Working it out: Randomized restructuring and entrepreneurial effort in a collateralized debt market*

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Abstract

Loan modification is increasingly important as advances in lending technology facilitate greater risk-taking. We examine how liquidity constraints and moral hazard shape borrower responses to modifications, and their implications for contracting, using an RCT on vehicle-collateralized debt, unusually rich administrative data on entrepreneurial effort, and an enriched workhorse model. The RCT randomizes the near-universe of a publicly-traded lender's poorly performing loans to either payment reduction (liquidity relief) or debt reduction (debt overhang relief). The borrowers are small businesses providing minibus taxi services that are essential to the functioning of the South African economy. GPS devices installed to facilitate vehicle repossession also measure borrower effort, in the form of driving activity. Our model accounts for repossession risk and its effects on effort—in contrast to standard models, which define debt overhang assuming full repayment—and predicts that: a) debt reduction will not improve repayment performance or effort for liquidity constrained borrowers; b) payment reduction will generate improvements, for borrowers with sufficient equity in their vehicle; c) payment reduction will often induce payment increases before effort increases. Our results thus far are consistent with these predictions.

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1 Introduction

Loan modification has long been important for lenders, policymakers, and courts — increasingly so as technological advances facilitate riskier lending. Effective and optimal modification depends on the nature and extent of liquidity constraints, moral hazard, and externalities, yet identification challenges and data limitations have constrained attempts to generate pertinent empirical evidence.

Most existing studies concern households, leaving the effects of business loan modifications largely unexplored despite decades of corporate finance research on debt overhang (Myers 1977; Kalemli-Özcan, Laeven and Moreno 2022; Jordà, Kornejew, Schularick and Taylor 2022). Existing studies largely concern policy-driven modifications in response to large aggregate shocks (e.g., Ganong and Noel (2020); Indarte and Kanz (2024); Gyongyosi and Verner (2024)), despite most modifications occurring in the normal course of lending business (Bidder, Crouzet, Jacobson and Siemer 2023). These studies tend to rely on quasi-experimental variation from policies that exclude borrowers deemed to have the strongest incentives for strategic default (Ganong and Noel 2023, p.1060), even though lenders must reckon with such borrowers. The two existing RCTs on loan modifications concern unsecured consumer lending (Dobbie and Song 2020; Aydin 2023), but collateralized lending is contractually distinct (e.g., Bester (1987); Berger and Udell (1990); Gertler, Green and Wolfram (2024)), and economically important in most settings.[1]

We address these gaps by combining a debt modification RCT, rich administrative data on entrepreneurial effort and borrower incentives, and an enriched workhorse model of collateralized debt contracting. The RCT is implemented by a publicly-traded lender on a near-universe of its delinquent loans, and compares the lender's standard modification of extending maturity to longer maturity extensions (payment reduction, in the form of lower monthly installment payments) and partial debt forgiveness (debt reduction, in the form of interest write-downs). The loans finance activity in an economically vital product market— minibus taxi services, the primary form of transit in many low- and middle-income countries—where borrowers pledge their business' primary productive asset as collateral.[2]

GPS data on driving activity, from devices embedded in the financed vehicles per loan covenants, provides unusually granular and accurate measures of entrepreneurial effort.[3] Together with data on repayments to our partner lender and outside lenders, our study paints an unusually complete and dynamic picture of how contract terms shape borrower behavior over a 12-month horizon.

[1] More than $14.7 trillion (out $18 trillion) of household debt (Federal Reserve Bank of New York 2024), and more than $1 trillion (out of $1.3 trillion) of small business debt in the US is secured by a physical asset in 2023 (Federal Deposit Insurance Corporation 2023). In South Africa, $100 billion of household debt and $20 billion of small business debt is estimated to be secured by a physical asset, making secured debt approximately 75% to 80% of total debt outstanding in each category (World Bank 2022).

[2] Prior work estimating effects of vehicle loan modifications uses non-randomized sources of variation, and focuses on consumer credit and bankruptcy provisions therein (Chakrabarti and Pattison 2019), with some incidental coverage in work on COVID-era forbearance (Cherry, Jiang, Matvos, Piskorski and Seru 2021). See also Eaglin and Gupta (2023), which we discuss below.

[3] Using directly observable and high-frequency measures overcomes self-report bias and measurement error associated with self-reported proxies of input utilization or effort in surveys of small businesses (e.g., Bassi, Muoio, Porzio, Sen and Tugume (2022); Walker, Shah, Miguel, Egger, Soliman and Graff (2024)).

Our model enriches Campbell and Cocco (2015) by endogenizing borrower effort and accounting for repossession risk that increases with accumulated arrears balance. The model motivates our experimental design, our focus on entrepreneurial effort as well as repayment behavior, and pre-registered heterogeneous treatment effect estimation by baseline equity in the collateral. It also helps make sense of the full pattern of our results, by highlighting the importance of repossession risk—the borrower's risk of losing its business' primary productive asset– in shaping borrower responses to contract parameters. The key accounting identity at the heart of our model and experimental design is:

$$\mathcal{D} = (1 - p_{\text{default}}) \times \text{NPV}[\text{full repayment}] + p_{\text{default}} \times \text{NPV}[\text{default}]$$

This equation states that the expected present value of debt for the borrower $\mathcal{D}$ depends on the probability of default p_{default}– which, in collateralized borrowing, can result in repossession of the pledged asset– and the expected present values of debt in the two key states of the world. Standard models of debt overhang focus on the net present value of debt in only one of these states: full repayment. But NPV in the other state is substantially different when default costs are high. Hence, accounting for repossession risk yields richer and more empirically realistic predictions when such risk is material– as it is in many contracting settings ex-ante, and in most settings when a modification is being considered.[4]

Our setting is well-suited for studying the implications of debt overhang and liquidity constraints for borrower behavior and lender modification strategies. Borrowers are largely subprime credit risks, with delinquency and default accordingly commonly realized states.[5] As such, repossession risk is substantial, particularly once a borrower enters the delinquency state considered in our experiment. Indeed, our GPS data on driving behavior comes from devices installed by the lender, and required to be operational per loan covenants, to facilitate repossession of the collateral. Observational data indicates that driving activity is indeed strongly negatively correlated with leverage. Minibus taxis do not follow set schedules, and firms thus have great discretion over when, how, and how much they operate. This, together with substantial "slack" in input utilization as in common in many and perhaps most business settings (Taubman and Gottschalk 1971; Walker, Shah, Miguel, Egger, Soliman and Graff 2024), implies a potentially large elasticity of entrepreneurial effort with respect to debt contract incentives.

A particularly nice feature of our setting for identifying mechanisms, relative to studies of mortgage modifications, is that it includes borrowers who are *a priori* most likely to default strategically due to having very negative equity positions.[6] We show that most borrowers financing new vehicle

[4] O'Malley (2021) finds that removing repossession risk increases mortgage default substantially, in relative terms, even when baseline risk is quite low.

[5] For example, of the 13,300 loans originated by the lender in 2016 and 2017, and those that reached maturity before our baseline, 57% became 90+ days delinquent and 47% had their vehicle repossessed at some point between loan origination and our experiment baseline.

[6] Per Ganong and Noel (2023, p.1060): "... by construction, the prior literature does not study borrowers excluded from mortgage modifications —which often have stringent eligibility criteria designed to exclude strategic defaulters — and borrowers who are deeply underwater."

purchases are meaningfully "underwater" (i.e., have strictly negative equity in the financed asset used as collateral) for much of their loan maturity, due to low downpayment requirements (1% at the median in our setting) coupled with discrete depreciation from the "drive off the lot" effect. The depreciation curve is also relatively steep in our setting due to the intense, productive use of the collateralized asset in our setting, as is often the case with business equipment and its financing (Benmelech and Bergman 2008; Luck and Santos 2024).

Our setting is also well-suited for studying entrepreneurial finance and decision making. Our borrowers are privately-owned small businesses, with most financing one minibus or small fleet, and many hiring drivers. Owners do face many difficult decisions with respect to input utilization and contracting, but the production function is relatively simple, and business owners have roughly zero control over pricing and entry on the margin, facilitating identification of mechanisms. Our linked data on financing and output is unusual for closely-held businesses.

Our setting moreover has some instructive parallels to the mortgage markets that have received far more scrutiny than vehicle and/or small business financing from researchers and policymakers interested in modifications. Our borrowers' minibus loan is almost always their primary debt obligation, as is the case for home mortgage borrowers. Default costs are plausibly quite high—here due to lost income generation in addition to the usual costs incurred in a well-functioning credit market; in the mortgage case due to various factors (see Ganong and Noel (2023, p.1057) and references therein). Spillovers from the product market to the macroeconomy are also plausibly quite substantial, as studied extensively in mortgage and housing markets, and documented in various minibus taxis markets across the world when driver strikes slow or imperil economic activity.

Following quasi-experimental work on the mortgage market, and RCTs in unsecured consumer credit markets, we worked with the lender to design an experiment that would identify and compare effects of payment reduction vs. debt reduction. First, everyone in a broad sample of 3,186 delinquent borrowers not yet in repossession status is administered the lender's standard modification of capitalizing arrears and extending maturity to target the originally-contracted monthly payment.[7] Our payment reduction treatment then targets a 20% lower monthly payment by extending maturity, holding amount owed constant. Our debt reduction treatment targets a 20% reduction in the total amount owed, holding monthly payment constant and shortening maturity accordingly.

We worked with the lender to implement this design in November 2023, randomizing borrowers with equal probability across the three arms, and stratifying on constraints imposed by funder covenants and accounting rules.[8] The lender communicated the modifications through its standard

[7]Despite occasional use of this approach to loan modification prior to our baseline, it neither alleviates liquidity constraints nor reduces debt burden. It nevertheless does potentially change repayment incentives by: (i) resetting arrears to zero and thereby giving the borrower a fresh opportunity to improve their credit score by making timely repayments; (ii) delaying repossession. Eaglin and Gupta (2023), using a discontinuity in the lender's COVID-era modification eligibility criteria, find that the standard modification improved repayment performance modestly relative to no modification over a 12-month horizon.

[8]We targeted 20 percent reductions in both treatment arms, but constraints resulted in a mean payment reduction of 8.7 percent (relative to the mean monthly installment at origination of R 16,300 , and a mean of R 16,067 in the control group receiving the standard maturity extension), and a mean reduction of 16.7% in the total amount owed (equivalent to an loan NPV reduction of 11% per a standard debt overhang calculation). As we detail in Section 4.3,

outreach channels, offering them on an opt-out basis because each represents a free and weakly valuable option to a borrower; e.g., someone getting a maturity extension can choose to pay more than the minimum required installment, without a prepayment penalty. As expected, the opt-out rate was less than 1%.

RCT-engineered variation in contract terms helps us test several key predictions of our model.

First, alleviating liquidity constraints in the short-term is a necessary condition for inducing behavior change by distressed borrowers. Conversely, reducing debt owed will not change behavior on its own. The mechanism operates through repossession risk: debt forgiveness only benefits the borrower under full repayment, and a modification that forgives debt while leaving monthly debt service untouched (as in our debt reduction arm) may not meaningfully increase the borrower's likelihood of full repayment. In contrast, our payment reduction arm does increase the likelihood of full repayment by making monthly debt service (more) feasible, thereby dynamically reducing debt overhang through expected and actual success in making monthly payments.

Our results thus far are consistent with this first set of predictions. Debt reduction does not improve repayment performance or induce entrepreneurial effort, while payment reduction does, although estimates of average effects on effort are noisy.[9] This pattern holds despite the fact that, due to lender funding constraints, the payment reduction treatment is smaller on average, in percentage terms, than the debt reduction (8.7% vs. 16.7%). The inference that payment reduction works by alleviating short-term liquidity constraints is corroborated with evidence that it reduces use of outside credit lines. Payment reduction's average treatment effect dynamics on effort are noisily estimated but also consistent with the model's predictions: repayment performance improves more or less immediately, while any effort increase seems to kick in only after several months of liquidity relief.

Second,the traditional debt overhang channel implies that alleviating liquidity constraints may not suffice to induce borrower behavior change, if the borrower is too far underwater on their productive asset. This insight parallels the "double-trigger" framework in household finance (O'Malley 2021; Ganong and Noel 2023), where default arises from a combination of both liquidity constraints and strategic incentives. As such we pre-registered plans to estimate heterogeneous treatment effects (HTEs) by the borrower's baseline equity position.

The vehicle equity HTE results are consistent with our model's version of a double-trigger for loan modifications. We find no evidence that low baseline equity (above-median loan-to-value (LTV)) borrowers increase effort following payment reduction. In contrast, our results show statistically strong evidence of large effort increases by high-equity borrowers, starting around four months post-treatment and persisting thereafter.[10] We also find evidence that payment reduction leads to better repayment performance on their minibus loan for higher baseline equity borrowers,

these magnitudes are comparable to those studied in prior work on effects of loan modifications.

[9] In consultation with the lender, our main and pre-registered repayment outcomes are based on measures of the loan's repayment status. We also consider amounts repaid. Our main and pre-registered effort outcomes are distance driven, days driven, and time spent on the job. We are currently working to measure risky driving behavior as well.

[10] Interestingly, the debt reduction arm seems to produce a decline in effort by low-equity borrowers, relative to the control group, starting around month 6 post-treatment. We are currently working to scrutinize this further.

and less borrowing on outside debt, although the estimates are noisier. In contrast, we find no evidence that debt reduction produces such patterns.

Another finding is consistent with the model's prediction of a positive feedback loop from alleviating liquidity-constraints to lessening moral hazard: payment reduction borrowers actually pay more than their new required amount on average. Consequently, short-term liquidity relief works not only by reducing repossession likelihood, but also by accelerating equity accumulation at a faster rate over time—which dampens strategic default incentives by increasing the value of the collateral that would be lost conditional on repossession.

We are currently working to test a fourth set of predictions that our model shares with standard double-trigger models: less liquidity-constrained borrowers respond less to liquidity relief, and more to debt relief.

Altogether, our results thus far suggest collateralized lenders (and policymakers) should account for repossession risk when formulating modification strategy. The presence of material repossession risk tends to generally favor payment relief over debt relief, and to specifically favor targeting payment relief to borrowers with sufficient equity in their in pledged collateral. We are currently working to make the model as quantitative and disciplined by our data and RCT results as possible, to make headway on estimating what constitutes "material" repossession risk and "sufficient" equity under different assumptions that capture various settings and states of interest.

In sum, our study is novel in several respects. We consider voluntary debt modification by a lender, not the policy-driven modifications that have been the focus of related literatures thus far. We focus on small businesses, including borrowers with the strongest incentives for strategic default, unlike most papers on mortgage modifications. We have and use rich measures of borrower effort, which is typically observed relatively coarsely if at all, especially in work on SME lending thus far. We have a field experiment on collateralized debt. And we add two key features to Campbell and Cocco (2015)'s workhorse model to bring it closer to the data.

As such we contribute to several abovementioned literatures that often work in relative isolation from each other, including work on the effects of loan modifications, determinants of default, collateralized debt contracting, debt overhang, input utilization and slack, and entrepreneurial finance. We are currently working to finish a detailed discussion of how our work connects, and contributes to, these literatures.

Our main caveat, as detailed and explored in Section 5, is that we only have findings over a 12-month horizon (per our pre-registration). Our model helps illustrate that , in principle, longer-run results could differ in various ways, depending on whether and how longer-run treatment effects on full-repayment probability and default cost differ from 12-month effects. In practice, our observational data suggests that 12-month outcomes are good proxies for longer-run outcomes (Athey, Chetty, Imbens and Kang 2024). The contracting parties' high discount rates further motivate our focus on 12-month outcomes.

2 Setting and data overview

This section provides background information about our setting, including the product market (minibus taxi mass transit), our partner lender and the financing market (loans collateralized by the vehicles), and an overview of borrower characteristics (we defer details on our experiment sample until Section 4.2). We then provide an overview of our various key data sources.

2.1 Market overview

As in many developing countries, a private minibus transport market sprung up decades ago to meet excess demand for mass transit and has grown to become the modal mode of mass vehicle transport in South Africa (Statistics South Africa 2020). A typical minibus in this market is a 16-seater manufactured by Toyota (Figure A.1). Approximately forty percent of the nation's population (15 million individuals) reports taking a minibus on a daily basis, with eighty percent riding at least once per year (Kerr 2017). There are an estimated 250,000 minibus taxis spanning all of the populated areas in South Africa (Appendix Figure A.3) , generating about R 100 billion in revenue annually in 2021 and thereby accounting for approximately three percent of the annual GDP (Competition Commission of South Africa 2021).[11]

Minibus taxi service is indeed a hybrid between bus and taxi services. Like a bus, it runs along a defined route. Routes are defined as a path between two points in space. The start and end points on the route are either taxi ranks, which is a formal bus station, or a bus stand where traffic density does not allow feasibility of a taxi rank (e.g., Figure A.2 depicts a route running back-and-forth between Wynberg Taxi Rank and Downtown Cape Town in the city of Cape Town). Like a taxi, route service is unscheduled and there are no formal stops: passengers hail a minibus using hand signals, and the driver picks up and drops off passengers anywhere along the route, at his discretion.

