which the total contract is repaid – and, therefore, change the path of future repayments. The Hybrid contract can, therefore, be understood as a dynamic optimisation problem with the outstanding debt (D_t) being the state variable. For a micro-distributor entering a given period with outstanding debt D_t, the value of the Hybrid contract can be written as:

$$V^h(D_t) = \max_{e \geq 0} \ \mathbb{E}_\eta \left[u \left(\max \left\{ \underbrace{\omega \cdot \Big[\pi_0 + \pi_1(e, \eta; \kappa)\Big] - 0.5F_d}_{\text{contract ongoing}}, \underbrace{\pi_0 + \pi_1(e, \eta; \kappa) - D_t}_{\text{contract ending/ended}} \right\} - 0.5e^2 \right) \right] \\ + \beta \cdot V^h(D_{t+1}), \tag{2}$$

where the law of motion for D_t is:

$$D_{t+1} = \max \left\{ \underbrace{D_t - 0.5F_d - (1-\omega) \cdot \Big[\pi_0 + \pi_1(e, \eta; \kappa)\Big]}_{\text{contract ongoing}}, \underbrace{0}_{\text{contract ended}} \right\}. \tag{3}$$

We note two important features of this dynamic model. First, the terminal value is known: once the debt is repaid, the micro-distributor owns the bicycle outright, so $V^h(0) \equiv V(\kappa, 0, 1)$. Second, the state dynamics are monotonic: the total debt always decreases until it is repaid (if $D_t > 0$, it follows that $D_{t+1} < D_t$). These two features enable $V^h(D_t)$ to be solved by backward induction in D_t.

Since the total repayment under the Hybrid contract matches that of the Debt contract – and, by experimental design, the expected monthly payment is approximately equal to that of the Debt contract – we average effort under the Hybrid contract is likely to approximate that of the Debt contract. That is, the contingent repayment structure in the Hybrid contract offers implicit insurance – but, by capping the micro-distributor's exposure, ensures that effort is not taxed.

Panel A of Figure 1 illustrates these predictions, for a particular numerical solution of the model.[8] In this figure, we show the pattern of effort as a function of risk aversion.[9] The predictions match closely those just described: effort is highest under the Debt contract, which is almost identical to effort under the Hybrid contract; this is followed by effort under the RevShare contract and then under no contract.

In Panel B of Figure 1, we turn to predictions about take-up. We do this by illustrating the

[8] We calibrated the model to our context by choosing $F_d = 10$, $\omega = 0.9$, $\mu = 1.6$, $\sigma = 0.25$, $\kappa = 1.4$, $\beta = 0.95$ and $\pi_0 = 20$.

[9] For ease of interpretation, we use the representation of Cohen and Einav (2007); we imagine a 50-50 gamble where the gain is \$10 and the loss is x. For each given coefficient of absolute risk aversion, we solve for x so that the respondent is indifferent between taking the gamble and not; this is given by $x \equiv \log\left[2 - \exp(-10r)\right]/r$. For the Hybrid contract, we find numerically the expected effort over the course of the contract.

'discounted certainty equivalent': the monthly increase in consumption (*ad infinitum*) necessary to make the micro-distributor indifferent between accepting and refusing the contract.[10] Critical for the take-up analysis is the magnitude of π_1 relative to π_0 – that is, the share of total output that is dependent upon the productivity shock. If $\pi_0 = 0$ (that is, if all of the micro-distributors' income flows from effort with the bicycle, with no 'sure thing' sales) we would expect the value of the debt and revenue-sharing contracts to be identical in the limit as $r \to 0$ (given that we designed the revenue-sharing contract so that repayments are approximately equalised with the debt contract). But if $\pi_0 > 0$, some part of the micro-distributor's income is invariant to the shock – so the requirement to share this income with the lender acts simply as a 'pure tax'.[11] Panel B of Figure 1 predicts that take-up of the Hybrid contract should be preferred slightly to that of the debt contract; for most values of risk aversion, these two contracts are both preferred to the RevShare contract.

We note that there is some evidence that some prospective borrowers are averse to holding debt (see, for example, Carney et al. (2022) and Azmat and Macdonald (2020)). Our framework can be extended straightforwardly to allow for this. If we denote by ϕ the currency-equivalent psychic cost of being in debt, then the value of refusing a contract is now $V(1, -\phi, 1)$, and the value of completing a financing contract is $V(\kappa, -\phi, 1)$.[12] If the micro-distributors are debt-averse, our framework predicts that (i) the value of the hybrid contract will be greater than that of the debt contract, and (ii) effort in the hybrid contract will exceed that of the debt contract, in order to achieve early repayment. We discuss this in more detail in appendix Section A1.

These insights can be extended to the IndexShare contract, which resembles the RevShare contract except that the 10% sharing payments depend on the revenues of other micro-distributors in the area, not on the client's own revenue. The main expected benefit of the IndexShare contract is to provide insurance against income shocks while eliminating the taxation of *additional* effort present in the RevShare contract.[13] As a result, we expect effort under the IndexShare contract to be higher than under RevShare and similar to the level of effort under the Debt contract (where the client is residual claimant on own profits). Take-up of the IndexShare contract, on the other hand, depends on the correlation between the index and the client's revenue. If the index closely tracks the client's own revenue, take-up of the IndexShare contract should be equal to the RevShare contract – or slightly higher due to the anticipated beneficial effect on effort. If, however, the index does not correlate well with the shocks that the client faces, the IndexShare contract exposes clients to substantial basis risk while still

[10] Specifically, this is calculated as $\left[-\log(1-\beta) - \log(-V)\right]/r$. In our view, this is more intuitive than comparing raw values of V – which exhibit the scaling features described in (for example) Apesteguia and Ballester (2018).

[11] In our calibration, we set $\pi_0 = 20$; this corresponds to about 40% of the micro-distributor's income flowing from 'sure thing' sales, which (for example) matches closely the average proportion of profits that the control group generates from sales within 1 kilometre of their stock point.

[12] The values of the debt contract, the revenue-sharing contract and the hybrid contract all keep the same algebraic forms, and adjust accordingly.

[13] This taxation may nonetheless resurface indirectly if micro-distributors emulate each other and simultaneously increase effort. The taxation of original effort π_0 remains.

taxing π_0. In this case, we anticipate take-up to be substantially lower than the RevShare contract, particularly among risk-averse clients (see, for example, Karlan, Osei, Osei-Akoto, & Udry, 2014). This negative effects on take-up relative to RevShare can nonetheless be reversed if additional effort is highly sensitive to taxation, π_0 is small, and the client's level of risk aversion is negligible. Take-up of the IndexShare contract thus remains an empirical question.

2.4 Descriptive statistics, contract assignment and take-up

Micro-distributors who had expressed an interest in purchasing a bicycle to expand their business were first invited to a baseline workshop, where they completed a household survey and a series of behavioural games. Micro-distributors were also given the opportunity to inspect several kinds of bicycles on offer; most bicycles were 'work friendly' models with a rear rack.[14]

At the end of the session, each of the microfinance contracts was carefully explained to the respondents; this included several example scenarios and tests of understanding. Respondents were then introduced to a manager from our partner microfinance institution, who explained that they would be offering the financing contracts for bikes to a randomly-selected subset of participants. When communicating with participants, the words 'debt', 'equity' and 'insurance' were never used; contracts were explained using their cash-flow structure in the local language (Swahili), with each contract colour-coded for ease of remembering.

The microfinance contracts were assigned using a public randomisation device (an opaque bag containing 100 coloured balls, with 20 balls for each of the five treatment arms). Micro-distributors had earlier made take-it-or-leave-it decisions for each of the contracts; respondents who drew a colour for which they had specified their acceptance were immediately directed to a representative from the MFI, to proceed to sign the contract. Individuals who drew a ball for the control group were not offered the opportunity to finance a bicycle using any contract, but they maintained full 'business as usual' access to the FoodCo micro-distribution program; similarly, individuals who had rejected the contract for which they drew a ball were also not given any contract. The choice of bicycle was made before contract decisions were elicited.

