Forbearance vs. Interest Rates:
Tests of Liquidity and Strategic Default Triggers in a Randomized Debt Relief Experiment*

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Abstract

I study debt relief policies in a large-scale field experiment with a unique 2-by-2-by-2 design. I then provide novel tests of models in which default is triggered by solvency, liquidity, and strategic behavior. In contrast to solvency driving decisions, modifications orthogonal to face value affect whether and when to default. Forbearance has no effects beyond expiration, whereas rate reductions have immediate effects that persist. In contrast to liquidity being the sole trigger, reduction in payments has a weak association with default. Forbearance reduces payments twice as much as rate reductions, whereas delinquencies are much more responsive to a rate reduction. Compatible with strategic behavior, news about a dollar increase in future payments increases defaults by as much as a 30-cent increase in current payments. Compatible with the endogeneity of triggers, the efficacy of forbearance and rate reductions, the sensitivity of behavior to current versus future payments—hence whether the default is strategic—is tightly linked to balance sheets. Results are most compatible with the interpretation whereby every default is strategic, with the endogenous trigger being influenced by liquidity and distress. Findings provide a unified explanation for disagreeing results from previous debt relief studies and have implications for modeling the pass-through of interest and the design of loan modifications.

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What triggers default on debt obligations, and what relief policy best prevents it? The answers to these questions have important implications for macroeconomics, finance, and policymaking. In policymaking, the answer guides the targeting and prioritization of commonly used debt relief policies, such as forbearance and rate reductions. In finance, the answer distinguishes between widely used models that emphasize solvency, liquidity, and strategic behavior. In macroeconomics, models that simulate monetary and fiscal policy will only provide accurate predictions if the channels and sizes of effects through which

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relief policies affect behavior are disciplined through credibly identified moments, which have proven difficult to estimate due to the limits of research designs.

In this paper, I report the results of a large-scale field experiment to provide new evidence for this debate. I design a debt relief program at a European bank in Turkey that refinances unsecured borrowers representative of the bank's delinquent population. The design isolates classical solvency constraints by holding constant the face value owed. It then deliberately and randomly provides the most widely used debt relief in a novel 2-by-2-by-2 design. Rate reductions are the primary tool for macroeconomic stabilization: they entail a small reduction in current payments, accompanied by a large reduction in the present value of future payments. Since rate reductions unambiguously benefit the borrower, the design automatically passes through rate reductions for all participants, randomly varying the magnitude of the reduction. Forbearance is the other most commonly used debt relief policy. Full forbearance temporarily postpones the payment of principal, here for 3 months, and entails an immediate, easy-to-implement, front-loaded, large, and targeted reduction in payments, backloading this reduction to future payments one for one. I study this alongside a partial forbearance term extension policy that partially reduces the payment of principal and spreads the payments over time. Since the benefits of postponing payments depend on borrower preferences, in these aspects, the design combines random encouragement with borrower choice. I then use the sharp counterfactuals and randomized shocks to current versus future payments to analyze the qualitative dynamics and quantitative determinants of defaults and provide novel tests of widely used models for why borrowers default.

The current paper provides a unique opportunity to study an unexpected and randomized experiment, analyzed using the language and framework of a randomized control trial. The design complements a large literature that studies defaults (e.g., Karlan and Zinman (2009), Verner and Gyöngyösi (2020)) and debt relief (e.g., Fuster and Willen (2017), Cherry et al. (2021))—as well as recent influential work by Dobbie and Song (2020) and Ganong and Noel (2020) that uses *either-or* designs to study the relative merits of write-downs compared with policies that act on payments.[1] Most importantly, it allows for the direct investigation of important theoretical and policy-relevant questions that cannot be answered using naturally occurring variations or previous research designs.[2] The experiment's internal validity is quite strong and yields surprising and informative results.

I organize the empirical analysis into four subsections. Each section scrutinizes a testable implication of a commonly used default model. I then provide a unifying explanation of what may appear to be mixed and conflicting findings documented in different settings with respect to what triggers default and discuss critical policy implications.

First, I use transparent event studies to analyze the qualitative dynamics of defaults under alternative debt relief policies. In contrast to models in which solvency is the sole driver of borrower decisions (i.e., default if the face value is too high), modifications orthogonal

[1] Similarly, Indarte (2022) and Ganong and Noel (2022) provide evidence that liquidity and Guiso et al. (2013) and Mayer et al. (2014) that strategic considerations drive borrower default decisions.