Services on a given route are controlled in part by one of about 1,200 informal taxi associations. The taxi associations are member-based organizations run by and for the operators. These associations control who operates on a given route, limit drivers to a single route, control competition by regulating issuance of permits to operate, and set pricing for the entire length of the route. Operators nevertheless typically face stiff competition for customers. For example, in the City of Cape Town, one of the most populous metropolitan areas in South Africa with approximately 1,000 minibus routes, 200 routes have a operator financed by our partner lender alone. Of those, median route has 4 operators with a standard deviation of 8 operators. Taxi operators compensate associations through a fee structure comprised of an upfront joining fees and an recurring membership fees. The one-time upfront joining fee is due at the time of joining the association and starts from R 10,000 for routes with less customer demand or for which the association has less negotiating power over its operators. The fees can reach up to R 200,000 for routes in busiest areas (Competition

[11] R denotes South African Rand, with 1 US Dollar (USD) worth about 18.7 South African Rand (R) in December 2024, at the end of our experiment.

Commission of South Africa 2020). Recurring membership fees pay for the right to operate the route and support costs that associations incur for operating and maintaining taxi ranks. This fee varies between a daily fee of R 25 and R 2,500 depending on profitability of the route, and is paid either daily or weekly.

The minibus operators resemble the typical small, entrepreneurial businesses found in the literature. First, despite the role of the taxi association, operators do have control over several key aspects of their business: among the other things, the operator decides when and how to drive, select the type of vehicle improvements and maintenance, and determine how how they collect passengers. These discretionary aspects are important from the perspective of a lender concerned with moral hazard in entrepreneurial effort, and we detail how we use GPS data to measure them in Section 2.2. Second, the typical business is largely owner-operated or has one employee when the owner hires a driver as operator.[12] Third, personal loans are the main form of debt outside the collateralized loan used to acquire the vehicle. This feature is consistent with the cross-country evidence about small business lending in Beck, Demirgüç-Kunt and Maksimovic (2008).

The minibuses are the primary assets of these firms, costing about R 500,000 at time of purchase, and are posted as collateral for the debt financing used to purchase them (cash purchases are rare, and our sample is comprised entirely of financed vehicles and their borrowers). They are also the primary source of liabilities for minibus-operating firms; the loan from our lender represents a mean of 82 percent of total loan balance outstanding (measuring the latter using credit bureau data), in October 2023. Financing is widely available for both new and used purchases, with new comprising 67.4 percent of the loans and 68.4 percent of the dollar value originated in our lender's portfolio. The median used minibus financed by our lender is new (with 2.6 years being the standard deviation of the age of vehicle) at time of purchase.

Given the organization of minibus-operating firms, loans are made to owners as individuals, as is often the case for SMEs worldwide. Most borrowers are in the bottom 50 percent of the credit score distribution, with mean score of 622 at origination in our lender's portfolio and standard deviation of 25 (credit scores in South Africa ranges from 300 to 850). As in the subprime auto lending market in the U.S., lenders screen and underwrite applications with risk-based pricing models that consider credit history, vehicle condition, driving records, detailed business plans for the use of the taxi, the proposed route, and the affiliated taxi association.[13] Our lender rejects approximately 65% percent of loan applications.

Figure 2 shows the distribution of loan terms in the Lender's portfolio at baseline. Panel (a) shows that most loan amounts fall in the R 350,000 to R 650,000 range, with a median loan size of approximately R 485,000 (average loan size of R 487,000). Panel (b) shows that about two-thirds of loans have a contracted maturity of 72 months, with 60, 66 and 84 months making up most of the remaining sample. There are no prepayment penalties, yet prepayment is uncommon; e.g., only

[12]This is similar to the US, where the typical small business is entirely owner operated (https://www.fedsmallbusiness.org/reports/survey/2023/2023-report-on-nonemployer-firms)

[13]Work on risk-based vehicle finance pricing in the U.S. subprime market has focused on the consumer side; see e.g., Einav, Jenkins and Levin (2012) and Jansen, Pierce, Snyder and Nguyen (2024).

3.5 percent of about 13,300 loans originated in 2016 and 2017 reaching maturity before our baseline were prepaid in full. Borrowers are typically required to pay five to ten percent of the amount upfront. Panel (a) of Figure 3 shows the distribution of loan-to-value (LTV) at origination: the median is 0.98, with a standard deviation of 0.05.[14] The debt service on these loans is substantial relative to income, as illustrated in Panel (b) of Figure 3, which shows the distribution of debt-to-income (DTIs), measured per standard practice as the ratio of the required monthly payment (including mandatory insurance, as described below) to monthly income at baseline (median = 0.23 and s.d. of 0.13).[15]

Both interest and default rates are high, as one would expect given the high DTIs and low credit scores documented above, together with the substantial exposure to negative shocks detailed in Section 5. Panel (c) of Figure 2 shows that the contract interest rate varies between 13 percent and 28.5 percent, with the average rate being 21.6 percent. The share of loans 90+ days delinquent stood at 18 percent at the start of 2021, gradually increasing to about 22 percent by mid-2023.

These default rates are high despite mandatory property and liability insurance on the collateral[16], vigorous collection efforts by the lender, and several incentives to repay for borrowers. The latter include credit reporting (Section 2.2), eligibility for future loans from the lender, avoiding court proceedings and judgements, and avoiding repossession of the minibus. Repossession of the minibus leads to lost of primary income-generating asset for the borrower in an economy with limited outside employment option. Thus, many, perhaps most, borrowers face high default costs.

Our cooperating Lender is one of the five largest minibus financiers in the country, with about 32,000 loans and R 11.6 billion in principal outstanding in its portfolio as of October 2023. The lender has been in operation for over 18 years, is publicly-traded, and has a market share of about 15 percent. Along with providing credit for purchases of new and used minibuses, the lender also provides auxiliary services, including comprehensive coverage insurance, credit life insurance, maintenance, and spare parts. Loan proceeds are disbursed only after verified installation of a global positioning satellite (GPS) telemetric device in the vehicle in the minibus.[17] Thus far, the lender has primarily used GPS to locate vehicles in the event that a repossession vehicle is warranted. We use this data to measure borrower's enterpreneurial effort (as detailed in the next sub-section).

[14]The high LTV at origination does not imply that borrowers did not make any down-payment on average. Some borrowers rolled over their past outstanding debt with the Lender into the new loan in which case their loan amount exceeded the cost of the new financed vehicle. The average down-payment on the loan typically ranges between 5 to 10 percent.

[15]We estimate the monthly income for operators by multiplying our estimate of monthly trips made by the operator by an average income of R 200 per trip. To arrive at the average income of R 200 per trip, we first use the average passenger trip fare of R 30, and multiply it by an average vehicle capacity utilization of 12 (in a 16-seater minibus which fits 14 passengers) which gives us revenue per trip of R 360. From this we subtract the marginal cost of 45% per trip which includes fuel costs, toll costs and other associated costs.

[16]The lender requires that the vehicle be insured for comprehensive coverage with its affiliated insurer, and adds the monthly premium (median = R 2,400, s.d. = R 921) to the required monthly loan installment. The lender also requires that the loan be insured against borrowers' death or permanent disability before the loan is fully paid off. For this, the lender require a credit life insurance and adds a monthly premium (median = R 870, s.d. = R 188) to the required monthly loan installment.

[17]The lender requires a monthly fees (median = R 294, s.d.= R10) that covers the costs of maintaining the GPS device, and adds that to the monthly loan payment.

2.2 Data overview

This section describes how we measure loan performance, other borrowing behavior, and entrepreneurial effort.

For both the entrepreneurial effort and loan measures, we take similar approaches to summarizing multiple measures and considering various horizons for outcome measurement. For summary purposes, we take the increasingly standard approach of using pre-registered, standardized indices of multiple correlated component measures that provide informative signals about the underlying construct of interest. This approach also reduces the number of statistical hypotheses tested. For horizons, we pre-registered monthly and 12-month versions of each outcome. 12-month versions of stock variables, like loan performance or balances, are defined as the 12th-month snapshot.

Minibus loan performance. The Lender shared loan performance data on its entire portfolio, in monthly snapshots pulled from January 2021. As such we have data for loans originated as far back as January 2016.

In principle, a summary measure of loan performance should capture risk-adjusted profits. In practice, most lenders lack such a summary statistic at the loan level because they do not track all variable costs, or allocate fixed costs, accordingly. As such, after consulting with the Lender, we pre-registered a standardized summary index based on three equally-weighted component measures: (1) a delinquency indicator, defined as having R 100 or more past due after the payment due date); (2) arrears amount; and (3) arrears amount scaled by the required monthly payment. Panel (a) of Appendix Table A.1 describes these variables and the correlations among them.

Credit Bureau Outcomes. We use data from Experian, one of the major credit bureaus in South Africa,[18] to help measure outside borrowing, total leverage, and overall credit access (including updated credit scores) for the estimating various treatment effects of loan modifications and other shocks. For example, Section 5.2 presents estimates of randomized loan modifications on repayment to other lenders. And Section 5.3 presents estimates of heterogeneous treatment effects by borrowers' credit utilization. Panel (b) to (d) of Appendix Table A.1 provide details on the measures we construct from credit bureau data.

Measuring entrepreneurial effort. As noted above, the Lender requires that each financed vehicle have an operating GPS device, for the purposes of tracking the location of the collateral. The GPS device captures the vehicle's location every six seconds and uploads the data to a vendor's server, allowing us to extract several signals about driving behavior and the resulting income generation.

[18] Given the prominence of owner-driver and single-employee firms, most of which are informal firms not registered with the national or local tax authority, the credit for minibus is lent out as consumer credit. As such the lender reports it to a consumer bureau instead of a business bureau. Consumer credit bureau reporting practices and market structure in South Africa are similar to the U.S.

We label the resulting measures "entrepreneurial effort" One key advantage of our setting is that the only relevant margin of adjustment for the entrepreneur is the level of asset utilization. Indeed, the only significant capital investment in our setting is the acquisition of the vehicle, which is a necessary condition for all borrowers in our sample. Once they own a vehicle, the strategic decisions of the entrepreneurs all aim to optimize the amount of asset utilization, which can be proxy using driving behavior. This focus on asset utilization as a key business decision is not unique to our context; it is a common pattern, especially in developing countries (Walker, Shah, Miguel, Egger, Soliman and Graff 2024).

In our context, entrepreneurial effort, as captured by driving data, goes beyond the owner's labor allocation. Maintenance and vehicle upgrades also play a crucial role in ensuring the minibus operates at its full potential. One way to validate this claim is to examine the distribution of the proportion of days in which the vehicle operates, as a proxy for how well the vehicle is functioning.

Figure 4 shows the mean and stanard deviation of days in operation over the life of vehicles in our lender's portfolio. The percentage of days in operation declines significantly over time, reflecting the role of wear and tear in driving heterogeneity.[19] However, the data also shows a high degree of heterogeneity in days in operation, particularly after the first year of operation. This evidence suggests that minibus owners can exert varying levels of entrepreneurial effort (e.g., investments in maintenance, safe driving, etc.) to minimize the impact of wear and tear, thereby maximizing asset utilization.

Specifically, we construct a standardized summary index of entrepreneurial effort by averaging the following equally-weighted component measures, each aggregated to the monthly level after excluding data points based on pre-registered rules for identifying likely data recording errors and non-work trips:[20] (1) distance driven in kms.; (2) number of hours driven; (3) number of days worked in the month (i.e., number of days with non-zero trips were made);[21] and (4) the number of hours spent on the job (the total duration between start of vehicle's first trip and the end of vehicle's last trip during the day). Panel (e) of Appendix Table A.1 describes these variables and the correlations among them.

We are also interested in risky driving, as a potential margin of induced moral hazard and source of negative externalities. We again construct a standardized summary index by averaging the following equally-weighted component measures, each aggregated to the monthly level after excluding data points based on pre-registered rules for identifying likely data recording errors and

[19]The fact that the gap only appears over time suggests that the difference in days in operation does not simply reflect heterogeneity in preference for driving across operators.

[20]The details are provided in the pre-analysis plan available at: https://www.socialscienceregistry.org/trials/13052

[21]We use the detailed GPS data to identify the most frequented taxi ranks for an operator over a one-year period. We consider a travel between the most frequented taxi rank for that operator as a work trip for that operator. Given the routes for the minibuses are pre-allocated, this algorithm allows us to to determine the total number of work trips made by the operator.

non-work trips:[22] (1) number of accidents (based on insurance claims filed with the Lender);[23] and (2) number of instances speeding over 120 km per hour.

3 Conceptual Framework

This section outlines a conceptual framework for understanding the relationship between debt overhang, borrower repayment behavior, and entrepreneurial effort.

3.1 Debt Overhang and Business Activity

In a standard debt-overhang setting, excessive leverage distorts borrower incentives, leading to inefficient underinvestment (Myers 1977). When a borrower carries a substantial debt burden, the marginal return on additional effort or investment declines, as a significant portion of any gains accrues to creditors rather than the borrower. In extreme cases, borrowers nearing default may have little or no incentive to preserve the business's franchise value, anticipating that the lender will repossess the business's assets.

Extensive research has shown that debt overhang in the private sector can significantly constrain business investment (Kalemli-Özcan, Laeven and Moreno 2022; Jordà, Kornejew, Schularick and Taylor 2022). The same concern is likely relevant in our setting. As discussed in Section 2, the fundamental characteristics of this market imply that businesses typically operate with relatively low equity, particularly in the early stages of a loan. Consistent with the debt overhang model, we find that heterogeneity in minibus equity helps explain differences in entrepreneurial effort. Specifically, Figure 6, which examines the full portfolio of drivers active in October 2023, shows a negative correlation between minibus equity and total distance driven by the business. While this evidence is purely correlational, it provides an initial indication that debt overhang may be a significant factor in this market.

A second aspect of our setting further amplifies these concerns. Our experiment focuses on borrowers who were already in financial distress before the intervention. For these borrowers, strategic incentives become especially relevant due to the collateralized nature of their debt. Once delinquency persists, the lender initiates repossession proceedings and applies additional legal fees, further increasing the borrower's financial burden. At that point, incentives to invest in the business decline even further. Figure 7 illustrates this dynamic, showing a sharp drop in entrepreneurial effort among delinquent borrowers compared to those who remain current while operating under similar conditions. Although this evidence is correlational, it highlights why both policymakers and our lender may be particularly concerned about the reinforcing cycle between financial and economic distress in this setting.

[22] We exclude trips which meet either one of these criteria: (i) distance covered is greater than 1000 km.; (ii) duration of the trips is more than eight hours; (iii) implied average speed (distance covered divided by time taken) for the trip was greater than 200 km per hour. We exclude these trips as these as likely due to either a GPS device measurement error, or non-work trips (details available in the pre-analysis plan).

[23] As noted above, a loan requirement is that the financed vehicle by insured by the Lender.

Altogether, debt overhang is likely to contribute to the variation in business activity among our borrowers. With all caveats discussed above, empirical evidence provided aligns with the predictions of a debt overhang model and thus supports the motivation for our conceptual framework.

3.2 Debt Overhang and Loan Modification

To mitigate the economic cost of debt overhang, a policy maker needs to identify how to reduce a borrower debt burden D. As we discuss more in detail in Section 4, this paper considers two possible interventions: (a) an interest write-down that would directly lower the total debt burden of the company, while keeping the monthly payment constant; (b) a payment reduction, which instead lowers the monthly payment while keeping the present value of the debt obligation constant.

For presentation purpose, we can simplify our problem and describe the present value of the debt obligation for the borrower as the weighted average of the debt value under full repayment and default, where the weight between these two scenarios is the probability of default. In other words:

$$D^{\mathcal{T}} = (1 - p^{\mathcal{T}}_{\text{default}}) \times \text{NPV}^{\mathcal{T}}\{\text{full repayment}\} + p^{\mathcal{T}}_{\text{default}} \times \text{NPV}^{\mathcal{T}}\{\text{default}\}. \tag{1}$$

where $p^{\mathcal{T}}_{\text{default}}$ represents the probability of default under restructuring scheme $\mathcal{T}$, while the two terms inside the equation capture the expected present value of debt under full repayment and default, respectively. As it will be clear below, this representation highlights the important role of $p^{\mathcal{T}}_{\text{default}}$ in determining the present value of the debt burden.