Between 2017 and 2019, there were an average of 478 active micro-distributors each month in the FoodCo programme from which our experimental participants were drawn. The total number of unique micro-distributors in the programme over that period was 1,727, and we have access to high-frequency (daily) data on their purchases of all gum products from FoodCo, from which we can create administrative measures of monthly profits (described further below). We use this to test for spillovers in Section 3.5. The experiment itself consisted of 161 individual distributors, and was

[14] The menu of bicycles included one model that is of a higher quality and nearly twice as expensive, and a 'female-friendly' bicycle with a dipped bar. See Fiala, Garcia-Hernandez, Narula, and Prakash (2022) for evidence of the significant benefits of bicycles for young women, in a setting geographically similar to ours and using the same Kenyan bicycle manufacturer.

designed (considering the sample size) to be sufficiently powered to detect effects when considering the large hypothesised treatment effect, homogeneous sample, and high-frequency profit data that results in nearly 3,000 data points for administrative data regressions.[15]

The experiment was implemented across 19 waves. In total, 138 of the 161 participants were assigned to treatment (one of the four financing contracts), with the remainder assigned to control. Appendix Table A2 provides summary statistics, disaggregated by treatment assignment; the table also reports tests of randomisation balance. For all variables in Table A2, individual balance tests do not reject the null of no difference across treatment groups. An omnibus balance test, assessing the equality of coefficients for each treatment across all variables, also comfortably passes (p-value = 0.980). Respondents' average age was 31, with 15% female and 70% married. 20% had a post-secondary education. On average, respondent households had three members. In the three months prior to the baseline survey, mean profits from all selling activities were Ks 13,329 (median Ks 10,666), and Ks 2,874 (median Ks 2,261) from just FoodCo products (for which we use administrative data).[16] Only 16% of distributors had employees; 26% also engaged in another income-generating activity (mostly casual labour), with average income of Ks 2,000 from that source (and a median of zero).

Several variables suggest that micro-distributors face liquidity and credit constraints. First, the median household had total monthly consumption expenditure of Ks 17,375 compared to total household income from all sources of Ks 14,225. Second, more than half of micro-distributors report that none of their FoodCo purchases are received on credit. Further, the median micro-distributor only extends trade credit for 5% of their sales. Even where trade credit is provided, the duration is extremely short – for those who receive trade credit from their stockpoint, the average number of days of credit is 2.9 (median of 1), and for those who extend trade credit, average days to repay is 2.2 (median of 1).

3 Treatment effects

We had access to administrative data from FoodCo on stock purchases by all 1,727 unique distributors in their programme (regardless of whether they participated in our experiment); FoodCo performs meticulous checks with field officers and stockpoints to verify the quality of data on purchases, based on which distributors are paid their monthly bonuses.

[15] Our approach bears some resemblance to that of Bloom, Eifert, Mahajan, McKenzie, and Roberts (2013), who conducted an experiment involving only 17 firms (28 plants) and relied on an intervention with a large hypothesised impact, homogeneity of the sample (from a similar business sector), and the availability of a long time series complemented by high-frequency data. These features are also present in our study. We anticipated a substantial treatment effect in our experiment because we were providing a highly targeted asset to specifically address a major constraint faced by micro-distributors seeking to expand their businesses: transportation. This hypothesis was strongly supported by qualitative work during the experimental design phase; this consistently highlighted transportation as a key impediment to business growth.

[16] We use Ks throughout to refer to Kenyan Shillings (KES). The USD-KES exchange rate at baseline was approximately equal to 102.

We create a panel of monthly profits by using the purchase data and the profit margin made by distributors for each of the six possible chewing gum products, based on the fixed price at which FoodCo requests distributors to sell. We aggregate the profits across the six products to create our primary outcome variable. Technically, our measure is gross profit, or "net income before non-working-capital expenses": it includes the main category of business expenditure, inventory costs, but excludes other costs such as travel and labour.[17]

We begin with the data for the 161 distributors who entered our experiment between 2017 and 2019. For all other variables, we use survey data collected quarterly for up to one year after treatment. Our data covers all available post-treatment months up until the COVID-19 lockdowns in March 2020.[18] For each outcome, we use an intent-to-treat ANCOVA specification:

$$y_{it} = \beta_0 + \sum_{k \in \{1,\ldots,4\}} \beta_k \cdot \texttt{Offered}_{ik} + \gamma \cdot y_{i0} + \varepsilon_{it}. \tag{4}$$

Here, $\texttt{Offered}_{ik}$ is a dummy for whether individual i had contract k randomly drawn. In this specification, y_{i0} refers to the baseline value for outcome y (or the average prior outcome, in the case of administrative data on profits). We winsorize at 90%, and we cluster standard errors at the individual level. In Appendix Section A3.5, we show that results are robust when using randomisation inference. There is zero attrition in the administrative data on profits. For the additional survey data, attrition is very low, with an overall attrition rate of approximately 4% that is uncorrelated with the treatments.

3.1 First-stage results: Take-up, asset usage, and effort

Table 1 presents results for take-up of the financing contracts offered, usage of the financed assets, and business effort. Panel A presents results pooling all financing contracts, to explore the overall impact of being offered any form of asset-based financing. Panel B presents regressions with separate dummies for each contract.

We begin by describing take-up – by which we mean that a respondent had agreed to an offered contract, provided the requisite deposit and supporting documentation, and received the bicycle. Results are presented in column 1 of Table 1. The overall take-up rate of any financing contract was 59%. The highest take-up rate was for Hybrid, at 73%, followed by 68% for Debt and 51% for RevShare; the lowest take-up was for IndexShare at 47%. Formal statistical tests indicate that take-up of Hybrid is significantly greater than take-up of RevShare (p = 0.061) and IndexShare (p = 0.063). A formal test

[17] On average, inventory expenditure is 40 times larger than the next largest category (transportation costs).

[18] We ended the project in March 2020, with approximately 85% of the planned survey follow-up data collected before the COVID-19 lockdown. As in many other settings, the lockdown presented a huge shock to operations; in our case this affected not only the operations of micro-distributors, but also structural changes in the way FoodCo managed the program, and an inability for the MFI to collect microfinance repayments. All of our analysis uses data up until and not including the lockdown.

also rejects that take-up of Debt is the same as IndexShare (p = 0.082), but does not quite reject euqality between take-up of Debt and RevShare at conventional levels (p = 0.142).[19] In Appendix Figure A5, we illustrate the distribution of financed bike prices for individuals who took up their contract. The mean price was KES 9,658, with a median of KES 10,000.[20]

In columns 2 and 3 of Table 1, we ask a key preliminary question: Did the distributors who took the bicycle actually use it for their business? In general, the answer is yes: the pooled estimate suggests that 78% of distributors who took the bicycle mainly used it for business purposes, and the the average number of hours that the bicycle was used per week was 28. Turning to cross-contract comparisons in Panel B, we find evidence of greater utilisation of the asset for business purposes and greater effort under the Hybrid contract that contains both debt- and equity-like features. Specifically, 90% of individuals under Hybrid used their bicycle primarily for business purposes, compared to 73% under Debt, and 71% under RevShare.[21] Formal tests confirm that those differences are statistically significant, with p-values of 0.008 and 0.006 respectively. Average bicycle usage was 34.8 hours under Hybrid: significantly larger than the 22.3 hours under Debt (p = 0.036 for a cross-contract test) and the 24.9 hours under RevShare (p = 0.094 for a cross-contract test against Hybrid).

We next explore two further measures of business effort. We present both intent-to-treat (ITT) and local average treatment effect (LATE) estimations, given the differential take-up seen in column 1. Columns 4 and 5 use administrative data capturing how often distributors visit stock-points in a given month to purchase inventory. Beginning with the pooled treatments in Panel A, the ITT estimate indicates an increase of 1.5 visits per month (p = 0.093), compared to a control mean of 2.6, and with a LATE estimate of 2.3 implying a near 100% increase in visits for those who took up the treatment. Columns 6 and 7 explore a different measure of effort, captured by survey data on the percentage of their selling portfolio that comes from customers greater than 1 km from their stockpoint. Results indicate a large geographical expansion of customers, with an ITT estimate on the pooled variable of 16 percentage points (p = 0.026), and a LATE coefficient of 27 percentage points which implies that distributors who took up any contract now generate 85% of their profits from customers greater than 1 km from their own stock point, compared to a control mean of 58%. These results, which suggest a significant expansion of distributors' sales networks, align with data from GPS trackers attached to all bikes. As shown in Figure 2, data from the GPS trackers in various project implementation sites across the country reveal that the distributors traversed extensive geographical areas with their bicycles.

[19] The relatively lower take-up for our index insurance contract is not surprising, given the important role here for basis risk (Carter, de Janvry, Sadoulet, Sarris, et al., 2014; Clarke, 2016; Cole et al., 2013). Appendix Figure A4 illustrates the relationship between micro-distributor performance and required payments under each contract; in doing so, it illustrates an important role for basis risk.

[20] We do not observe any noteable patterns in the amount financed across contracts, or in the type of bicycle purchased.

[21] The vast majority of individuals who took up the bicycle report that they primarily used it themselves – only 7% report that someone outside of their household used it for any period of time.

3.2 Results: Main business outcomes

Table 2 presents results for the main business outcomes. Panel A presents pooled results; Panel B presents results by contract (including both ITT and LATE estimates). Our primary hypothesis, as specified in our pre-analysis plan, was that our treatments affected participants' business profits. Column 1 pools all follow-up data (up to 36 months after treatment); it shows that assignment to treatment nearly doubled monthly business profits from the sale of FoodCo products (as measured from administrative data). Specifically, we estimate an ITT of Ks 813 per month (p = 0.034); this compares to a control mean of Ks 897. In column 2, we report the LATE: we estimate a 136% increase in monthly business profits from taking up a contract (Ks 1,221). Compared to the average asset price of Ks 9,658, these large treatment effects suggest very favourable cost-benefit ratios, which we explore more systematically in Section 4.

Columns 3, 4, and 5 demonstrate the stability of treatment effects over time. Specifically, we restrict the time period to (i) months 1 to 6 after delivery of the assets; (ii) months 7 to 12, and (iii) months 13 to 24. The pooled treatment effects are relatively similar over time. Focusing on the by-contract impacts, the main result is that the impact of the Hybrid contract is large and statistically significant across all time periods, and significantly more so than the debt contract in several specifications. First, it is clear that large treatment effects appear soon after the asset is disbursed, with a coefficient on Hybrid in the first six months of Ks 1,601 (p = 0.002). The coefficient on Hybrid in months 7 to 12 is Ks 1,764 (p = 0.005), and in months 13 to 24 it is 1,330 (p = 0.053). We also present cross-coefficient tests to explore if there is a significant difference in treatment effects across contracts. In columns 3, 4, and 5, we see strong evidence that the coefficient on Hybrid is significantly greater than the coefficient on Debt (p-values of 0.049, 0.012, and 0.080, respectively). We cannot reject the null of Hybrid and RevShare being equal in any of the specifications.

In Appendix Section A3.4, we show that these conclusions are robust to using a Poisson specification. Specifically, we find large and stable treatment effects for Hybrid across time. Specifically, the coefficient on Hybrid from the poisson regressions in the first six months is 0.89 (p = 0.001), in months 7 to 12 it is 1.30 (p = 0.003), and in months 13 to 24 it is 1.10 (p = 0.051). The cross-coefficient tests again show Hybrid significantly outperforming Debt (p-values of 0.049, 0.012, and 0.080, respectively).

Finally, columns 6 and 7 of Table 2 provide no evidence that the increase in profits from FoodCo products observed in the previous columns crowded out other forms of earnings (including profits from selling non-FoodCo products, as well as wage income), with the coefficients statistically indistinguishable from zero. In Table 3, we repeat the analysis of Table 2 while controlling for de-meaned baseline measures of total profits, risk aversion and loss aversion, as well as the interaction of the de-meaned variables with each treatment indicator. All of the previous results are robust, and the precision of most of the coefficients increases (particularly for the RevShare contract).[22]

3.3 Business management practices

In Table 4, we explore the impact of the contracts on business management practices, to shed further light on mechanisms. In column 1, we investigate the impact on an index of overall business management practices, which comprises questions on marketing, negotiation, cost, record-keeping, and sales targeting. The questions are based on McKenzie and Woodruff (2015), amended for a micro-distribution business. Column 1 shows that individuals assigned to Hybrid and to IndexShare experienced positive impacts on overall business management practices, with coefficients of 0.10 ($p = 0.073$) and 0.11 ($p = 0.035$).[23] One plausible explanation for why we see impacts on these contracts in particular is that they are the two contracts that require the greatest amount of 'mental engagement' in calculating payments: Hybrid requires participants to pay a proportion of their monthly income and to carry forward the 'state variable' (as modelled in our conceptual framework) of cumulative payments made to date and the re-adjusted notional debt outstanding, and IndexShare provides sharing based on the average sales of all other distributors in one's region. Column 2 provides evidence consistent with this hypothesis; there, we use a specific sub-category of questions that measure record-keeping, and we again find positive and statistical significant effects only on Hybrid and IndexShare, with coefficients of 0.15 ($p = 0.035$) and 0.12 ($p = 0.095$) standard deviations respectively.

In column 3, we analyse one particular business practice that relates to distributors' risk-taking: the extent to which they offer credit to their own customers. Financial contracts that provide a greater extent of risk-sharing may themselves allow business owners to take more risk (Karlan et al., 2014). We find evidence that is consistent with this for the Hybrid contract. Compared to the control group, who extend very little credit to their customers (only 8% of the value of their transactions), the increase for the Hybrid contract is a relatively large five percentage points ($p = 0.048$).

3.4 Downstream outcomes: Consumption

Table 5 presents treatment effects on three major components of household consumption expenditure. Beginning with expenditure on food, column 1 shows a large and significant positive effect for three of the four contracts. The coefficients on Debt, Hybrid, and IndexShare are Ks 866 ($p = 0.080$), 936 ($p = 0.066$), and 739 ($p = 0.077$) respectively, representing very large positive impacts on monthly food expenditure of 19%, 21%, and 16% respectively compared to the control mean of 4,546. Column 2 explores the effects on household clothing expenditure, with the only significant coefficient being on Hybrid, with a coefficient of 397 ($p = 0.029$) implying a very large 49% increase in monthly clothing

[22] This includes an increase in the precision of the Poisson estimates: seeAppendix Table A4.

[23] Each index ranges from zero to one, indicating the proportion of questions that receive a positive response regarding whether a specific business management practice is undertaken.

expenditure. Further, a cross-coefficient test reveals that the coefficient on Hybrid is greater than both Debt (p = 0.079) and RevShare (p = 0.043). Column 3 investigates the effect on the third biggest category of household consumption: schooling. Though no coefficient here is individually significant, the coefficient on Hybrid is large at 315 (p = 0.350) and the coefficient on Debt is a large negative at -333 (p = 0.189), with the cross-coefficient test of difference between the two being significant (p = 0.024).

In Appendix Section A4, we consider health outcomes. This was one key motivation for providing bicycles, given respondent's concerns about carrying large bags on their back, from qualitative work that provided one of the main motivations for providing a transportation asset in this experiment. We test for the impact of treatments on binary indicators for whether the distributors state that their health impedes their work, and for whether work caused physical pain. Relative to the control means of 26% and 19% respectively, the estimated coefficients on most contracts are meaningfully large and negative, though none are statistically significant at conventional levels.