To start, we consider a standard debt overhang setting, where borrowers are fully strategic but do not face financial constraints. In this case, it is clear how the interest writedown would be the best policy to improve debt overhang. In fact, this intervention would have two beneficial effects. First, it would directly reduce the debt burden in case of repayment $\text{NPV}^{\mathcal{T}}\{\text{full repayment}\}$. Second, since borrowers in this example are fully strategic, this intervention would also reduce the likelihood of default $p^{\mathcal{T}}_{\text{default}}$.[24] Altogether, the present value of the debt D would unambiguously decline, relaxing debt overhang concerns.

A key challenge in real-world settings is the uncertainty surrounding the primary friction affecting borrowers. Borrowers may default either for strategic reasons or due to liquidity constraints, and the success of restructuring depends on the true underlying cause of default. For instance, a borrower facing liquidity constraints may benefit from a payment reduction, whereas such an intervention would not have any impact on a strategic defaulter. Conversely, reducing the debt burden may help reducing strategic default incentives, but it would be ineffective to reduce $p^{\mathcal{T}}_{\text{default}}$ for borrowers that have defaulted because of liquidity.

This discussion is important because understanding the impact of an intervention $\mathcal{T}$ on the probability of default $p^{\mathcal{T}}_{\text{default}}$ is a crucial step to solve the debt overhang. In particular, we argue

[24] This second implication follows from the assumption: if financial constraints do not matter, but borrowers are strategic, default only happens from strategic reasons. Therefore, lowering the debt burden should also lower $p^{\mathcal{T}}_{\text{default}}$.

that – if the fixed costs of defaults are sufficiently large – a loan modification $\mathcal{T}$ will significantly reduce the present value of the debt $D^{\mathcal{T}}$ only if it also lowers the $p^{\mathcal{T}}_{\text{default}}$. The intuition behind this claim follows directly from equation 1: if $p^{\mathcal{T}}_{\text{default}}$ is high, the value of the debt is mostly driven by $\text{NPV}^{\mathcal{T}}\{\text{default}\}$. If the fixed costs of default are sufficiently large, this quantity remains largely unaffected by the intervention, implying that $D^{\mathcal{T}}$ does not change.

This argument underscores the importance of conducting a randomized experiment to assess the effects of different loan modifications. Given the uncertainty surrounding the reasons for default in our sample, it is unclear which policy will be most effective in helping borrowers stay current on their loans. This step is crucial because if borrowers remain delinquent, a loan modification may not significantly alter their perceived debt burden. This could explain why debt reduction—often considered a standard solution to debt overhang—may have only a limited impact in practice.

However, it is important to note that improving borrower repayment alone does not necessarily resolve debt overhang. As equation 1 illustrates, when the probability of default is low, the debt's value is primarily driven by $\text{NPV}^{\mathcal{T}}\{\text{full repayment}\}$. If a borrower's initial debt burden is excessively high, there is no assurance that an intervention will lower it enough to effectively mitigate debt overhang. To clarify this point, consider how a payment reduction affects the debt burden, assuming it fully eliminates the risk of default. This intervention lowers the borrower's debt burden in two ways: by reducing the expected cost of default and by allowing borrowers to gradually build equity through loan amortization. However, despite being beneficial in reducing D, there is no assurance that these effects alone will be enough to significantly reduce the total debt burden.

Taken together, this discussion highlights two important considerations when evaluating how a loan transformation affects debt overhang. In a context where fixed default costs are expected to be large (as in our case), improving borrowers' repayment conditions appears to be a necessary condition for lowering the debt burden and, consequently, mitigating the impact of debt overhang. However, this condition is not sufficient: if the initial debt burden is too high relative to the effect of the modification, borrowers may still be over-levered ex post, leaving business activity largely unaffected. This idea parallels the "double-trigger" concept in the household finance literature (Ganong and Noel 2023), where borrower default results from a combination of strategic and liquidity concerns. In the next section, we present the exact experimental framework.

4 Experimental design and implementation

4.1 Experimental Design

We worked with our partner lender to design an experiment that helps identify the importance of borrower liquidity constraints and moral hazard for debt modification contracting, subject to the lender's operational constraints and its priors about what was worth testing. To help identify the importance of liquidity constraints, we engineer relatively generous reductions in the required monthly installment payment, leaving debt burden and other terms unchanged from baseline ex-

cept for lengthening maturity accordingly.[25] To help identify the importance of moral hazard, we engineer relatively generous reductions in debt burden, leaving monthly payment and other terms unchanged except for shortening maturity accordingly.

We test our treatments relative to the lender's standard practice for modifying poorly performing loans. This "baseline modification" takes a loan that is defined as loan that had accumulated arrears of at least 1x and at most 9x of its contracted monthly payment, capitalizes its arrears into principal, and extends the maturity to keep the monthly payment and other contract terms unchanged.[26] Table 1 illustrates the mechanics. As we detail below, the resulting maturity extension is about 12 months at the median (s.d. = 8.5 months), on a baseline median of 49 remaining months. Between September 2021 and our baseline, the lender did offer baseline modification to a subsample of borrowers who were behind on their monthly payments. This modification was done in batches and our experiment sample excluded any borrowers who had received baseline modification.[27] Anecdotally, other minibus taxi lenders typically take a similar approach to modifications and other forms of debt restructuring were less common.

Despite occasional use of this approach to loan modification at baseline, it does not seem particularly attractive from either a theoretical or empirical perspective. Theoretically, it neither alleviates liquidity constraints nor reduces debt burden.[28] Empirically, the lender was motivated to experiment by prior observational data showing that repayment performance tends to improve only modestly following a baseline modification, a finding consistent with Eaglin and Gupta (2023) (also see Section 5 for some related results on the control group during our experiment).

We sought to engineer loan-level treatments that would reduce either the total debt burden or the monthly payment by 20% relative to control loans getting the baseline modification, subject to two constraints arising from the lender's external funding covenants and the cost of capital. First, the maturity of any loan on the lender's book could not exceed 10 years. Second, the interest rate on the new loan that resulted from any desired debt reduction on any loan contract had to be at least 14%.[29] The mechanics are as follows: In November 2023, we worked with the lender to first to create an experimental sample that would include nearly all of its poorly performing loans , as detailed in Section 4.2. We next performed the baseline modification on each loan in the sample before randomly assigning each loan, with equal probability, to one of the three arms: baseline modification only (control group); baseline modification + interest-write down (debt burden reduction); baseline

[25] We define debt burden as the sum of outstanding loan principal, any accumulated arrears, and total interest owed over the remaining loan maturity assuming the loan is not prepaid before the contract maturity.

[26] As with loans in good repayment status, there is no penalty for prepaying a modified loan.

[27] The affected borrowers from these programs were quite limited as the lender only targeted borrowers who were between 30 and 90 days delinquent at the time of the offer rollout.

[28] Modifications do potentially change repayment incentives through reporting to credit bureaus, although any effect is likely modest for most borrowers. The modification itself, reported as such as the lender does, has an ambiguous direct effect on a credit score. But it does reset arrears to zero, giving the borrower a fresh opportunity to improve their score by making timely repayments without first needing to pay back its arrears and delaying repossession at least in the short-run. This potentially improves repayment incentives by reducing the marginal cost of making timely repayments.

[29] The floor on the interest rate was imposed attributing to the lender's the cost of capital that stood around 13%.

modification + maturity extension (monthly payment reduction).[30] The randomization conditions on eight strata pertinent for the constrained randomization and heterogeneous treatment effect estimation.[31]

The constrained randomization produced an actual treatment reduction lower than the intended one of 20% in 93 percent of cases in the debt reduction arm and 72 percent cases in the payment reduction arm. Figure 8 shows the distribution of actual reductions in each treatment arm at the time of random assignment. Our primary treatment effect estimates are intent-to-treat and condition on the strata capturing this endogenous variation in treatment intensity, as we detail in Section 4.3.

After modifying the contract, the lender contacted each borrower in our experiment sample through SMS and phone calls, per its standard practices. Each message linked to borrower-specific information on the modified terms. Appendix Figure A.4 shows a letter received by a borrower in the payment reduction treatment. Borrowers had five business days to opt-out of the modification by repaying their outstanding arrears with the lender, and did so at a rate of 0.9 percent in the control arm, 1.3 percent in the payment reduction arm, and 1.2 percent in the debt burden reduction arm. The lender subsequently called each borrower in the sample who did not opt-out to further highlight the modified contract terms.

4.2 Experimental Sample Characteristics and Balance Tests

We worked with the lender to create an experiment sample frame of all 3,848 borrowers eligible for baseline loan modification by virtue of being at 30 to 270 days delinquent (defined in our setting as borrowers that accumulated arrears amounting with 1x to 9x of their monthly payment) and meeting several other criteria.[32] For each of these loans we then estimated the what the actual modification would be under each arm, per the constrained randomization, and limited the experiment sample to the 3,186 loans that would be eligible to receive all three modification regardless of their random assignment.

Table 3 presents summary statistics and balance tests for our key variables at baseline. Column 1 reports the means in the baseline group. The average borrower in the group has a baseline credit score of 592. 76 percent of borrowers in the baseline group are men and have about 1.48 loans with the lender. 69 percent of the borrowers took out loan with the lender to finance a new vehicle. The average loan principal amount outstanding at baseline for this group is R 388,570 and the average arrears at baseline is R 54,020. The maturity of loan at origination for the baseline group

[30] Performing the baseline modification first, on all loans in the experiment sample, creates a control group that is identical to the treatment group in all respect except for the contract variation of interest.

[31] Specifically, we stratify on all combinations of indicators for: whether the loan would receive an above-median interest write-down amount if assigned to that arm x whether the loan would receive an above-median reduction in monthly payment if assigned to that arm x above-median baseline debt-to-income ratio.

[32] Standard eligibility requirements excluded borrowers that (i) had arrears amounting exceeding 9x the required monthly payment; (ii) had received an maturity extension offer in the past; (iii) had outstanding maturity of 118 months or more; (iv) were currently undergoing repossession proceedings; (v) were severely delinquent; or (vi) had a vehicle with GPS device that stopped reporting telematics data.

is 73.9 months and the loan to value at origination (LTV) is 99%. The average interest rate for the baseline group is 24 percent, the annual monthly payment is R 16,248 and average remaining maturity on the loan is 47.5 months.

Columns 2 and 3 of the table report the results from an OLS regression of assignment to interest write-down and payment reduction treatments, respectively, on the baseline characteristics, conditional on randomization strata fixed effects. The prevalence of significant correlation between whether the borrowed vehicle was new and assignment to the interest write-down (1 out of 45 cases) is what one would expect to occur by chance. The means of all of the baseline variables are similar across the baseline and the two treatment groups: the p-value from an F-test of the joint significance of all of the variables listed in Panels A-C is 0.535 for the interest write-downs (column 3) and 0.756 for the payment reductions (column 4), suggesting that the randomization was successful.

4.3 Empirical strategy and first-stage

Our main treatment effect estimation specification estimates intent-to-treat (ITT) effects of interest write-downs and monthly payment reductions as follows:

$$y_{it} = \alpha + \beta^{IW}\ 1(\text{Interest write-down})_i + \beta^{PR}\ 1(\text{Payment Reduction})_i + \Gamma_t'\ \alpha_{s(i)} + \epsilon_{it} \qquad (2)$$

where y_{it} is the outcome or first-stage measure of interest for borrower i in time t, ϵ_{it} is the error term, and $\alpha_{s(i)}$ represents the fixed effects for eight randomized strata. The omitted category is control group, which is assigned to get the baseline modification only. We cluster standard errors at the borrower level when using multiple observations per borrower.

We begin our estimation by quantifying the first-stage effects on contract terms suggested by Figure 8. Table 4 does this by estimating equation 2 at baseline i.e. at randomization time. These estimates capture the net effects of the randomization constraints (described in Section 4.1), the few opt-outs (less than 1%) on the initial loan modification terms, and any initial non-compliance by the lender (we have not detected any). Column 1 shows that the interest rate is 6.6 percent point lower in the interest write-down group compared to the baseline modification control group. It is unchanged in the payment reduction group, as intended. Column 2 shows that the monthly installment is lower by R 1,416 in the payment reduction group. It is unchanged in the interest write-down group, as intended. Column 3 shows how maturity adjusts to engineer the results in the previous columns– specifically, the debt burden reduction holding monthly payment constant in row 1, and the monthly repayment reduction holding debt burden constant in row 2. Maturity decreases by 11.21 months in the debt burden reduction arm (row 1), and increases by 19.25 in the payment reduction group (row 2).

The lender committed to leave the randomly assigned modifications in place for at least 12 months, and month-by-month first-stage estimates thus far confirm that effects on the key contract terms are largely unchanged since the initial random assignment (Figure 9, and n.b. the Table 4

estimates are presented here at time zero).

Before concluding, it is important to highlight that our loan modifications are economically significant (Figure 9). On average, borrowers receiving a payment reduction see their monthly payments shrink by about 8.7%. Over a year, this corresponds to almost R20,000 in lower payments, equivalent to 6% of the average annual salary in the country in 2022.[33] By construction, this intervention is NPV-neutral for the company, which is assumed to have a cost of capital of 23.9%.

The interest rate reduction is instead designed to keep the immediate payment constant, but reduce the NPV of the debt. From the firm's perspective, we estimate that the intervention reduces the NPV of the loan by around R50 thousand, which corresponds to an 11% reduction relative to the pre-existing amount of principal outstanding plus arrears. This reduction is large in absolute terms, but also sizable compared to the literature. For instance, Dobbie and Song (2020) studies a similar reduction in interest for card borrowers, finding strong evidence of strategic response. In this case, the authors report that the maximum cost for the lender in NPV was around 11.8% of the initial loan size. Similarly, Ganong and Noel (2020) similarly studies an intervention that generates a reduction in loan balances (without any present value adjustment) of about 20%.[34]

5 Results

In this section, we examine the effects of debt restructuring using the intent-to-treat design described above.

5.1 Minibus Loan Performance

We begin by analyzing the effects of debt restructuring on minibus loan repayment. Table 5 presents the estimates of receiving an interest write-down and payment reduction on measures of repayment for the minibus loans over the following twelve months. Following the pre-analysis plan, we first normalize all three outcomes of loan performance — whether the borrower was current on their loan, the outstanding amount in arrears, and scaled arrears — by subtracting the average and dividing by the standard deviation of that variable for each month. For each month, we then create a repayment index, which is an equally weighted average of the three normalized measures. The final outcomes of interest in Table 5 are averaged over the period.

These estimates show that receiving an interest write-down offer has no effect on debt repayment. In fact, the results reported in column 1 highlight that the impact of an interest reduction is very small in magnitude, and this effect is statistically indistinguishable from the behavior of the control group. In columns 2, 3, and 4, we report the results for all the sub-components of the

[33] https://www.wearedevelopers.com/en/magazine/311/south-africa-average-salary

[34] Another example is Aydin (2023): in this paper, the author studies an interest rate reduction, where the interest goes down by about 29% relative to the ex-ante APR. In our case, the interest charge declines on average by 28.7% relative to the control group interest rate. As we discussed earlier, a key difference in these studies is that they focus on household borrowing, rather than small businesses.

index, confirming the lack of response. Specifically, we detect no significant effects on the average probability of being current, the amount of payments in arrears, or the amount of arrears scaled.

In contrast with this finding, the payment reduction leads to an improvement in the repayment index. On average, borrowers receiving a reduction in the monthly payment are characterized by a 0.137 standard deviation higher payment index, which is significantly different from the control group (column 1, Table 5). The same effect is documented in all three components of our index: entrepreneurs in this condition are more likely to be current and accumulate significantly less arrears.

Figure 11 plots the month-by-month estimates of the two conditions relative to the control group. Consistent with the null effect discussed above, we find that the interest write-down is never tied to an increase in repayment. Instead, the positive impact of the payment reduction can be detected in every month, although this effect is not statistically significant during the first month of the intervention (i.e., December 2023). Altogether, this evidence confirms that relaxing the monthly payment is successful in inducing improvements in repayment behavior, but lowering the size of the debt burden is not.

Before discussing the interpretation of these findings, we provide a few additional tests to better characterize our results.[35] In column (1) of Appendix Table A.2, we estimate the impact of our loan modifications on the absolute level of payments made by borrowers, measured by the rolling total payments made by the borrower. This outcome is particularly interesting because borrowers in the payment reduction arm are more likely to be in good standing, but also required to make smaller payments. Consistent with previous findings, the interest write-down does not affect this outcome in a statistically significant way. However, borrowers receiving a reduction in the monthly installment end up paying less overall. Combining this result with our evidence on the repayment index suggests that the payment reduction allows borrowers to remain in good standing while paying less.

We further examine this issue in the following three columns of Appendix Table A.2. In these analyses, we estimate the impact of our loan modifications on the probability that the borrower has systematically underpaid, overpaid, or paid exactly the amount due.[36] As expected, borrowers in the payment reduction condition are less likely to underpay their loan and more likely to overpay relative to the due installment. The probability of making the exact payment remains unchanged. Consistent with earlier findings, the interest write-down does not have any effect. Thus, despite the reduction in absolute payment, the payment reduction enables borrowers to prepay part of the loan.

The differential impact between the interest write-down and payment reduction supports the notion that defaults in this market were largely driven by liquidity issues rather than strategic

[35] To be clear, the results in Appendix Table A.2 were not part of our pre-analysis plan, as a way to better characterize our main result on the repayment index.

[36] We define a borrower to have systematically paid the "exact" amount if its total payments made up to a month are within a 1% bandwidth around the aggregate payment due up to that point. Naturally, overpayments and underpayments are defined relative to this benchmark.

incentives. Specifically, we find that reducing the size of the monthly payment has a large positive effect on repayment, while a significant reduction in debt balance does not appear to change repayment relative to the control group. More broadly, this underscores the critical role of liquidity for the business owners in our sample.

5.2 Loan Performance and the Financial Conditions

Before examining the impact of our intervention on entrepreneurial effort, we consider how the payment response benefits borrowers and influences their overall financial condition. Entrepreneurs in the payment reduction arm benefited from the intervention in several ways. First, borrowers in this group were more likely to remain current on their debt obligations, facing a significantly lower probability of default compared to the other two groups. Given that the cost of default is likely substantial in this setting (Section 2), this outcome should be highly beneficial for borrowers, effectively reducing the present value of their debt burden. In contrast, borrowers in the interest reduction group did not experience similar benefits; their likelihood of remaining current and the amount of arrears accumulated were not significantly different from those in the control group.

Second, once current, borrowers in the payment reduction group benefit from loan amortization and gradually increase their equity over time. Notably, borrowers in this group do not merely make the minimum payments; on average, they tend to overpay by some margin, implying that they build equity at a faster rate than the standard repayment schedule. This factor underscores the importance of considering the dynamic effects of our modification, as our intervention will affect both the initial level of equity and its growth.

A last benefit of the payment reduction is that it allows borrowers to free up liquidity that can be used for other business purposes (e.g., maintenance). As discussed above, borrowers in the payment reduction arm improve their repayment condition but—given the substantial reduction in installment—they achieve this despite paying less. This implies that these businesses now face a lower demand for cash and, more broadly, an improved financial position.

To further explore this idea, Table 6 explores the impact of our interventions on other borrowing activity by the entrepreneur using the data from Credit Bureau discussed earlier. As specified in the pre-analysis plan, this analysis examines the impact on indexes that capture the level of credit market access, the level of borrowing of the firm outside our Lender, and the firm overall debt repayment on liabilities outside our Lender.

We find that neither interest write-down or payment reduction affect the level of credit access: both estimates are small and not statistically different from zero (column 1). This evidence suggests that the intervention did not improve credit market access for the businesses in our sample. However, we find that the payment reduction lowers the borrowing index, while the interest write-down has no impact (columns 2 and 3). The combined evidence in terms of lack of change in credit access but a decline in borrowing is consistent with the presence of a decline in credit demand from borrowers in the payment reduction arm. This also aligns well with our previous hypothesis that

the payment reduction is relaxing some of the financing issues of the business owner.[37]

This discussion highlights the financial impact of the loan modification program. The payment reduction benefits borrowers by lowering their debt burden and immediately easing their overall financing needs. In contrast, the interest write-down has no significant effect on the entrepreneur's financial condition. As discussed in Section 3, the lack of response in terms of payments suggests that—despite directly reducing total debt—this intervention provides little relief.

5.3 The Impact on Entrepreneurial Effort

We now examine the impact of our interventions on entrepreneurial effort. The previous results suggest that payment reduction is more likely to influence effort by alleviating debt overhang distortions. However, as discussed in Section 3, the debt reduction achieved through payment reduction may not be sufficient to elicit a meaningful response.

Using the empirical approach outlined in Section 4.3, we examine the direct impact of loan modification in Table 7. We construct an index capturing entrepreneurial effort using GPS data, following the pre-analysis plan. Specifically, we normalize three measures of effort—distance driven, time spent on the job, and the number of operational days—by subtracting their mean and dividing by the standard deviation for each month. The index is then computed as an equally weighted average of these normalized measures. To start, we estimate the impact on the average index over the year following the loan modification.

Examining the interest write-down, we find no effect on the overall entrepreneurial effort index (column 1). The estimated impact is positive but small, with the treatment linked to an average monthly increase of 0.08 standard deviation of the index. More importantly, the effect is statistically insignificant. A similar pattern emerges for the sub-components of the index (columns 2, 3, and 4), with the only partial exception being total days driven; this estimate, while larger in magnitude, remains statistically insignificant. Panel (a) of Figure 12 presents the month-by-month estimates, consistently showing small, stable, and statistically non-significant effects.

This evidence suggests that the interest write-down has no impact on entrepreneurial effort, a result that aligns with our earlier discussion: since this intervention does not increase the likelihood of borrowers staying current on their loans, it is unlikely to alter the incentives related to repossession risk.

The same table reports the effect of the payment reduction, showing consistently positive but statistically insignificant effects on effort. However, unlike the interest write-down, the estimated effects are large in magnitude. For instance, the payment reduction increases the average entrepreneurial effort in a month by 0.421 standard deviations (s.e. = 0.49) of the index. While we cannot reject the null, these estimates challenge the view that the policy was entirely ineffective.

[37] Lastly, we also find no evidence that the interventions had an impact on repayments of other debts (column 4 and 5).

Consistently, Panel (b) of Figure 12 shows that, apart from the first three months, the estimated effects are generally large, with some months significantly different from zero.

In principle, the null effect of the payment reduction is not surprising relative the previous discussion. This intervention increased borrower payments, thereby reducing the risk of repossession. Additionally, entrepreneurs receiving a payment reduction were able to gradually pay down their loans, lowering their overall leverage relative to the control group. Within this framework,this reduction in leverage may not be sufficient for these borrowers, as a large share of them were already highly leveraged before the experiment began. This could explain the null effects on average, despite the relatively large estimates.

We test this hypothesis in Table 8, where we estimate the heterogeneous impact of debt restructuring across borrowers with different levels of baseline equity at the start of the experiment, measured using the loan-to-value (LTV) ratio for minibus loans, as described in Section 2. This analysis was outlined in our original pre-analysis plan. Figure 13 shows the distribution of baseline LTV for the borrowers in the experiment sample. The median LTV for the borrowers in our sample is 0.95 (s.d. = 0.22), which is similar to the median LTV of 1.02 (s.d. = 0.55) for all the borrowers with the lender at baseline. Consistent with our intuition, we find that borrowers with lower baseline leverage significantly increased their entrepreneurial effort after the experiment (column 1). This positive effect is observed across all sub-components (columns 2, 3, and 4), with particularly strong effects on time spent on the job and total days driven.[38] Instead, borrowers with high LTV do not significantly change their effort after the restructuring.

Before concluding, we highlight two ancillary results. First, Figure 14 presents the intent-to-treat estimate of entrepreneurial effort, estimated separately for borrowers with high and low equity at baseline. Borrowers with above median equity at baseline are classified as high equity, and low otherwise. Consistent with the evidence in Table 8, we find that the payment reduction significantly increases entrepreneurial effort among borrowers with lower ex-ante leverage. Moreover, the month-by-month estimates grow larger over time, aligning with the dynamic impact of our modification on equity accumulation.

Second, Table 9 examines the same heterogeneity tests based on LTV but focuses on loan repayment. Here, we find little evidence that low-LTV borrowers reacted more aggressively to the modifications. This null result supports our hypothesis that liquidity constraints, rather than strategic considerations, are the primary driver of default. In other words, while borrowers may respond to incentives, their underpayment behavior was largely dictated by financial constraints. Moreover, this finding suggests that the increase in entrepreneurial effort observed among low-LTV borrowers does not simply reflect ex-post differences in repayment behavior.

5.4 Discussion

Examining the experiment's results offers key insights into how debt restructuring affects small businesses. The first key takeaway from our analysis is that liquidity constraints, rather than

[38] We also note that we find no heterogeneous effects for interest write-down.

strategic incentives, primarily drive defaults in our setting. Consistent with this idea, we find that reducing monthly payments significantly improves repayment rates, whereas lowering the debt burden does not lead to meaningful behavioral changes. We also did not find evidence that - within the repayment conditions- differences in LTV explains heterogeneity in repayment.

As outlined in Section 2, evaluating repayment behavior is a critical first step in assessing whether a loan modification can meaningfully reduce debt overhang. The payment reduction helps entrepreneurs stay current on their loans and, more broadly, alleviates financial strain. These borrowers are less likely to default and face repossession, thereby directly improving their equity position relative to the control group. Additionally, the amortization structure of the loan enables them to build equity over time, further strengthening their financial position.

However, our findings also underscore the intertwined relationship between liquidity and strategic incentives. Improving payments alone may not be sufficient to fully mitigate the effects of debt overhang. For some borrowers, initial leverage is so high that the benefits of a payment reduction may not be enough to cross the tipping point (Myers 1977) at which debt overhang ceases to be a constraint. Our analysis of driving behavior supports this idea, as we find that the increase in entrepreneurial effort is concentrated among borrowers with higher ex-ante equity. These results suggest a potential rationale for policies that combine payment reductions with more aggressive reductions in overall debt balances.

The overall picture emerging from our analysis highlights the crucial interplay between liquidity constraints and strategic concerns in designing restructuring policies that not only improve repayments but also stimulate real economic activity.

6 Conclusion

Understanding the drivers of default and repayment behavior is crucial for designing optimal loan modification strategies. This study leverages a unique randomized experiment involving 3,186 minibus taxi operators in South Africa to examine the effects of different loan restructuring approaches on repayment behavior, entrepreneurial effort, and external borrowing. By distinguishing between liquidity constraints and strategic default incentives, we contribute to a broader understanding of debt dynamics in small business lending.

Our experiment involved three arms: a control group receiving a standard restructuring, a treatment group receiving a payment reduction via extended maturity without changing long-run debt obligations, and another treatment group receiving an interest write-down, an intervention that effectively lowers the long-term obligations for the borrowers without changing short-run liquidity. By exploiting loan repayment histories, credit bureau records, and GPS-tracked driving data, we assess how these modifications impact borrower behavior. This setting, characterized by strong competitive pressures and financially constrained entrepreneurs, provides a useful testing ground for evaluating debt restructuring policies in developing countries.

Borrowers who received a payment reduction were significantly more likely to stay current on

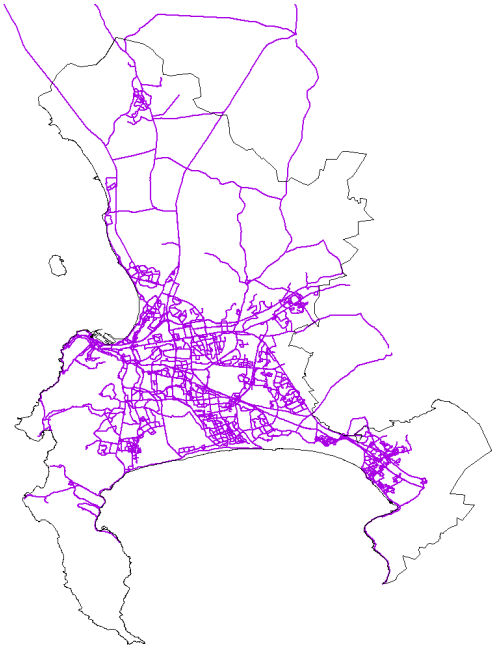
their loans and exhibited a lower level of accumulated arrears, while those receiving an interest write-down showed no significant change in repayment behavior. We also find that borrowers in the payment reduction group reduced their external borrowing, reinforcing the idea that improved liquidity conditions allowed them to stabilize their finances. The evidence on entrepreneurial effort is more mixed. As expected, we find that the interest write down does not have any impact on the driving. The payment reduction instead induces more entrepreneurial effort for those businesses with low leverage ex-ante.

The significant response to a payment reduction suggests that liquidity constraints are a primary driver of default in this market. However, this finding does not necessarily rule out the importance of strategic incentives. Lowering the monthly installment may help borrowers building equity and therefore reducing the cost of debt overhang. However, we find that this effect is sufficiently large only for borrowers with high baseline equity in the vehicle, suggesting that strategic incentives can still represent an important hurdle to clear to make these policies effective. Overall, our results highlight the important interplay between liquidity and strategic concerns.

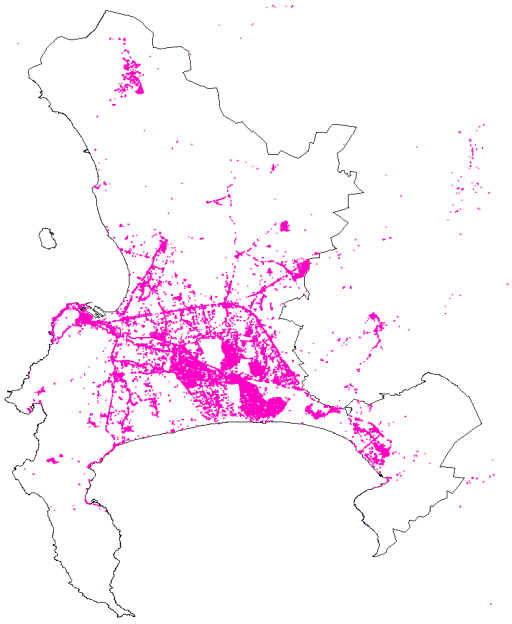
7 Figures and Tables

Figure 1: All minibus routes and GPS coordinates of minibuses from our experimental sample in the City of Cape Town

(a) Map of all minibus taxi routes



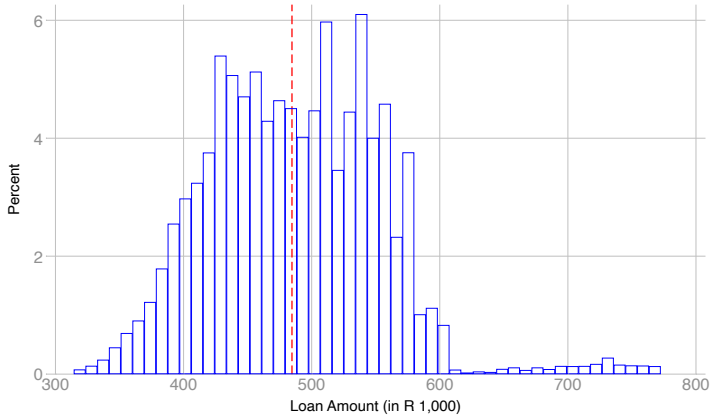
(b) Geo-coordinates of operators in experiment



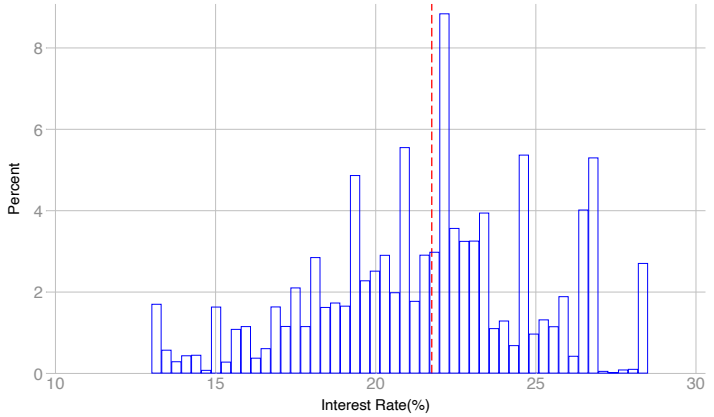
Notes: Panel (a) documents all official minibus routes in the city of Cape Town. Panel (b) denotes the geo-coordinates from the GPS data for the accounts in our experiment that operate in the city of Cape Town.