3.5 Robustness: Spillovers and GPS trackers

One worry may be that our very large impacts are driven by treatment respondents on bicycles stealing business from control participants or from distributors outside of the experiment. To test for this, we use administrative data on the universe of micro-distributors who were in FoodCo's program but not in our experiment. We test the consequence on these micro-distributors of random variation in the treatment status of their peers: to do this, we exploit detailed baseline data in which our participants answered a series of dyadic questions about the extent of their relationship (if any) with other micro-distributors at the stockpoint. Appendix Section A2 discusses this analysis and shows results. We find no evidence of spillovers, which is reassuring for the robustness of our main results. This is consistent with the provision of bicycles having expanded the geographical reach of the distributors, as indicated in the results from Table 2 (which showed, using survey data, a large increase in the likelihood of treated micro-distributors selling to customers further than 1km away from their stockpoint). Figure 2 shows several maps that are consistent this hypothesis, using GPS data from trackers that we installed (with clients' agreement) on all bicycles. We can see that our bicycles were spread across all the most populous areas of Kenya and – within a particular region – individuals travel significant distances with the bicycles.

4 Cost-benefit analysis

We now explore cost-benefit ratios and internal rates of return (IRR).[24] Four distinct market participants contribute to the returns factoring into our cost-benefit calculations: the distributors, along with three formal for-profit entities – namely, the multinational that produces the gum (FoodCo), the stockpoints purchasing gum from FoodCo and selling it to the distributors (reaping their own margins from each sale), and the MFI responsible for providing the financing contracts (bearing all associated risks). The previous section analysed outcomes for micro-distributors; in this section, we discuss the returns for the remaining three participants, and then combine these outcomes to calculate overall returns and cost-benefit ratios.

4.1 Total return analysis: distributors, stockpoints, and FoodCo

In Table 6, we display the returns to each of the three participants in FoodCo's supply chain. Column 1 reproduces the treatment effects on distributors from our earlier analysis. Column 2 illustrates the effect of each contract on FoodCo's profits – which we calculate based on the price for which the distributor purchased the gum from the stockpoint, using and a gross profit margin of 50%.[25] In general, although noisily estimated, we see very large magnitudes of coefficients for the multinational's profits. For example, while the ITT coefficient on Hybrid for distributor profits (column 1) is Ks 1,496, for the multinational (column 3) it is Ks 4,929 in greater profits per $month$.

Column 3 presents a similar analysis, examining the impact of each contract on stockpoint profits. We have information on the profit margin that stockpoints earn from each of the six products, based on the price that they purchase the products from the multinational, and the price that they sell to the distributors. Column 3 indicates coefficients that are also quite large in magnitude (and noisy), though not as large as the profits for the distributors themselves. For example, the ITT coefficient on Hybrid for stockpoint profits is 859 ($p = 0.185$).

Finally, we aggregate the returns for the three participants in FoodCo's supply chain. The resulting 'total return' in column 4 illustrates the very large overall monthly returns to the intervention, especially when compared to the average cost of bicycle (Ks 9,658). Specifically, the ITT coefficient for total return on Debt is 2,614 ($p = 0.410$), on Hybrid it is 7,295 ($p = 0.172$), on RevShare it is 3,825 ($p = 0.288$), and on IndexShare it is 1,779 ($p = 0.496$).

[24] We build upon the methodology of Banerjee, Duflo, et al. (2015), Bandiera et al. (2017), Alfonsi et al. (2020), and Bari, Malik, Meki, and Quinn (2021)

[25] We take this figure from the company's last publicly available historic financial accounts. We would expect the multinational's profits to increase if the treatments induce greater purchases from the distributors. However, the exact magnitude of increase is not mechanical, as distributors might alter the composition of their sales basket among the six different types of chewing gum, and the different types of gum have different profit margins.

4.2 Repayments to the MFI

We next analyse returns to the MFI. Figure 3 plots the average repayment amount over time for each of the four financing contracts. It is evident – from as early as the first quarter – that repayment under the Hybrid contract begins to increase above that of other contracts. This is consistent with our previous finding of higher treatment effects of Hybrid on business effort and performance. Note that this is not a mechanical result – contract payments were *not* deducted automatically at source by the multinational.[26] Rather, payments due to the MFI were calculated for each individual based on monthly administrative data shared by the multinational on profits for all distributors, both those inside and outside of the experiment (which was needed for the IndexShare contract).[27] Therefore, this higher repayment under Hybrid reflects deliberate repayment decisions by individuals. This is reassuring, and consistent with our empirical results that they were able to pay more due to their greater earnings.

By month 6, it is clear that payments under RevShare also begin to diverge from average payments under Debt and IndexShare. Once again, this finding is reassuring and aligns with our previous results, which indicated that the second-largest treatment effect in terms of business profits was observed under the RevShare contract. Cumulative payments under RevShare converge with those under Hybrid by month 9. This outcome is as expected, given that the Hybrid contract limits upside sharing to the total due amount of an equivalent Debt contract. In contrast, the RevShare contract allows some individuals to pay significantly larger amounts, surpassing the initial capital plus 15% interest.[28] A clear dichotomy becomes evident in month 10, where cumulative payments under the Hybrid and RevShare contracts converge – while diverging from cumulative payments under Debt and IndexShare contracts.

By month 15, payments under Hybrid and RevShare are nearly equal and notably higher than cumulative payments under Debt and IndexShare, which are also almost identical in absolute terms. Figure 4 illustrates the average total repayment under each of the contracts after 15 months.[29] Repayment under Hybrid is 78% of the total capital disbursed on average, and repayment under RevShare is 81% on average. This is significantly higher than average repayment under Debt (59%) and IndexShare (58%) (p=0.055 for a test that the repayment rate under Hybrid and RevShare is the same as that under Debt and IndexShare).

Apart from the cross-contract comparisons, Figure 4 shows that none of the contracts generated 100% repayment. This is partly due to the Covid-19 shock; although the majority of repayment delinquency occurred before Covid-19, the latter part of our project coincided with the pandemic – during

[26] One may want to implement such a model when scaling up such contracts, but we were not able to implement that change in the payment system in time for this project.

[27] Performance data is clearly not necessary for calculating payments for the debt contract.

[28] For a clearer depiction of capped repayments under the Hybrid model versus the unlimited upside sharing of the RevShare contract, see Appendix Figure A6. This figure presents individual payment trajectories for each contract type, illustrating that under the RevShare contract, some individuals ultimately paid substantially more than the original financing amount.

[29] Recall that the contractual duration of the Debt, RevShare, and IndexShare is 12 months, but the duration of Hybrid may be as much as 24 months.

which the Kenyan Central Bank asked banks to provide relief to borrowers. Our MFI was therefore not able to apply its standard enforcement procedures – which, ordinarily, would have resulted in significantly higher collection of outstanding amounts due. Further, there is evidence that default rates under digital credit are higher than traditional cash-based lending (Carlson, 2017; Suri, Bharadwaj, & Jack, 2021).[30] That said, the magnitude of the MFI's loss is very small compared to the treatment effects for distributors. The average default amount is approximately Ks 3,000; this compares to an ITT estimate on the pooled treatment indicator for *monthly* profits of Ks 813 (and Ks 1,221 for the LATE estimate).

4.3 Benefit-cost ratios and IRR

We combine these results to conduct an overall cost-benefit analysis of the intervention, illustrated in Figure 5. The costs comprise: (i) the capital disbursed for the initial asset purchases for take-up clients, subtracted from the total recovered capital (factoring in the small overall loss to the MFI, as discussed in Section 4.2); (ii) staff salaries; and (iii) other implementation expenses like venue rentals for workshops. The total costs are then compounded up to the two-year mark using a conservative 10% social discount rate.[31] We divide the total costs by the number of take-up clients in each contract and then incorporate the benefits from each contract.

We employ the estimated treatment effects derived from our LATE regressions, as well as an estimate of future benefits extending beyond the project period. For benefits during the project period, we sum up the treatment effects calculated on business profits for all four market participants, as depicted in the total return analysis of Section 4.1. Additionally, we incorporate the estimated net present value of future benefits from the fourth year onwards, using the LATE estimates as the annual value of these future benefits. Further details on the cost-benefit inputs are provided in Appendix Section A5.

Our analysis of benefit-cost ratios and IRRs is conducted under various assumptions concerning the persistence of benefits beyond the three-year mark of the project. Figure 5 demonstrates remarkably high benefit-cost ratios and IRRs across all contracts, and particularly for the Hybrid and RevShare contracts. This is the case even when assuming minimal persistence of treatment effects beyond the three-year mark of the project. For example, we estimate a benefit-cost ratio of 28.6 for the Hybrid contract when assuming only two years of persistence in treatment effects (with corresponding ratios of 18.5 for RevShare, 8.6 for Debt, and 9.5 for IndexShare). This corresponds to internal rates of return of 605% for Hybrid, 391% for RevShare, 181% for Debt, and 190% for IndexShare. Assuming 10 years of benefits (which is a common assumption made in cost-benefit analyses in the literature), we

[30] For example, Brailovskaya, Dupas, and Robinson (2021) report from a digital credit experiment that default is common, with 11% of loans never paid back at all, 4% paid back partially, 47% fully paid back but late, and only 38% paid back fully on time.

[31] This falls within the range recommended by the World Bank (Lopez, 2008).

have a benefit-cost ratio of 55.3 for the Hybrid contract, 35.8 for RevShare, 16.6 for Debt, and 17.4 for IndexShare.

5 Conclusion

We conduct a field experiment involving performance-contingent contracts for financing investments of micro-distributors in the supply chain of a major food multinational. We find especially large gains from a novel hybrid contract that blends debt-like elements (requiring repayment of a fixed sum throughout the contract's duration) with equity-like aspects (performance-contingent monthly repayments). The hybrid contract mitigates liquidity risk while avoiding the adverse incentives effects of total wealth being exposed to unlimited upside sharing. We find that the hybrid contract led micro-distributors to earn higher overall profits, through exerting greater effort in their business. To interpret the results, we build a dynamic stochastic model to illustrate that the the hybrid contract breaks the traditional trade-off between implicit insurance and reduced effort: the contract offers repayment flexibility (and, with it, implicit insurance) while also incentivising additional effort in order to clear the debt. Our total return analysis reveals large income gains to all three actors in the multinational supply chain (the micro-distributors, the multinational, and the stockpoints from which micro-distributors source their product), and highly favourable benefit-cost ratios and internal rates of return for all contracts, and particularly for the hybrid contract.

Our setting is an ideal one to test the effectiveness of performance-contingent contracts for productive asset financing in a low-income country – given, in particular, (i) a homogeneous sample of micro-distributors operating the same type of business; (ii) the availability of detailed administrative data on purchases, and (iii) a clear mechanism for how the productive asset could be used to expand operations for microfinance clients. These two key features are already shared by a large variety of different self-employment contexts, in both low-income and high-income settings. First, the kind of micro-distributor program that we study is common to many route-to-market programs and retail distribution networks, particularly for consumer goods and food and beverage firms. Second, and more generally, these characteristics are shared by many 'gig work' and 'dependent contractor' arrangements – where the host firm typically has a wealth of information about the quality and quantity of worker performance.

Indeed, as consumer markets expand in low- and middle-income countries, and as route-to-market programs grow, large companies are likely to place increasing reliance on 'dependent contractors' – many of whom are risk averse, face precarious economic circumstances, and lack access to the fixed capital necessary to do their work effectively. Our paper provides a proof of concept for a new class of microfinance contract, and our results show that such contracts may be particularly useful for such workers. Across a wide variety of contexts, rapid developments in financial technology – in particular, increasing adoption of mobile money and of electronic point-of-sale technologies – promise cheap access to credible information on the performance of microenterprises, gig workers and sub-contractors, to improve both screening and enforcement (Annan et al., 2024; Higgins, 2019; Suri, 2017). The next generation of microfinance contracts can leverage these developments to expand the portfolio of products it offers clients – specifically, to include contracts with performance-contingent repayment obligations, offering better sharing of risk and reward. One promising development relevant to asset financing is lockout technology, which has been shown to dramatically reduce moral hazard and improve credit risk management and repayment rates for MFIs (Gertler, Green, & Wolfram, 2021). In our setting, the financing was offered by the MFI, rather than the actual multinational. In certain contexts, multinationals may be restricted from lending activities by financial regulations or may choose not to engage in them. Yet, in other settings, it may be preferred for the multinational to finance assets directly. This is supported by theoretical work demonstrating suppliers' comparative advantage as financial intermediaries, stemming from their informational advantages in assessing creditworthiness and their ability to enforce repayments by withholding future supplies (Biais & Gollier, 1997; Burkart & Ellingsen, 2004; Cull et al., 2023; Petersen & Rajan, 1997); analogous arguments have been made in the nascent theory on 'BigTech' lending, as done by Amazon in the US (Li & Pegoraro, 2022).

Thus, for example, ride-sharing and delivery platforms could use contingent-repayment contracts to help their drivers to finance the purchase of their vehicles. Similarly, such contracts could readily apply to a very wide range of other sub-contractors – for example, farmers who 'finish' livestock animals for sale with equipment loans, or cut-and-trim manufacturers for their machinery, and so on (Casaburi & Willis, 2024). One could certainly imagine such contracts being offered by the host firm; however, one could also imagine third-party sharing agreements – more similar to the model adopted here by FoodCo – in which a specialized lender channels funds to a host firm for contingent lending to gig workers or sub-contractors, in return for clients agreeing to have the host firm share performance data with that lender.[32] This opens several novel possibilities for contractual innovations that benefit both low-income microentrepreneurs and large firms.

[32] This is broadly analogous to factoring – in which a company sells its accounts receivable to a financial company, which then collects payment.

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Tables and figures

Table 1: First-stage: take-up, bicycle usage, and effort

	(1) Take-up	(2) Uses for business	(3) Usage: hours	(4) Stockpoint visits	(5) Stockpoint visits	(6) Sales expansion	(7) Sales expansion
Panel A: Pooled regression							
Any contract	0.59***	0.78***	27.83***	1.49*	2.28*	0.16**	0.27**
	(0.043)	(0.030)	(2.141)	(0.882)	(1.345)	(0.071)	(0.121)
Panel B: By contract							
Debt	0.68***	0.73***	22.32***	1.41	1.85	0.10	0.14
	(0.080)	(0.055)	(2.142)	(1.113)	(1.466)	(0.082)	(0.117)
Hybrid	0.73***	0.90***	34.82***	2.88*	3.72*	0.19**	0.26**
	(0.087)	(0.037)	(5.553)	(1.499)	(1.955)	(0.090)	(0.126)
RevShare	0.51***	0.71***	24.90***	1.32	2.21	0.13	0.26
	(0.078)	(0.058)	(2.067)	(0.998)	(1.677)	(0.087)	(0.170)
IndexShare	0.47***	0.79***	31.23***	0.29	0.58	0.22***	0.46***
	(0.088)	(0.068)	(5.981)	(1.137)	(2.167)	(0.076)	(0.179)
Estimation	Take-up	LATE	LATE	ITT	LATE	ITT	LATE
Observations	161	468	468	2888	2888	468	468
Individuals	161	160	160	161	161	160	160
Timeframe	Take-up	1m-12m	1m-12m	1m-36m	1m-36m	1m-12m	1m-12m
Control mean	0.00	0.00	0.00	2.57	2.57	0.58	0.58
Test: Debt = Hybrid	0.646	0.008	0.036	0.351	0.358	0.228	0.316
Test: Debt = RevShare	0.142	0.847	0.386	0.935	0.822	0.665	0.397
Test: Hybrid = RevShare	0.061	0.006	0.094	0.255	0.413	0.457	0.997

Note: In Panel A, "Any contract" pools all financing contracts, while Panel B presents regressions with separate dummies for each contract. We present both intent-to-treat (ITT) and local average treatment effect (LATE) estimations, given the differential take-up seen in column 1. Column 2: usage of the bicycle for business purposes (a binary variable). Column 3: number of hours that they use the bike in a typical week. Columns 4 and 5: how often distributors visit stock-points in a given month to purchase inventory (using administrative data). Columns 6 and 7: proportion of their portfolio that comes from selling to customers that are greater than 1km from their stock-point (using survey data; results for geographic expansion are also consistent with GPS data from trackers, as shown in Figure 2). The bottom three rows of the table display p-values for the three main cross-coefficient tests of theoretical interest: the difference in treatment effects between Hybrid, Debt, and RevShare. Standard errors, clustered at the individual level, are reported in brackets. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. All currency amounts are in Kenyan Shillings. The USD-KES exchange rate at baseline was approximately equal to 102.