Figure 2: Distribution of loan terms in the Lender's portfolio

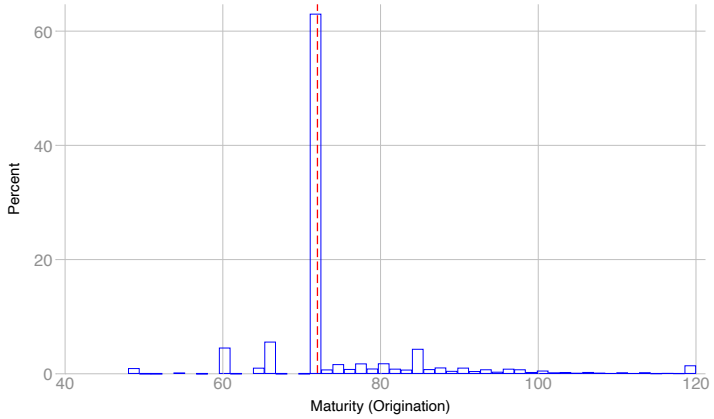
(a) Loan Amount



(b) Interest Rate



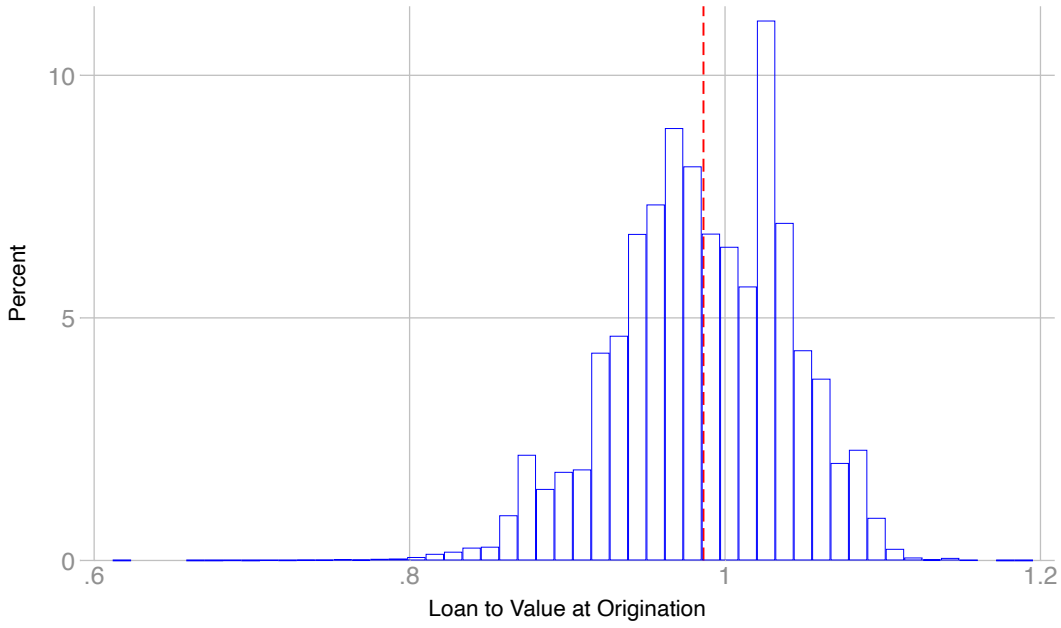
(c) Maturity (at Origination)



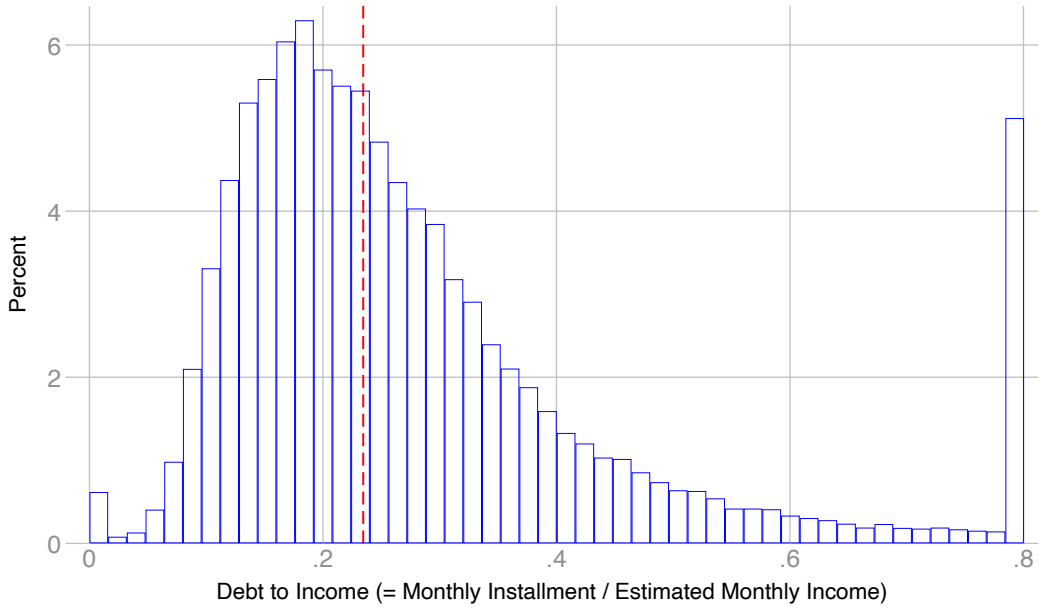
Notes: The figure plots the distribution of loan characteristics as observed at origination of the loan. The sample is all the accounts active with the lender as of October 2023 (the month before the experiment rollout). The red vertical lines on each subplot corresponds to the median value for the reported variables. Panel (a) plots the loan amount (in R 1,000); Panel (b) plots the interest rate (in percent); and Panel (c) plots the loan maturity (in months). (N = 32,079)

Figure 3: Distribution of loan-to-value (at origination) and debt-to-income

(a) Loan to Value (LTV) at origination

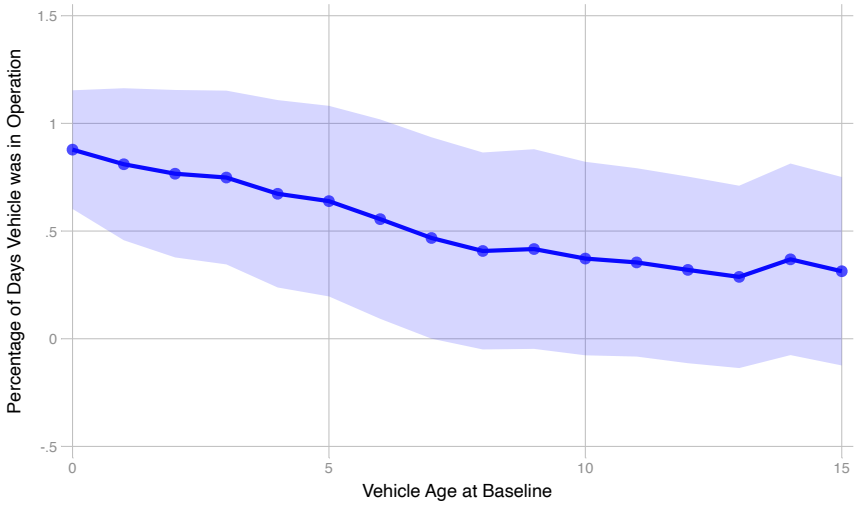


(b) Debt to Income (DTI) at baseline



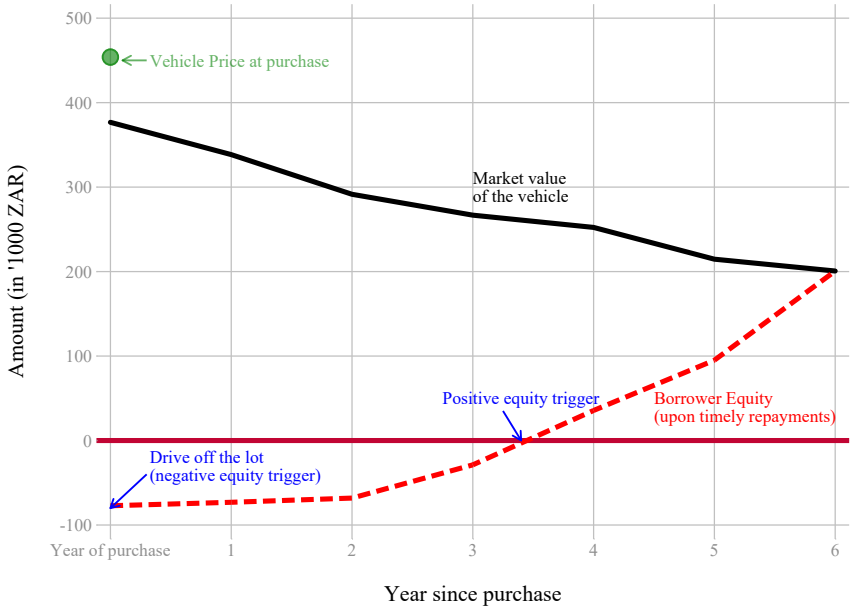
Notes: The figure plots the distribution of loan to value at loan origination (Panel a), and the debt-to-income ratio (Panel b). For Panel (b), we winsorize the observations in top 5% of the distribution. The sample is all the accounts active with the lender as of October 2023 (the month before the experiment rollout). The red vertical lines on each subplot corresponds to the median value for the reported variables. (N = 32,000)

Figure 4: Share of days driven at baseline by age of the vehicle



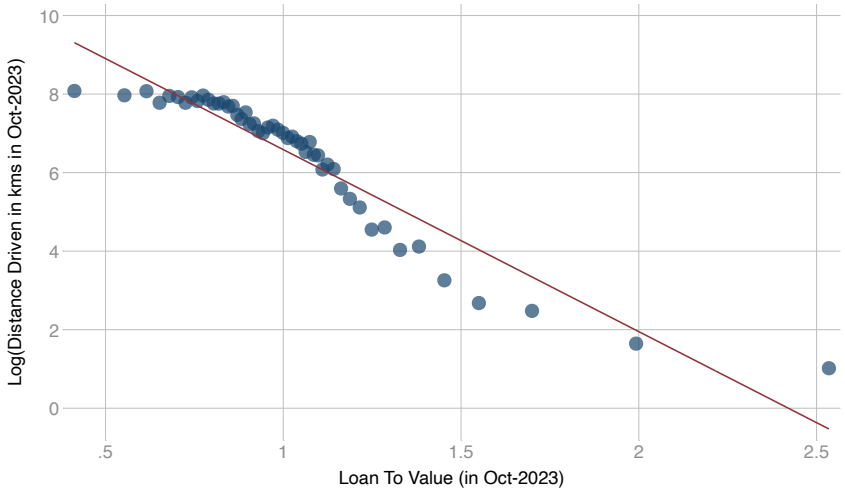
Notes: The figure shows the mean and standard deviations for the percentage of days a vehicle was in operation in October-2023 by the age of the vehicle (in years) as measured at baseline month.

Figure 5: Evolution of equity over time for new borrowers



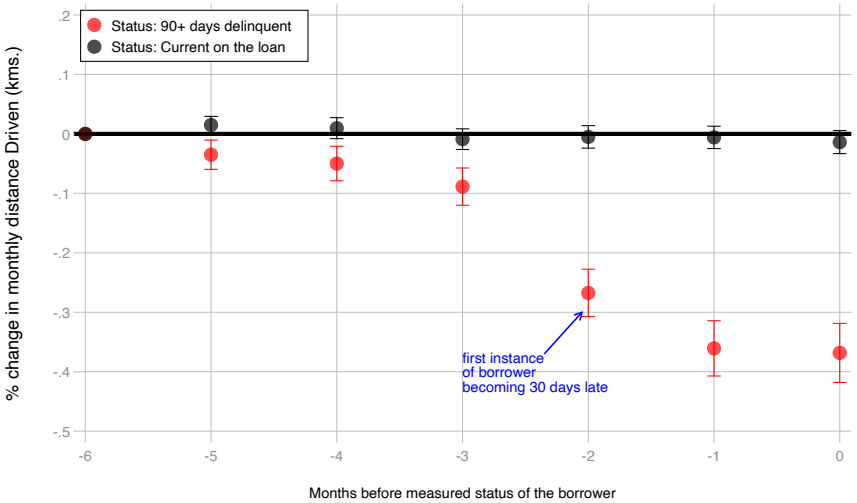
Notes: The figure provides an example of the evolution of equity (red dashed line) for borrowers that make timely repayment on loan with a newly collateralized vehicle. The black solid line represents the market value of a new minibus (Toyota Quantum 16 seater in this example). The green dot represents the market value of vehicle upon purchase. The vertical axis reports the monetary value (in R 10,000). The horizontal axis plots the time (in years) that has passed since vehicle purchase.

Figure 6: Borrower Equity and Entrepreneurial Effort at Baseline



Notes: The figure plots the relationship between (log) of distance borrower — one of the component of borrower effort index — and loan to value in at baseline month (at October 2023). Controls include indictor for loan origination month and indicator variable for that takes the value of one when the vehicle is new and 0 when it is refurbished. *Sample:* All loan accounts with lender for which vehicles not repossessed in October 2023. (N = 28,519)

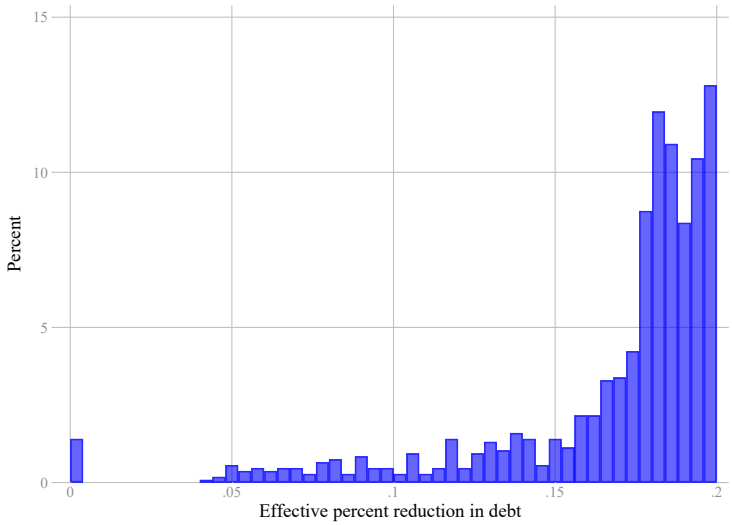
Figure 7: Evolution of Entrepreneurial Effort and 90+ Day Delinquency



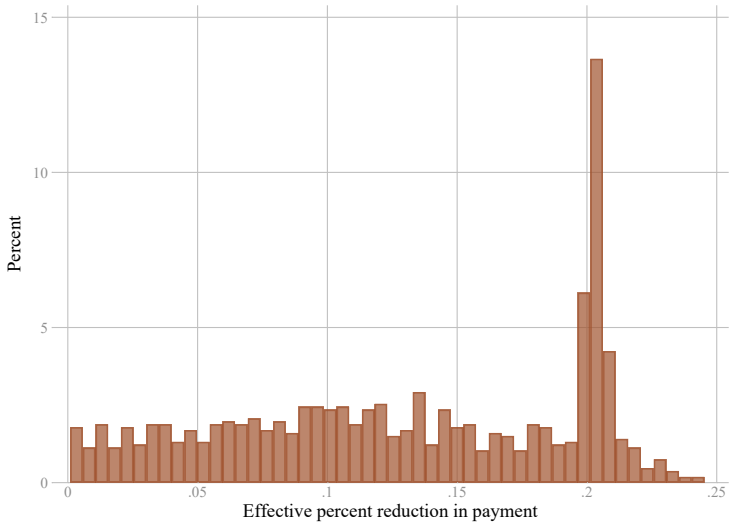
Notes: The figures plots the estimates β^s from following two regressions for the set of account i that have the following status $s = \{1(\text{current}), 1(90+ \text{ days delinquent})\}$ every month from $t_0 = [\text{June 2024}, \text{January 2025}]$: $log(distance)_{i,t} = \alpha_i + \alpha^i_{t_0} + \sum_{k=0}^{-5} \beta^s_k \cdot \mathbf{1}(t = t^i_0 + k) + \epsilon_{it}$ t^i_0 is the month for which the status of the account i is measured. For delinquent account it is the month in which the account become delinquent for the first time. For current account, it is the month for which the account i remain current for the preceding six months. If an account remain current for multiple times between June 2024 to January 2025, we random allocate it to one of the eight months. Standard errors are clustered at the account-level. Solid dots represent the point estimates, with black dots corresponding to the accounts with current status and red dots corresponding to the accounts that enter become 90+ delinquent for the first time. We exclude accounts that were part of our experimental sample. The omitted month is month 6 before the month in which borrower status is measured. 95% confidence intervals are reported using the vertical bars.

Figure 8: Effective treatment intensity

(a) Interest write-down

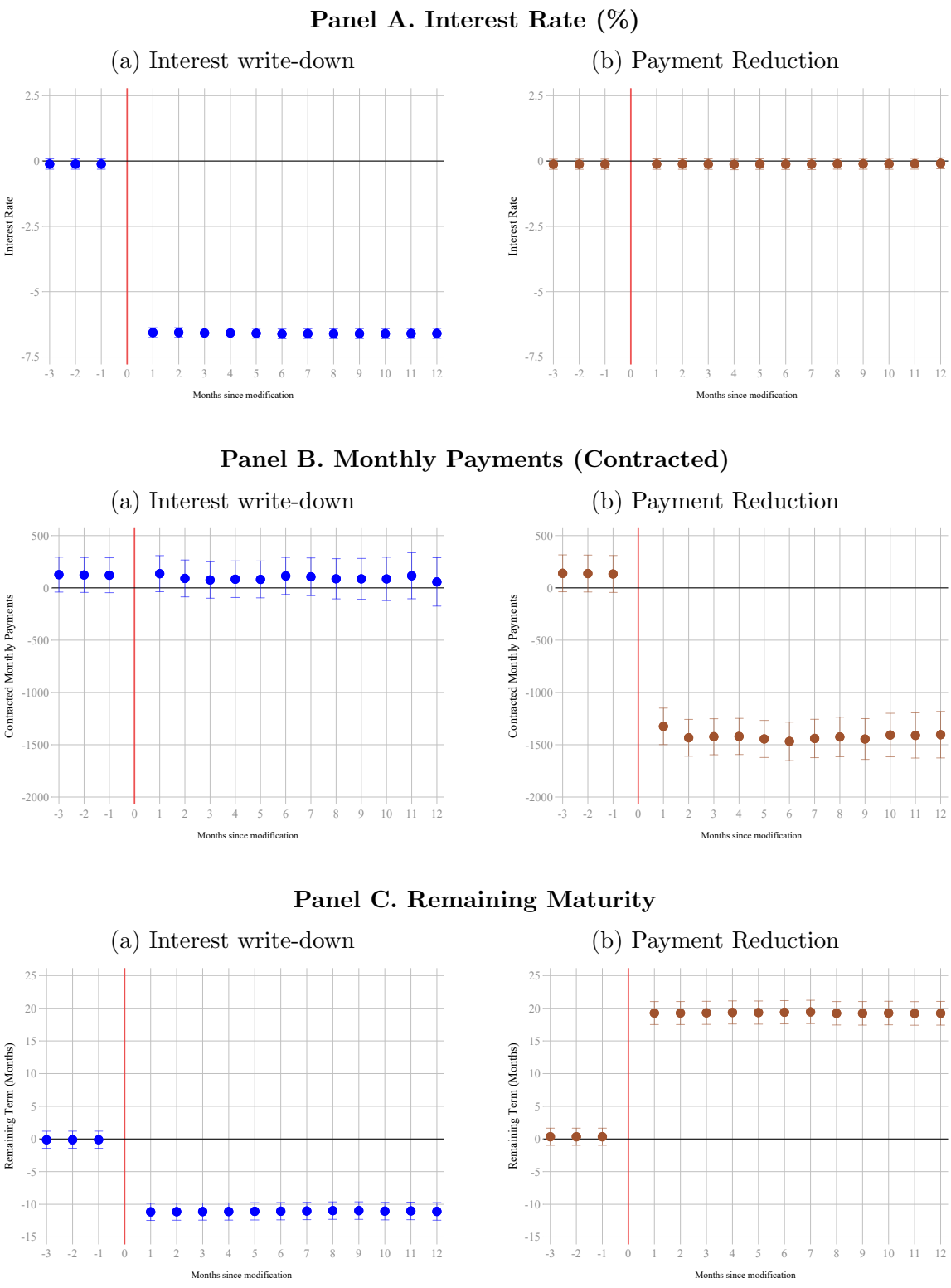


(b) Payment Reduction



Notes: These panels report month-by-month reduced-form estimates of the impact of loan modifications on entrepreneurial effort index. The effort is defined as equal weighted average of (i) total distance covered by the vehicle (ii) total number of days worked in the month (iii) the number of hours on the job. The top panel reports the monthly estimates for the interest write-down modification relative to the baseline modification. The bottom panel reports the monthly estimates for the payment reduction modification relative to the baseline modification. All regressions control for randomization strata-month fixed effects. Standard errors are clustered at the loan account level. Vertical lines indicate 95% confidence intervals.

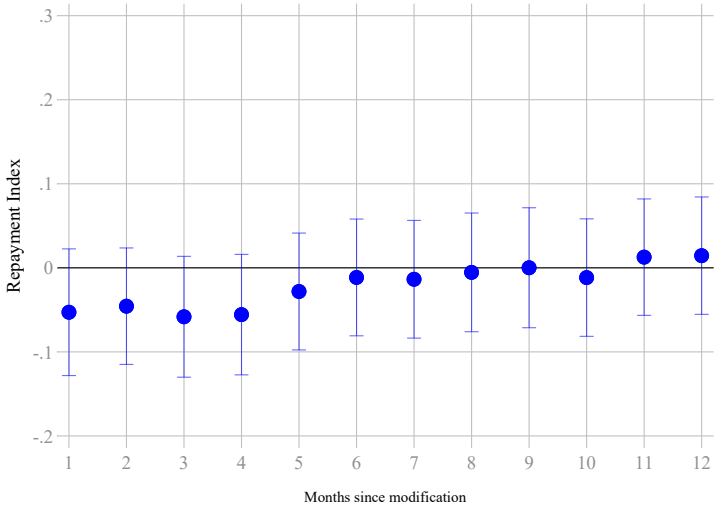
Figure 9: First-stage: Impact on contract terms across treatment arms



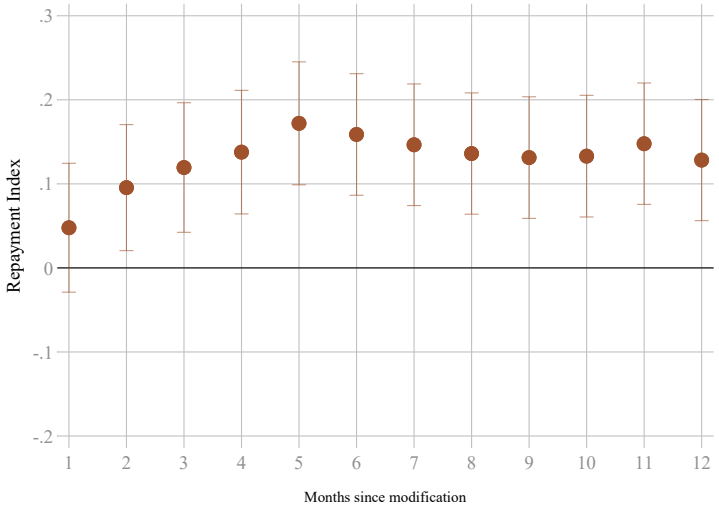
Notes: These panels report the estimates on contract terms — Interest Rate (Panel A), Contracted Monthly Payments (Panel B), and the outstanding maturity (Panel C) — in the three months before and eight months after the loan modifications (November 2023) relative to the baseline modification. For each panel, the left column reports the contract terms under the interest write-down modification relative to the baseline modification, and the right column reports the contract terms under the payment reduction modification relative to the baseline offer. All regressions control for randomization strata-month fixed effects. Standard errors are clustered at the loan account level. Vertical lines indicate 95% confidence intervals.

Figure 10: Impact of loan modifications on minibus loan repayment

(a) Interest write-down



(b) Payment Reduction

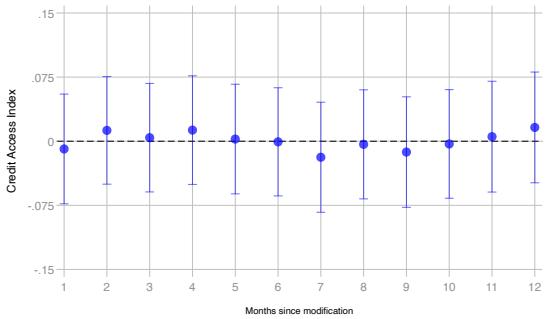


Notes: These panels report month-by-month reduced-form estimates of the impact of loan modifications on minibus loan repayment. Loan repayment index is defined as equal weighted average of (i) indicator for whether a borrower is current on the loan (ii) (negative of) total amount in arrears (iii) (negative of) total amount in arrears divided by monthly owed installment. The top panel reports the monthly estimates for the interest write-down modification relative to the baseline modification. The bottom panel reports the monthly estimates for the payment reduction modification relative to the baseline modification. All regressions control for randomization strata-month fixed effects. Standard errors are clustered at the loan account level. Vertical lines indicate 95% confidence intervals.

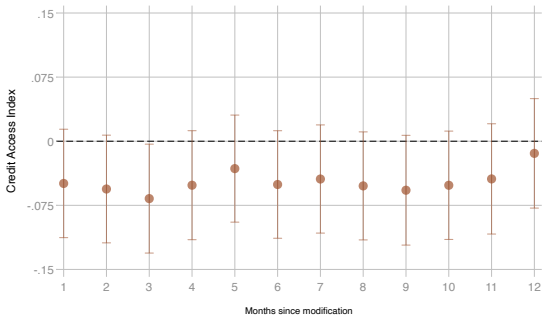
Figure 11: Impact of loan modifications on outside debt

Panel A. Credit Access Index

(a) Interest write-down

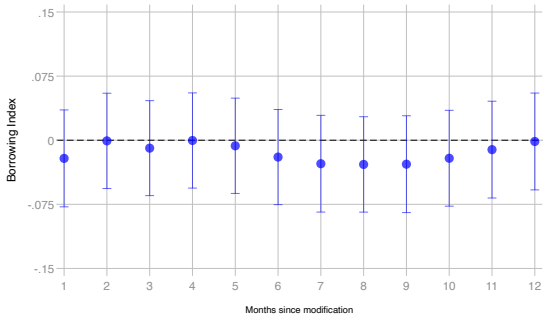


(b) Payment Reduction

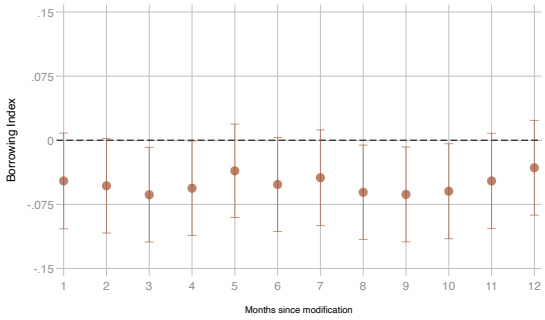


Panel B. Borrowing Index

(a) Interest write-down

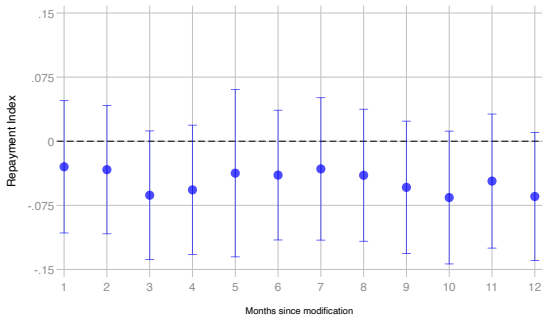


(b) Payment Reduction

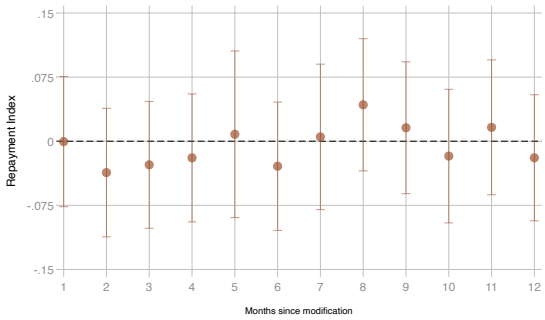


Panel C. Repayment Index

(a) Interest write-down



(b) Payment Reduction

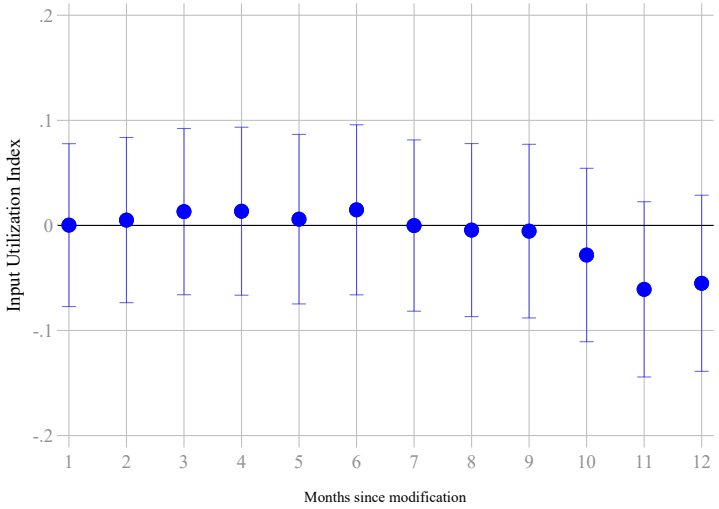


Notes: These panels report month-by-month reduced-form estimates of the impact of loan modifications on three indices measuring performance on outside debt: credit access index (panel A); borrowing index (panel B); repayment index (panel C). The indices are defined as follows:
1. *Credit Access Index (month 12)* = (1(has credit card) + 1(has credit line) + Total amount on credit lines + 1(has installment loan))/ 4
2. *Borrowing index (average)*= (1(outside debt > 0) + Line Utilization + Total Amount Owed on Outside Debt)/3
3. *Repayment index (average)* = (1(any account past due)+(Num. accounts past due) + 1(any account in default)+ (Num. accounts in default) + (Balance past due) + (Balance in default))/6. Only accounts active at baseline considered.

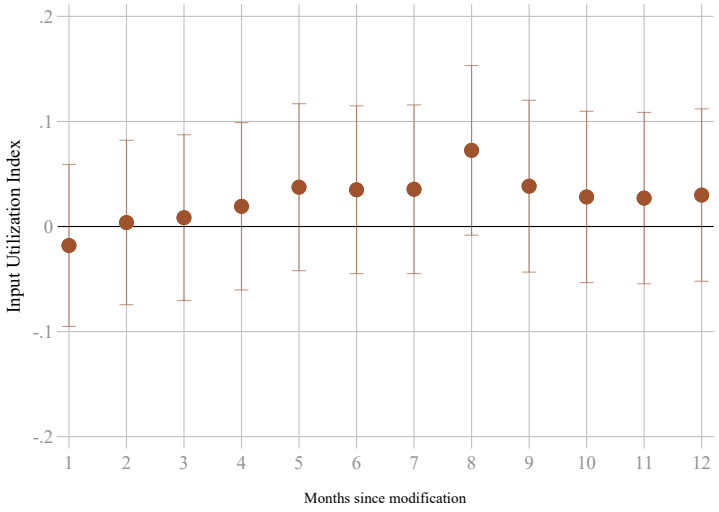
All index components are normalized to mean zero and standard deviation of one. The left sub-panels within each panel report the monthly estimates for the interest write-down modification relative to the baseline modification. The right sub-panels within each panel report the monthly estimates for the payment reduction modification relative to the baseline modification. All regressions control for randomization strata-month fixed effects. Standard errors are clustered at the loan account level. Vertical lines indicate 95% confidence intervals.

Figure 12: Impact of loan modifications on entrepreneurial effort

(a) Interest write-down

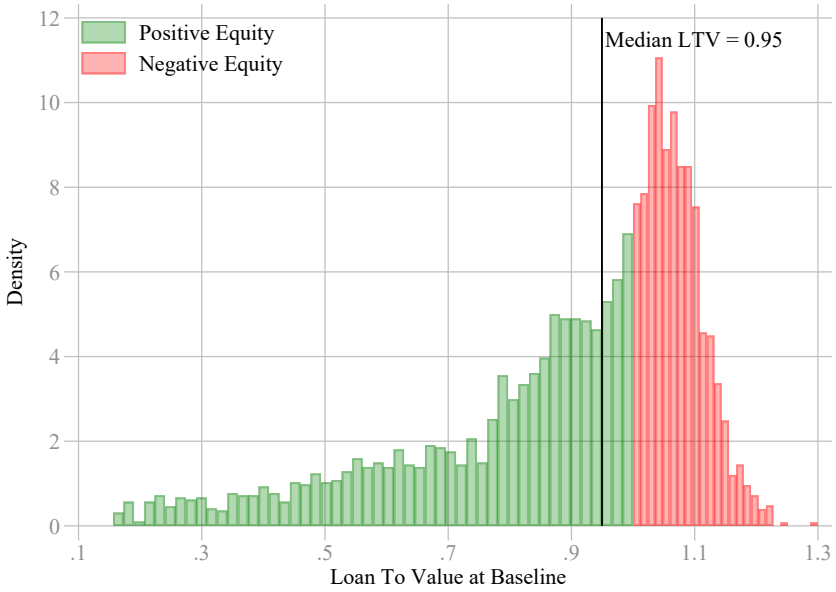


(b) Payment Reduction



Notes: These panels report month-by-month reduced-form estimates of the impact of loan modifications on borrowers' effort. The index is defined as equal weighted average of (i) total distance covered by the vehicle (ii) total number of days worked in the month (iii) the number of hours on the job. The top panel reports the monthly estimates for the interest write-down modification relative to the baseline modification. The bottom panel reports the monthly estimates for the payment reduction modification relative to the baseline modification. All regressions control for randomization strata-month fixed effects. Standard errors are clustered at the loan account level. Vertical lines indicate 95% confidence intervals.