Table 2: Main business outcomes

	(1) Profits: Foodco	(2) Profits: Foodco	(3) Profits: Foodco	(4) Profits: Foodco	(5) Profits: Foodco	(6) Other earnings	(7) Other earnings
				Panel A: Pooled regression			
Any contract	813**	1221**	660**	738*	618	446	755
	(380)	(560)	(321)	(390)	(457)	(1029)	(1731)
				Panel B: By contract			
Debt	583	771	718**	341	74	1127	1599
	(432)	(566)	(345)	(393)	(577)	(1362)	(1952)
Hybrid	1496**	1920**	1601***	1764***	1330*	-339	-454
	(609)	(819)	(500)	(620)	(680)	(1192)	(1584)
RevShare	787*	1314*	495	675	718	321	600
	(441)	(691)	(363)	(426)	(558)	(1113)	(2117)
IndexShare	279	532	58	336	-15	499	1036
	(440)	(816)	(396)	(519)	(526)	(1349)	(2815)
Estimation	ITT	LATE	ITT	ITT	ITT	ITT	LATE
Observations	2,888	2,888	785	817	910	468	468
Individuals	161	161	160	145	119	160	160
Timeframe	1m-36m	1m-36m	1m-6m	7m-12m	13m-24m	1m-12m	1m-12m
Control mean	897	897	1389	940	806	6088	6088
Test: Hybrid = Debt	0.121	0.149	0.049	0.012	0.080	0.233	0.232
Test: Hybrid = RevShare	0.633	0.371	0.456	0.368	0.281	0.475	0.584
Test: RevShare = Debt	0.227	0.462	0.019	0.056	0.375	0.484	0.505

Note: In Panel A, "Any contract" pools all financing contracts, while Panel B presents a regression with separate dummies for each contract. ITT refers to Intent-to-Treat regressions, while LATE refers to Local Average Treatment Effect estimations (instrumenting take-up with assignment). Columns 1 to 5 use administrative data on profits from selling FoodCo products. Columns 6 and 7 use survey data that measures profits from all other sources (including profits from selling non-FoodCo products, as well as wage income). The administrative data on profits is winsorized at the 10% level, but for additional robustness given the right-skewed distribution of the profit data and the large number of zeros, Appendix Section A3.4 replicates the analysis of dynamic treatment effects using Poisson regressions, and finds similarly large and significant effects, particularly for the Hybrid contract. Standard errors, clustered at the individual level, are reported in brackets. * p < 0.10, ** p < 0.05, *** p < 0.01. All currency amounts are in Kenyan Shillings. The USD-KES exchange rate at baseline was approximately equal to 102.

Table 3: Controlling for baseline heterogeneity in profits, risk aversion, and loss aversion.

	(1) Stockpoint visits	(2) Sales expansion	(3) Profits: Foodco	(4) Profits: Foodco	(5) Profits: Foodco	(6) Profits: Foodco	(7) Other earnings
Panel A: Pooled regression							
Any contract	2.05**	0.14**	946**	839**	1066***	860**	162
	(0.892)	(0.069)	(363)	(354)	(374)	(431)	(1430)
Panel B: By contract							
Debt	1.65	0.08	643*	861**	596	254	786
	(1.058)	(0.078)	(374)	(363)	(367)	(458)	(1743)
Hybrid	3.11**	0.19**	1429**	1698***	1894***	1250**	-580
	(1.398)	(0.087)	(563)	(508)	(574)	(567)	(1511)
RevShare	2.37**	0.12	1098**	722*	1078**	1288**	241
	(1.053)	(0.080)	(441)	(398)	(430)	(607)	(1548)
IndexShare	0.95	0.19**	455	250	765	331	114
	(1.177)	(0.075)	(453)	(457)	(555)	(518)	(1626)
Estimation	ITT	ITT	ITT	ITT	ITT	ITT	ITT
Observations	2888	468	2888	785	817	910	468
Individuals	161	160	161	160	145	119	160
Timeframe	1m-36m	1m-12m	1m-36m	1m-6m	7m-12m	13m-24m	1m-12m
Control mean	2.57	0.58	897	1389	940	806	6088
Test: Hybrid = Debt	0.309	0.137	0.136	0.051	0.017	0.069	0.284
Test: Hybrid = RevShare	0.499	0.579	0.268	0.652	0.241	0.081	0.678
Test: RevShare = Debt	0.560	0.340	0.552	0.038	0.145	0.954	0.387

Note: We repeat the previous ITT analysis for business effort and performance from Tables 1 and 2, controlling for de-meaned baseline measures of total profits, risk aversion and loss aversion, as well as the interaction of the de-meaned variables with each treatment indicator. Standard errors, clustered at the individual level, are reported in brackets. * p < 0.10, ** p < 0.05, *** p < 0.01. All currency amounts are in Kenyan Shillings.

Table 4: Business management practices

	(1) Management practices	(2) Record keeping	(3) Credit extension
Debt	0.00	-0.02	0.02
	(0.062)	(0.073)	(0.023)
Hybrid	0.10*	0.15**	0.05**
	(0.055)	(0.069)	(0.026)
RevShare	0.03	0.01	0.01
	(0.055)	(0.068)	(0.020)
IndexShare	0.11**	0.12*	0.00
	(0.052)	(0.070)	(0.018)
Estimation	ITT	ITT	ITT
Observations	468	468	468
Individuals	160	160	160
Timeframe	1m-12m	1m-12m	1m-12m
Control mean	0.68	0.65	0.08
Test: Hybrid = Debt	0.091	0.014	0.182
Test: Hybrid = RevShare	0.165	0.035	0.117
Test: RevShare = Debt	0.674	0.651	0.913

Note: We explore the impact of assignment to each contract on business practices, based on a set of questions developed by McKenzie and Woodruff (2015), and amended for a micro-distribution business. Each index ranges from zero to one, indicating the proportion of questions that receive a positive response regarding whether a specific business management practice is undertaken. In column 1, we use an overall index of ten business management practices. In column 2, we use a specific subcategory of four questions that relate to record-keeping. In column 3, we analyse a specific business practice that relates to distributors' risk-taking: the extent to which they offer credit to their own customers. Standard errors, clustered at the individual level, are reported in brackets. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 5: Household consumption expenditure

	(1) Expenditure: Food	(2) Expenditure: Clothing	(3) Expenditure: Schooling
Debt	866*	98	-333
	(491)	(161)	(252)
Hybrid	936*	397**	315
	(506)	(180)	(336)
RevShare	116	34	-23
	(412)	(170)	(278)
Index	739*	-155	34
	(415)	(159)	(255)
Estimation	ITT	ITT	ITT
Observations	468	468	468
Individuals	160	160	160
Timeframe	1m-12m	1m-12m	1m-12m
Control mean	4546	808	886
Test: Hybrid = Debt	0.898	0.079	0.024
Test: Hybrid = RevShare	0.085	0.043	0.267
Test: RevShare = Debt	0.092	0.680	0.151

Note: In columns 1 to 3, we explore treatment effects on downstream household outcomes, focusing on the largest categories of household consumption expenditure. Standard errors, clustered at the individual level, are reported in brackets. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. All currency amounts are in Kenyan Shillings.

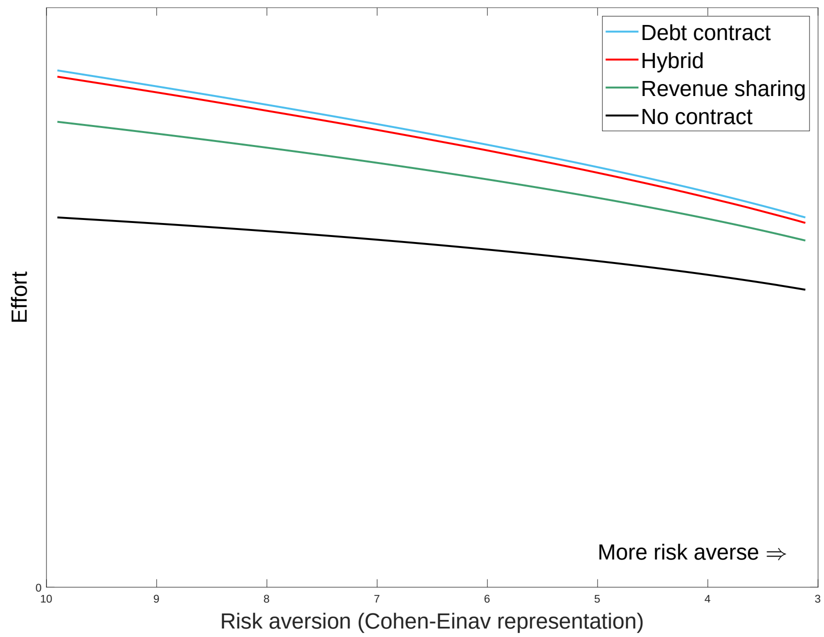
Table 6: Total Return Analysis

	(1) Distributors	(2) FoodCo	(3) Stockpoints	(4) Total Return
	Panel A: ITT			
Debt	583	1649	300	2614
	(432)	(2407)	(372)	(3168)
Hybrid	1496**	4929	859	7295
	(609)	(4091)	(645)	(5317)
RevShare	787*	2475	463	3825
	(441)	(2731)	(445)	(3587)
IndexShare	279	1362	226	1779
	(440)	(1923)	(306)	(2610)
	Panel B: LATE			
Debt	771	2176	395	3440
	(566)	(3179)	(491)	(4181)
Hybrid	1920**	6660	1166	9796
	(819)	(5420)	(855)	(7048)
RevShare	1314*	4294	803	6581
	(691)	(4463)	(722)	(5795)
IndexShare	532	2566	431	3373
	(816)	(3610)	(575)	(4885)
Observations	2,888	2,888	2,888	2,888
Individuals	161	161	161	161
Timeframe	1m-36m	1m-36m	1m-36m	1m-36m
Control mean	897	5283	798	6972

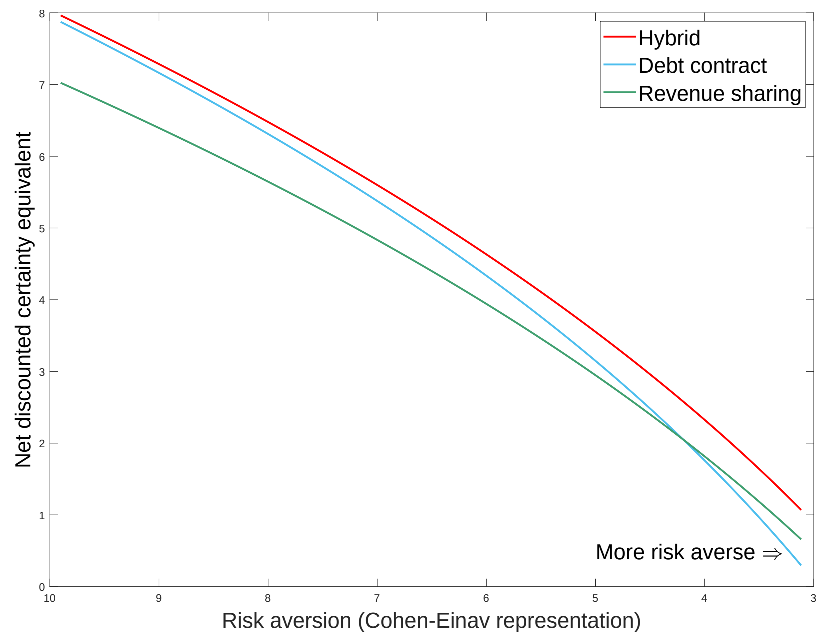
Note: We display the returns from the intervention to each of the three participants in FoodCo's supply chain. ITT refers to Intent-to-Treat regressions, while LATE refers to Local Average Treatment Effect estimations (instrumenting take-up with assignment). Column 1 reproduces the treatments effects on distributors from our earlier analysis in Table 2. Column 2 illustrates the effect of each contract on FoodCo's profits, which we calculate based on the price we know that the distributor purchased the gum from the stockpoint (which purchased it from FoodCo), and a gross profit margin of 50% using the company's last publicly available historic financial accounts. Column 3 examines the impact of each contract on stockpoint profits, based on information on the profit margin that stockpoints earn from each of the six products, the price that they purchase the products from the multinational, and the price that they sell to the distributors. Columns 4 aggregates the returns for all three supply chain actors. Standard errors, clustered at the individual level, are reported in brackets. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. All currency amounts are in Kenyan Shillings.

Figure 1: **Model predictions**

PANEL A: EFFORT AS A FUNCTION OF RISK AVERSION



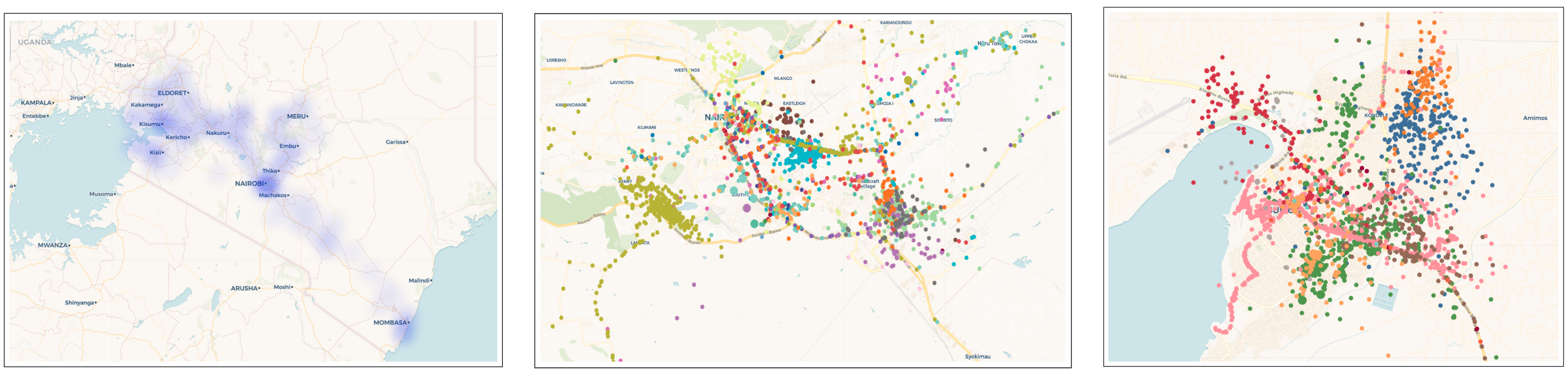
PANEL B: TAKE-UP AS A FUNCTION OF RISK AVERSION



Note: *We illustrate numerically the theoretical predictions as to effort and take-up under no contract, the Debt contract, the RevShare contract and the Hybrid contract. For ease of interpretation, we use the representation of Cohen and Einav (2007); we imagine a 50-50 gamble where the gain is \$10 and the loss is* x*. For each given coefficient of absolute risk aversion, we solve for* x *so that the respondent is indifferent between taking the gamble and not; this is given by* $x \equiv \log\left[2 - \exp(-10r)\right]/r$*. The net discounted certainty equivalent is calculated as* $\left[-\log(1-\beta) - \log(-V)\right]/r$*.*