Figure 13: Distribution of Baseline LTV in the experimental sample

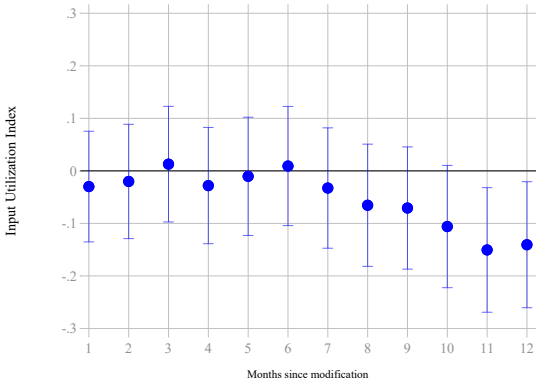


Notes: The figures plots the distribution of LTV (loan-to-value) across borrowers in our experimental sample at baseline month of October 2023. LTV is defined as the outstanding loan balance (sum of principal and any outstanding arrears) divided by the estimate of the market value of the underlying collateralized minibus. The vertical line represents the median value (LTV = 0.95) in the sample. The green bars corresponds to the accounts that have non-negative equity (LTV $\leq$ 1), while the red bars correspond to the accounts that have negative equity (LTV $>$ 1). (N = 3,186)

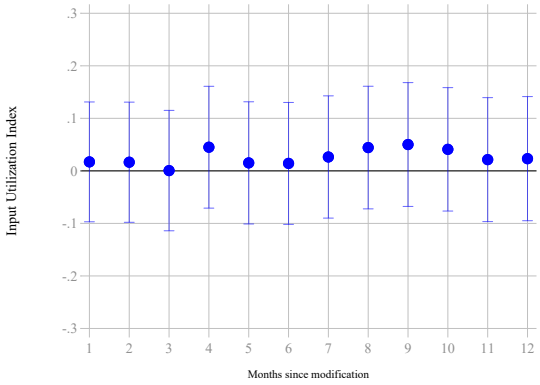
Figure 14: Dynamic effects on entrepreneurial effort

Panel A. ... following interest write-down

(a) borrowers with low baseline equity

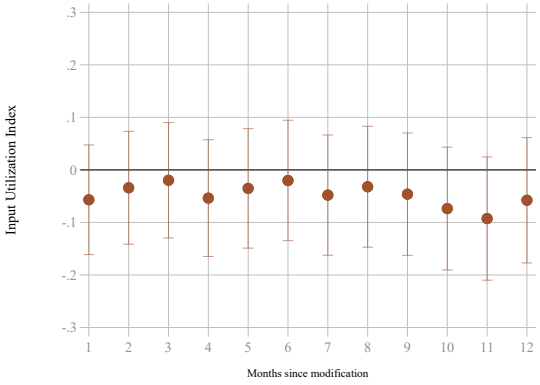


(b) borrowers with high baseline equity

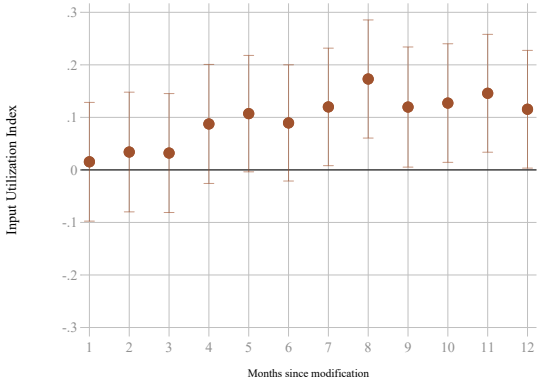


Panel B. ... following payment reduction

(a) borrowers with low baseline equity



(b) borrowers with high baseline equity



Notes: These panels report month-by-month reduced-form estimates of the impact of loan modifications on borrowers' effort by above-median (high) or below-median (low) baseline borrower equity. The index is defined as equal weighted average of (i) total distance covered by the vehicle (ii) total number of days worked in the month (iii) the number of hours on the job. The top panel reports the monthly estimates for the interest write-down modification relative to the baseline modification. The bottom panel reports the monthly estimates for the payment reduction modification relative to the baseline modification. Panel (a) reports estimates for low baseline equity and Panel (b) reports estimates for high baseline equity. All regressions control for randomization strata-month fixed effects. Standard errors are clustered at the loan account level. Vertical lines indicate 95% confidence intervals.

Table 1: Illustrative example of baseline modification

Status of the account ...	Loan characteristics					
	Principal Outstanding (1)	Accumulated Arrears (2)	Total Amount Outstanding (3) = (1) + (2)	Interest Rate (4)	Monthly Payments (5)	Remaining Months (6)
... *if* it was current	R 391,931	—	R 391,931	23.9%	R 12,824.7	47.6
... *actual status*: in arrears	R 391,931	R 54,829	R 446,761	23.9%	R 14,618.9	47.6
... after modification	R 446,761	—	R 446,761	23.9%	R 12,824.7	59.9

Notes: The table illustrates how enrollment into the baseline arm changes the loan contract for a hypothetical borrower. Column (1) shows the principal outstanding for an average loan from our sample. Column (2) shows the average accumulated debt for delinquent borrowers. Column (3) shows the total amount outstanding which is the sum of the original outstanding principal and accumulated arrears. Column (4) shows the annualized interest rate. Column (5) shows the effective monthly payments under each loan status. Column (6) shows the new maturity for the loan contract.

Table 2: Illustrative Example of Randomized Treatments

Treatments		Loan characteristics			
Interest write-down (1)	Payment Reduction (2)	Interest Rate (3)	Monthly Payment (4)	Remaining Maturity (5)	Total Interest (6)
—	—	23.9%	R 12,824.7	59.9	R 322,625
6.6 p.p.	—	17.3%	R 12,824.7	48.7	R 178,426
—	12.9%	23.9%	R 11,170.3	80.7	R 454,677

Notes: The table illustrates how loan characteristics change across various arms of the experiment. Row 1 corresponds to the baseline modification arm, which is the same as Row 3 of Table 1. Row 2 corresponds to the interest write-down modification arm. Row 3 corresponds to the payment reduction modification arm. Column (1) shows the average interest write-down (in percentage points). Column (2) shows the average payment reduction (in percent) over the average payment based on loan amortization. Column (3) shows the average interest rate. Column (4) shows the average monthly loan payment. Column (5) shows the outstanding loan maturity. Column (6) shows the total gross interest that will be paid upon full and timely repayment on the loan.

Table 3: Summary Statistics and Balance

Sample: *All Baseline: 3,186 firms*	**Control mean** (1)	**Interest Write-down** (2)	**Payment Reduction** (3)
Panel A. Borrower characteristics:			
Credit Score	592.194	0.001	0.000
		(0.000)	(0.000)
1(male)	0.761	–0.005	0.007
		(0.020)	(0.020)
No. of prior loans with lender	1.479	–0.020**	0.009
		(0.009)	(0.010)
Panel B. Loan characteristics:			
1(vehicle is new)	0.690	0.001	–0.017
		(0.023)	(0.023)
Loan Principal (R 1,000)	388.570	–0.000	0.000
		(0.000)	(0.000)
Arrears (R 1,000)	54.040	0.000	0.000
		(0.001)	(0.001)
Maturity (Origination)	73.952	–0.002	0.003
		(0.002)	(0.002)
Loan to Value (Origination)	0.999	0.256	–0.068
		(0.214)	(0.219)
Panel C. Baseline contract terms:			
Interest Rate	0.240	–0.647	–0.022
		(0.528)	(0.529)
Installments (R 1,000)	16.248	0.007	–0.003
		(0.008)	(0.008)
Remaining Maturity	47.492	0.001	–0.003
		(0.002)	(0.002)
Panel D. Baseline outcomes (normalized):			
Repayment Index	0.010	0.015	–0.007
		(0.020)	(0.022)
Effort Index	–0.021	0.006	0.002
		(0.010)	(0.010)
Credit Access Index	0.010	0.022	–0.026
		(0.021)	(0.021)
Borrowing Index	0.007	–0.009	0.008
		(0.024)	(0.024)
p-value (joint F-test)	—	[0.535]	[0.756]
Observations	1,063	1,062	1,061

Notes: The table reports the correlation of intent to treat with baseline characteristics for the loan and the borrower. All regressions control for randomization strata fixed effects. Standard errors are clustered at the loan account level.

Table 4: First-stage: Treatment Intensity

	Interest Rate (1)	Monthly Installment (2)	Remaining Maturity (3)
β^{IW} : 1(interest write-down)	-6.572***	96.948	-11.122***
	[0.095]	[91.933]	[0.669]
β^{PR} : 1(payment reduction)	-0.117	-1,421.016***	19.234***
	[0.102]	[90.804]	[0.897]
Observations	3,186	3,186	3,186
R-squared	0.713	0.197	0.484
Control mean	23.92	16067.48	55.18
p-value ($\beta^{IW} = \beta^{PR}$)	0.00	0.00	0.00
Strata f.e.	✓	✓	✓

Notes: The table reports the correlation of intent to treat with baseline characteristics for the loan and the borrower. All regressions control for randomization strata fixed effects. Standard errors are clustered at the loan account level.

Table 5: Results on repayment

	Repayment Index (1)	1(current) (2)	Arrears Amount (3)	Arrears (Scaled) (4)
β^{IW} : 1(interest write-down)	0.014	0.021	-0.004	-0.018
	[0.036]	[0.040]	[0.042]	[0.042]
β^{PR} : 1(payment reduction)	0.128***	0.150***	-0.165***	-0.070
	[0.037]	[0.043]	[0.043]	[0.043]
Observations	3,186	3,186	3,186	3,186
R-squared	0.077	0.047	0.077	0.054
Control mean	-0.05	-0.06	0.06	0.03
p-value ($\beta^{IW} = \beta^{PR}$)	0.00	0.00	0.00	0.21
Strata f.e.	✓	✓	✓	✓

Notes: The table reports the correlation of intent to treat with baseline characteristics for the loan and the borrower. All regressions control for randomization strata fixed effects. Standard errors are clustered at the loan account level.

Table 6: Externalities on outside debt

	Credit Access Index (1)	Borrowing Index (2)	Borrowing Index (Winsorized) (3)	Repayment Index (4)	Repayment Index (Winsorized) (5)
β^{IW} : 1(interest write-down)	0.016	-0.015	-0.009	-0.048	-0.059*
	[0.033]	[0.026]	[0.026]	[0.033]	[0.033]
	-0.014	-0.051**	-0.050*	-0.004	-0.014
	[0.033]	[0.025]	[0.026]	[0.032]	[0.033]
Observations	3,186	3,186	3,186	2,947	2,947
R-squared	0.027	0.070	0.073	0.025	0.025
Control mean	-0.00	0.02	0.02	0.09	0.10
p-value ($\beta^{IW} = \beta^{PR}$)	0.36	0.14	0.11	0.15	0.17
Strata f.e.	✓	✓	✓	✓	✓

Notes: The table reports the correlation of intent to treat with baseline characteristics for the loan and the borrower. All regressions control for randomization strata fixed effects. Standard errors are clustered at the loan account level.

Table 7: Results on entrepreneurial effort

	Effort Index (1)	Distance driven (2)	Time Spent on job (3)	Total days driven (4)
β^{IW} : 1(interest write-down)	-0.148	-0.158	-0.068	0.083
	[0.504]	[0.547]	[0.529]	[0.524]
β^{PR} : 1(payment reduction)	0.421	0.390	0.559	0.761
	[0.499]	[0.554]	[0.521]	[0.521]
Observations	3,186	3,186	3,186	3,186
R-squared	0.021	0.009	0.036	0.035
Control mean	-0.09	-0.08	-0.16	-0.28
p-value ($\beta^{IW} = \beta^{PR}$)	0.24	0.30	0.22	0.18
Strata f.e.	✓	✓	✓	✓

Notes: The table reports the correlation of intent to treat with baseline characteristics for the loan and the borrower. All regressions control for randomization strata fixed effects. Standard errors are clustered at the loan account level.

Table 8: Subsample Analysis: Effect on entrepreneurial effort

	Effort Index (1)	Distance driven (2)	Time Spent on job (3)	Total days driven (4)
1(interest write-down)	-0.690	-0.589	-0.890	-0.390
× 1(low baseline equity)	[0.615]	[0.683]	[0.649]	[0.639]
1(interest write-down)	0.358	0.261	0.662	0.473
× 1(high baseline equity)	[0.643]	[0.683]	[0.674]	[0.677]
1(payment reduction)	-0.608	-0.462	-0.843	-0.283
× 1(low baseline equity)	[0.617]	[0.700]	[0.647]	[0.641]
1(payment reduction)	1.233**	1.094	1.662**	1.530**
× 1(high baseline equity)	[0.629]	[0.685]	[0.655]	[0.664]
1(high baseline equity)	-2.469***	-2.361***	-3.021***	-2.060***
	[0.682]	[0.750]	[0.713]	[0.717]
Observations	3,178	3,178	3,178	3,178
R-squared	0.027	0.014	0.044	0.039
Control mean	-0.07	-0.07	-0.12	-0.24
p-value [IW × 1(high eq.) = PR × 1(high eq.)]	0.16	0.21	0.12	0.10
Strata f.e.	✓	✓	✓	✓

Notes: The table reports the correlation of intent to treat with baseline characteristics for the loan and the borrower. All regressions control for randomization strata fixed effects. Standard errors are clustered at the loan account level.

Table 9: Subsample Analysis: Effects on minibus repayment and outside debt

	Summary Index for					
	Minibus Repayment	Credit Access	Borrowing	Borrowing (Winsorized)	Repayment	Repayment (Winsorized)
	(1)	(2)	(3)	(4)	(5)	(6)
1(interest write-down)	-0.033	0.038	0.009	0.010	-0.007	-0.012
× 1(low baseline equity)	[0.050]	[0.046]	[0.032]	[0.033]	[0.043]	[0.047]
1(interest write-down)	0.069	-0.005	-0.036	-0.026	-0.086*	-0.102**
× 1(high baseline equity)	[0.050]	[0.048]	[0.040]	[0.040]	[0.049]	[0.046]
1(payment reduction)	0.099**	-0.020	-0.027	-0.028	0.038	0.051
× 1(low baseline equity)	[0.050]	[0.046]	[0.032]	[0.034]	[0.044]	[0.047]
1(payment reduction)	0.164***	-0.007	-0.075*	-0.071*	-0.044	-0.076*
× 1(high baseline equity)	[0.053]	[0.046]	[0.038]	[0.038]	[0.046]	[0.046]
1(high baseline equity)	0.187***	0.033	0.060	0.049	0.138***	0.179***
	[0.055]	[0.049]	[0.038]	[0.038]	[0.049]	[0.050]
Observations	3,186	3,186	3,186	3,186	2,947	2,947
R-squared	0.093	0.027	0.071	0.074	0.028	0.031
Control mean	-0.05	-0.00	0.02	0.02	0.09	0.10
p[IW*1(H eq.) = PR*1(H eq.)]	0.07	0.97	0.32	0.25	0.35	0.58
Strata f.e.	✓	✓	✓	✓	✓	✓

Notes: The table reports the correlation of intent to treat with baseline characteristics for the loan and the borrower. All regressions control for randomization strata fixed effects. Standard errors are clustered at the loan account level.

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A Appendix Figures and Tables

Figure A.1: A Toyota Quantum Minibux Taxi





Notes: Panel (a) of the figure shows the 16-seater minibus from Toyota that constitute 80% of the collateralized vehicles in our sample. Panel (b) of the figure shows the example of a taxi ranks.