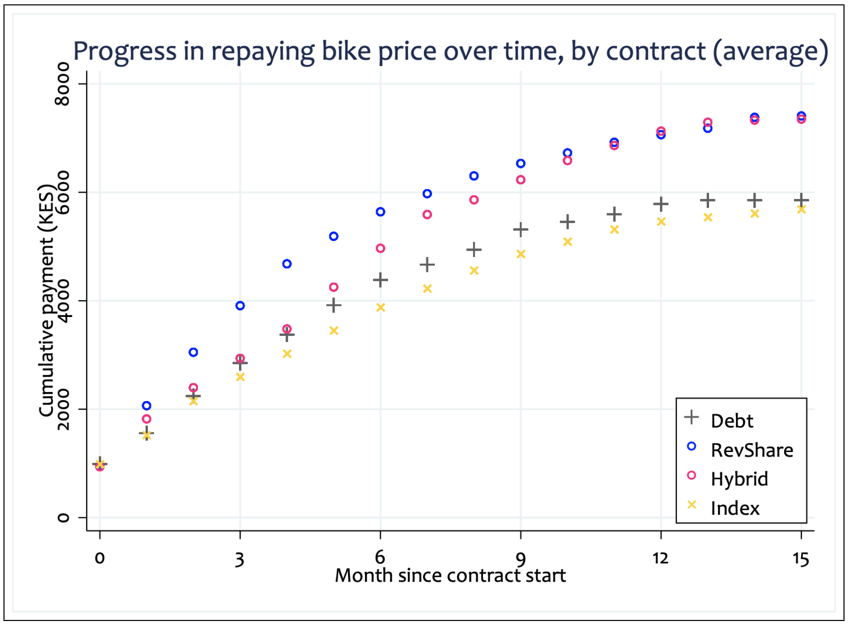
Figure 2: **Bicycle GPS data**

PANEL A: OVERALL | PANEL B: NAIROBI | PANEL C: WESTERN KENYA



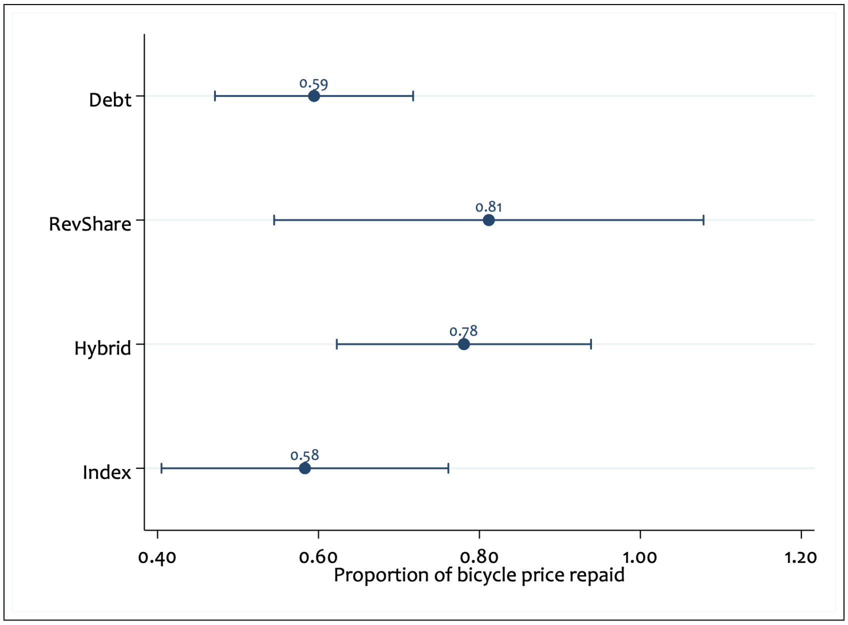
Note: *This figure utilises data from GPS trackers that were attached to each bike, between 2018 and 2020. The data is consistent with bicycles facilitating a geographic expansion in sales, as suggested in the regression analysis in Table 1 using survey data. The heat map in Panel A represents the density of visits in each location. The GPS data has been processed to build 20,683 areas with a resolution of approximately 5x5 meters and counting the frequency of trackers present in that area throughout the period of analysis. The colour intensity is proportional to the frequency of visits ranging from 1 visit (lighter blue) up to 1,954 visits (darker blue, corresponding to 69 visit per month on average). The picture shows the existence of clusters centred around the most populated areas (Nairobi, Western Kenya, Mombasa) and displacements between them. In Panels B and C, each colour represents data points for a distinct individual, highlighting the trip across the regions around Nairobi and Western Kenya (the two most populous regions in Kenya). On average each individual travelled 4.8 km per day (with a standard error of 0.4 km per day, and a median of 4.0 km per day).*

Figure 3: **Contract payments over time**



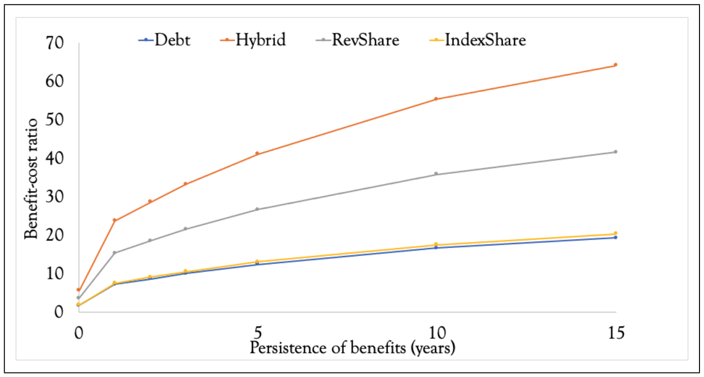
Note: *Each line represents the average repayment amount over time under each of the four contracts. All amounts are in Kenyan Shillings.*

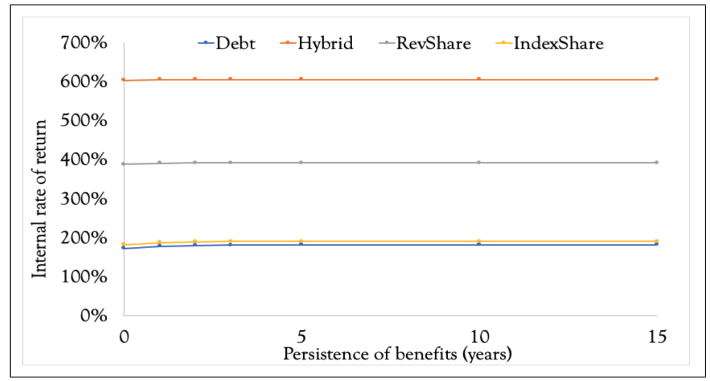
Figure 4: **Total percentage paid**



Note: *This figure illustrates the average repayment amount under each contract, as a percentage of the capital amount disbursed.*

Figure 5: **Cost-benefit analysis**





Note: *We present benefit-cost ratios and internal rates of return for each contract, under different assumptions for the persistence of benefits beyond the three-year mark of the project. For benefits during the project period, we sum up the treatment effects calculated on business profits for the three key actors in the multinational's supply chain: the distributors, FoodCo, and stockpoints, as depicted in the total return analysis in Table 6. We use the estimated treatment effects derived from our LATE regressions, which we extrapolate when assuming future benefits. For costs, we use: (i) the capital disbursed for the initial asset purchases for take-up clients, subtracted from the total recovered capital (factoring in non-payment of contractual obligations); (ii) staff salaries; and (iii) other implementation expenses like venue rentals for workshops. The total costs are then compounded up to the two-year mark using a conservative 10% social discount rate (Lopez, 2008). We divide the total costs by the number of take-up clients in each contract and then incorporate the benefits from each contract.*