Table A.1: Correlation across index component for main outcomes indices

Panel a. Minibus loan performance

	Repayment Index	1(current)	Arrears Amount	Arrears (Scaled)
Repayment Index	1			
1(current)	0.756	1		
Arrears Amount	-0.920	-0.483	1	
Arrears (Scaled)	-0.918	-0.478	0.904	1

Panel b. Credit Access Index

	Credit Access Index	1(has card)	1(has credit line)	1(has installment loan)	Number of credit lines
Credit Access Index	1				
1(has card)	0.842	1			
1(has credit line)	0.860	0.765	1		
1(has installment loan)	0.525	0.166	0.208	1	
Number of credit lines	0.825	0.640	0.651	0.227	1

Panel c. Borrowing Index

	Borrowing Index	1(non-zero debt)	Credit Utilization	Balance (Installment loans)	Borrowings (Credit Lines)
Borrowing Index	1				
1(non-zero debt)	0.763	1			
Credit Utilization	0.733	0.603	1		
Balance (Installment Loans)	0.547	0.211	0.0676	1	
Borrowings (Credit Lines)	0.640	0.233	0.296	0.188	1

Panel d. Repayment Index

	Repayment Index	1(any past due account)	Number of past due accounts	Overdue Amount
Repayment Index	1			
1(any past due account)	-0.798	1		
Number of past due accounts	-0.880	0.644	1	
Overdue Amount	-0.725	0.272	0.469	1

Panel e. Entrepreurial Effort Index

	Effort Index	Distance Driven	Drive Time	Time in job (hours)	Total days driven
Effort Index	1				
Distance Driven	0.895	1			
Drive Time	0.944	0.844	1		
Time in job (hours)	0.951	0.759	0.858	1	
Total days driven	0.925	0.719	0.801	0.914	1

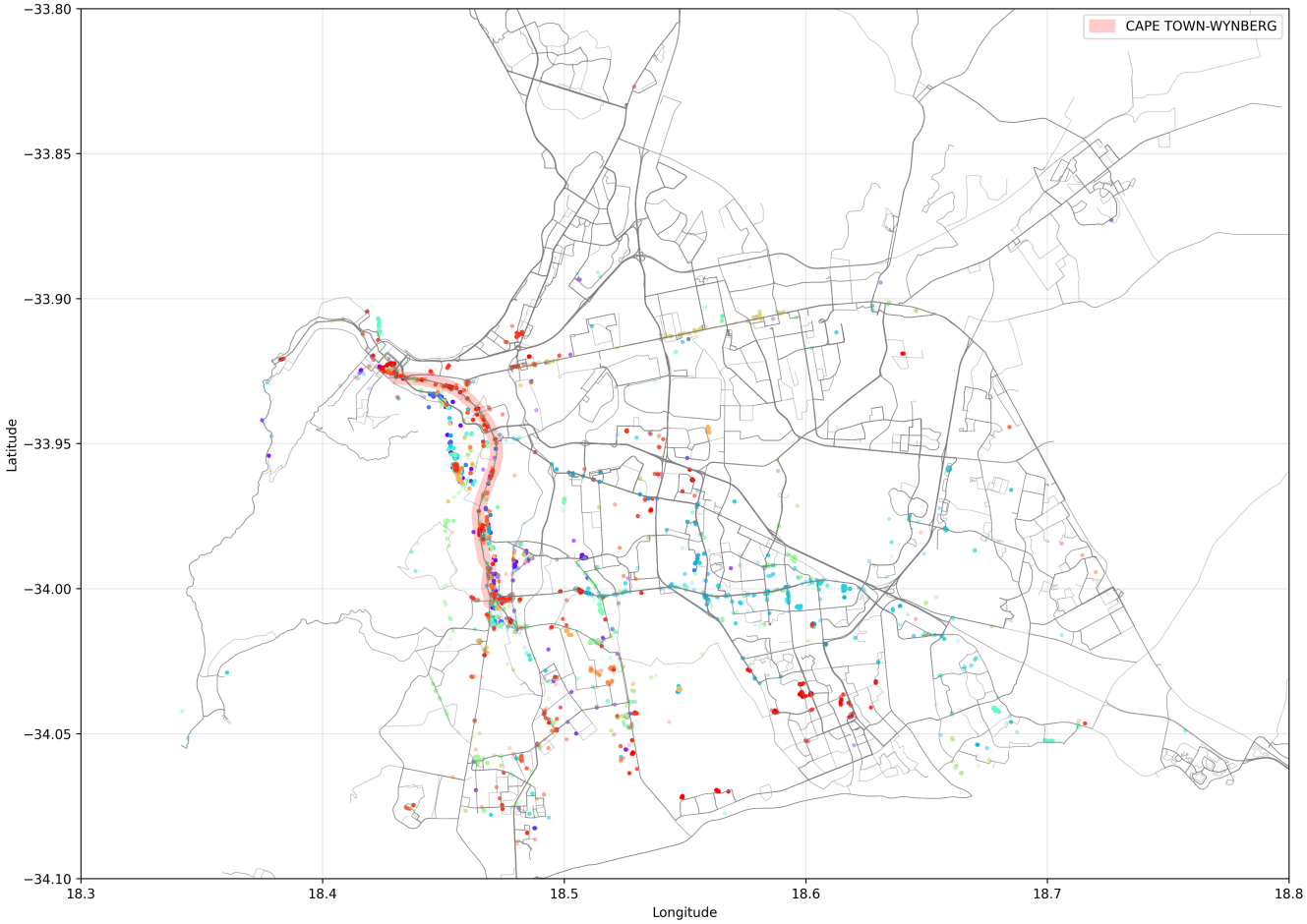
Notes: This table the correlations across the various components with our main outcomes indices.

Table A.2: Other Results on Repayment

	Repayment metrics ...			
	Total Payment	1(Payment in Full)	1(Under Payment)	1(Over Payment)
	(1)	(2)	(3)	(4)
1(interest writedown)	-3,186.882	0.009	-0.002	-0.007
	[2,843.014]	[0.008]	[0.012]	[0.010]
1(payment reduction)	-6,616.986**	0.003	-0.039***	0.036***
	[2,841.116]	[0.008]	[0.013]	[0.011]
Observations	3,186	3,186	3,186	3,186
R-squared	0.026	0.006	0.032	0.029
Control mean	1.2e+05	0.03	0.91	0.06
p-value [IW=PR]	0.21	0.49	0.01	0.00
Strata f.e.	✓	✓	✓	✓

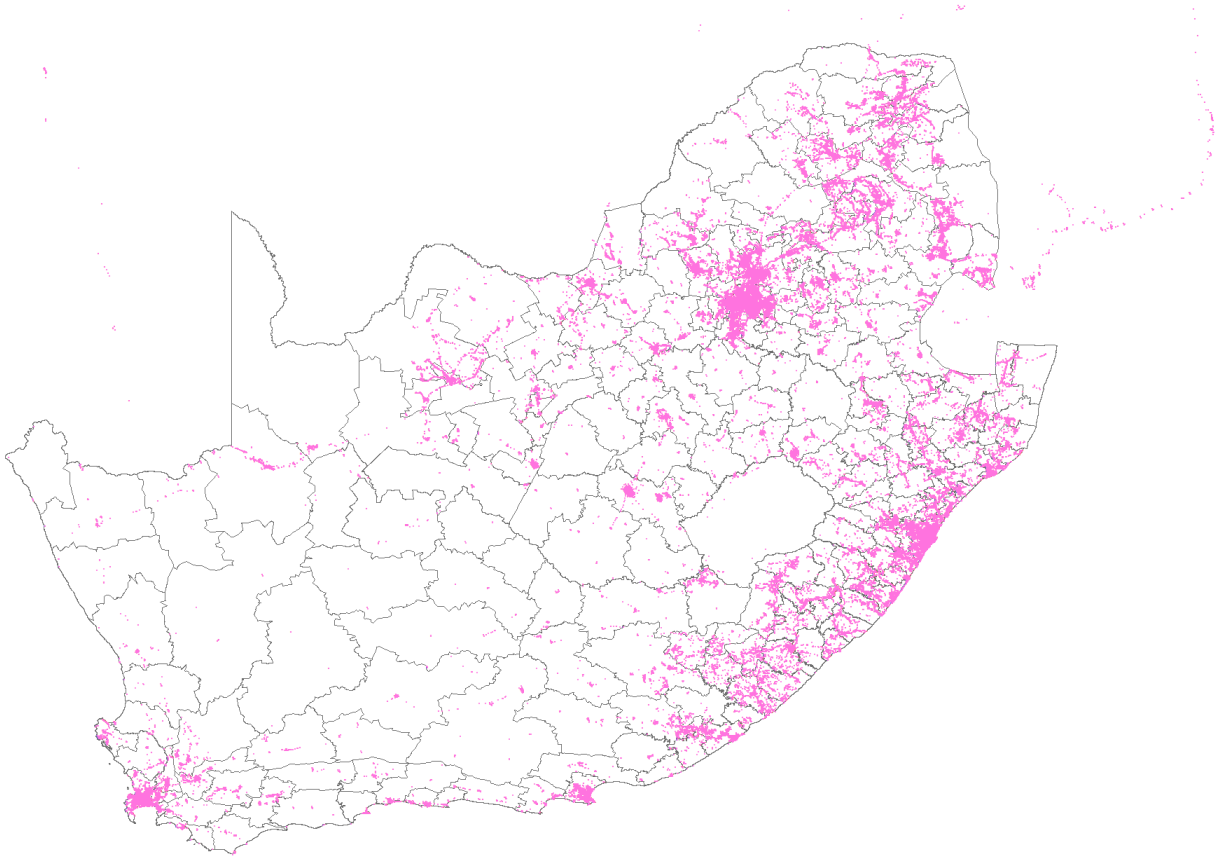
Notes: This table reports the impact on other repayment metrics. All regressions control for randomization strata fixed effects. Standard errors are clustered at the loan account level.

Figure A.2: Example of a minibus route in Cape Town



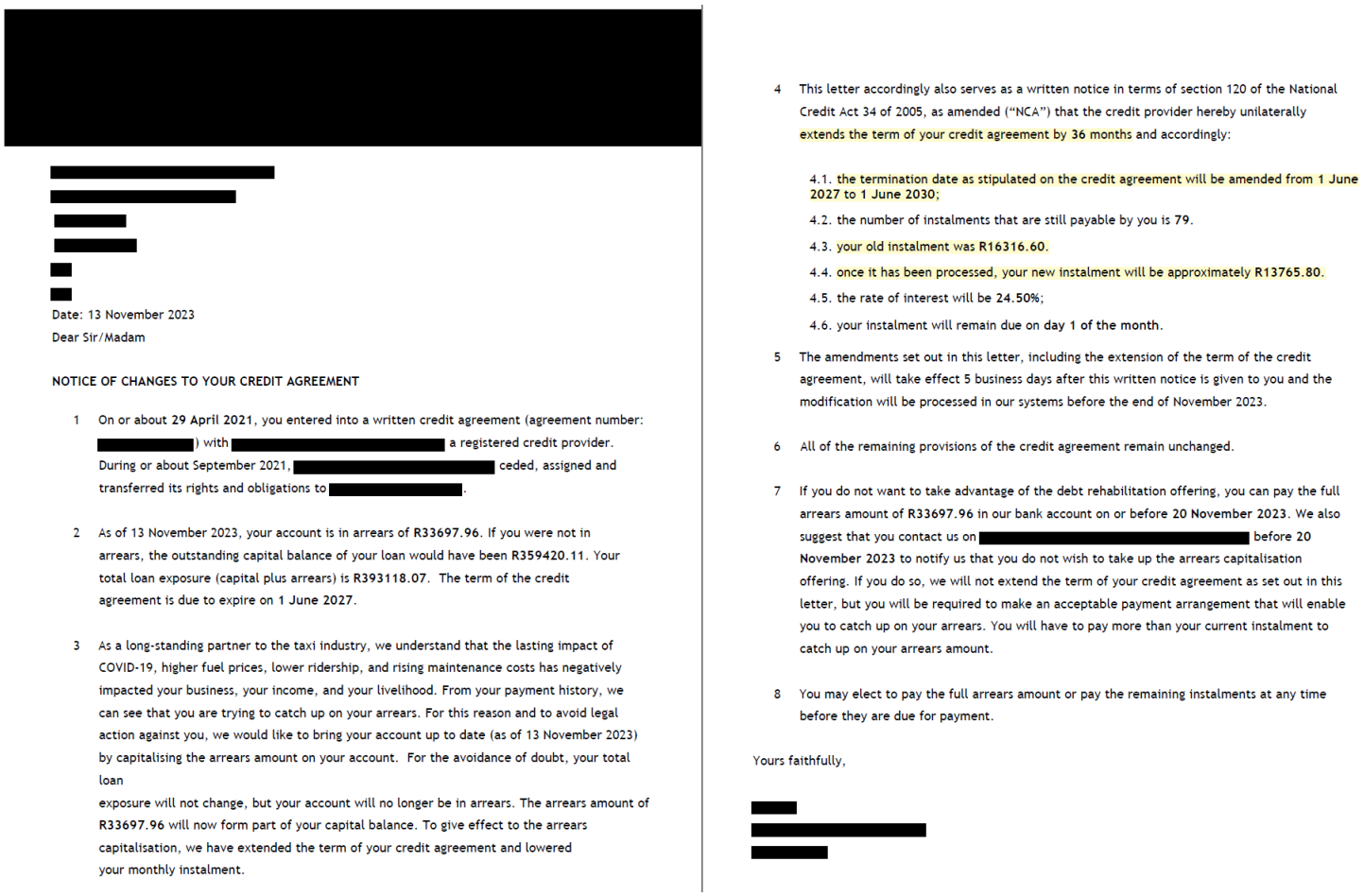
Notes: The gray lines indicates the official routes; the red shaded thick line represents the official route of Cape Town CBD to Wynberg (and back); the dots represents the coordinates of various vehicles determined to operate on the Cape Town CBD - Wynberg Route Jan'24 to Feb'25, with each color of the dot representing a different vehicle (total = 17 vehicles).

Figure A.3: GPS coordinates of all minibus taxis in experiment sample



Notes: The figure shows the municipalities in South Africa. Each dot on the map denotes the geo-coordinates from the GPS data for the accounts in our experiment.

Figure A.4: Modification Communication Example



[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

Date: 13 November 2023

Dear Sir/Madam

NOTICE OF CHANGES TO YOUR CREDIT AGREEMENT

1 On or about **29 April 2021**, you entered into a written credit agreement (agreement number: [redacted]) with [redacted] a registered credit provider. During or about September 2021, [redacted] ceded, assigned and transferred its rights and obligations to [redacted].

2 As of 13 November 2023, your account is in arrears of **R33697.96**. If you were not in arrears, the outstanding capital balance of your loan would have been **R359420.11**. Your total loan exposure (capital plus arrears) is **R393118.07**. The term of the credit agreement is due to expire on **1 June 2027**.

3 As a long-standing partner to the taxi industry, we understand that the lasting impact of COVID-19, higher fuel prices, lower ridership, and rising maintenance costs has negatively impacted your business, your income, and your livelihood. From your payment history, we can see that you are trying to catch up on your arrears. For this reason and to avoid legal action against you, we would like to bring your account up to date (as of 13 November 2023) by capitalising the arrears amount on your account. For the avoidance of doubt, your total loan exposure will not change, but your account will no longer be in arrears. The arrears amount of **R33697.96** will now form part of your capital balance. To give effect to the arrears capitalisation, we have extended the term of your credit agreement and lowered your monthly instalment.

4 This letter accordingly also serves as a written notice in terms of section 120 of the National Credit Act 34 of 2005, as amended ("NCA") that the credit provider hereby unilaterally extends the term of your credit agreement by **36 months** and accordingly:

4.1. the termination date as stipulated on the credit agreement will be amended from **1 June 2027** to **1 June 2030**;

4.2. the number of instalments that are still payable by you is **79**.

4.3. your old instalment was **R16316.60**.

4.4. once it has been processed, your new instalment will be approximately **R13765.80**.

4.5. the rate of interest will be **24.50%**;

4.6. your instalment will remain due on **day 1 of the month**.

5 The amendments set out in this letter, including the extension of the term of the credit agreement, will take effect 5 business days after this written notice is given to you and the modification will be processed in our systems before the end of November 2023.

6 All of the remaining provisions of the credit agreement remain unchanged.

7 If you do not want to take advantage of the debt rehabilitation offering, you can pay the full arrears amount of **R33697.96** in our bank account on or before **20 November 2023**. We also suggest that you contact us on [redacted] before **20 November 2023** to notify us that you do not wish to take up the arrears capitalisation offering. If you do so, we will not extend the term of your credit agreement as set out in this letter, but you will be required to make an acceptable payment arrangement that will enable you to catch up on your arrears. You will have to pay more than your current instalment to catch up on your arrears amount.

8 You may elect to pay the full arrears amount or pay the remaining instalments at any time before they are due for payment.

Yours faithfully,

[redacted]

[redacted]

[redacted]

Notes: This figure shows the letter sent by the lender to the borrower in the experiment sample through messages. The example shows borrower receiving a payment reduction treatment. It provides details on modified payment terms as explained to borrowers in the modification agreement. Example terms are shown for a loan with a post-modification principal balance of R 393,118, payment reduction of R 2,500 (a 15.6 percent reduction), new loan term of 79 months (an extension of 36 months from a loan payoff date from 1 June 2027 to 1 June 2030), and unchanged interest rate of 24.50%. The main changes to the contract are highlighted in yellow by the research team for illustration. The lender name and any personally identifiable information for the borrower has been redacted.