[2] The experiment abstracts away from intermediation frictions and the endogenous matching of borrowers with particular lenders and contracts. In contrast to previous work, this allows for the identification of causal effects using a purely experimental variation. The experiment is associated with a very strong first stage (F of 7,551 and 2,216 on rates and forbearance; 401 and 2,128 on current and future payments). The bank offered rate reductions and forbearance for the first time; these aspects were not preannounced and likely unanticipated. Due to tightly related regulatory, ethical, targeting, and external validity reasons, the design does not force a borrower into forbearance or a particular term but only encourages them to do so, targeting borrowers most in need while respecting intertemporal preferences.

to the face value and other observable and unobservable determinants of the default decision (e.g., income, wealth, risk, costs of default) have discernible and distinct effects on the borrower's decision whether and when to default. Forbearance take-up prevents one in three defaults in the first month and one in five defaults in the last month before expiration. However, these short-term reductions in payments are repaid with higher payments later, and the effects of the short-term reduction in payments do not extend beyond the expiration as delinquencies increase when payments increase. Hence forbearance only shifts the timing of the default decision. This qualitative pattern is broadly in contrast to the effect of interest rate reductions which occurs immediately and persists in the long run.

Second, I use the first stage and intent-to-treat estimates in superimposition to analyze the association of defaults with the payments borrowers make. Previous *either-or* research designs that test liquidity triggers either reduce payments or don't. The current design varies current payments for similar participants in three ways. This feature allows for a direct confrontation of the association between current payments and delinquencies as predicted by theories that emphasize liquidity. In contrast to liquidity being the sole trigger (i.e., default because payments are too high), the reduction in current payments has an imperfect association with the decision to default. Notably, a dollar change in payments has drastically different effects depending on whether it is delivered through forbearance, term extension, or rate reduction. One striking pattern that motivates further tests is that although offering total forbearance reduces payments twice as much as reducing the interest rate, delinquencies are noticeably more responsive to the interest rate reduction: forbearance would have to reduce current payments by more than three times to obtain an impact on delinquencies similar to that of rate reductions.

Third, I use the experimental assignment as instrumental variables to estimate strategic default triggers in ways the literature has not yet addressed. What distinguishes forbearance and interest rates are their effects on future payments. The experimental variation shifts current and future payments in different directions, which allows for the identification of their relative contributions to borrower decisions. In contrast to work that focuses on face value write-downs, the current design allows for a separation of strategic behavior from solvency. This feature allows for the direct investigation of strategic default triggered by news about (non-callable) future payments, holding constant both face value and accounting for current payments—that is, the unwilling despite being able: solvent *and* liquid. Using unexpected variation also mitigates the identification difficulty whereby borrowers who anticipate default could strategically put themselves in a liquidity problem.

If liquidity is the sole driver of borrower decisions, the second testable implication is that borrowers should behave identically whether the reduction in current payments is accompanied by a dollar increase or decrease in payments tomorrow. In contrast, if the default is triggered by strategic considerations (i.e., default because future payments are too high), news about announced but not yet realized cash flows in the future trigger default. Using both nonparametric and instrumental variables methods, I provide evidence for strategic default. Using the randomized variation in the 2-by-2-by-2 design, I estimate a treatment effect—an identified moment—whereby a dollar increase in future payments causes an increase in defaults as much as a 30-cent change in payments in the current quarter.

Fourth, I scrutinize the empirical implications of endogenous default models by analyzing heterogeneity in the default triggers. Previous work focuses on average treatment effects due either to data limitations (i.e., no data on balance sheets) or research designs (i.e., no variation in balance sheets around the discontinuity that identifies the treatment effects). The current environment and design compensate for these shortcomings and allow for an investigation of mechanisms not yet tested. Although particular frictions differ, all emphasize an inability to substitute intertemporally hampering strategic motives and how borrowers respond to news about future payments—due to kinks or lack of liquid assets, precautionary saving, or financial distress, as in Kaplan and Violante (2014), Campbell and Cocco (2015), and McKay et al. (2016).

Consistent with these models, whether forbearance or interest rate reductions are relatively more effective, the relative sensitivity of behavior to current versus future payments—and hence whether the default is strategic or due to liquidity—are tightly linked to baseline balance sheets. Rate reductions are more effective, behavior more sensitive to future payments, and defaults more strategic for early-cycle delinquencies, borrowers whose constraints bind less frequently, and borrowers with ampler checking balances. Conversely, forbearance is more effective, behavior less sensitive to future payment, and defaults triggered by liquidity for financially distressed borrowers—late-cycle delinquencies—borrowers whose constraints bind more frequently, and borrowers with depleted assets with little leeway in checking balances to perform the intertemporal substitution. In contrast to models that feature simple heterogeneity, future payments and strategic channels remain pronounced for most borrowers, although they are muted compared with the benchmark of fungibility.

I interpret the findings as most compatible with the interpretation that *every default is strategic*, but the location of the strategic trigger is influenced by liquidity and financial distress, as emphasized by Campbell and Cocco (2015).

I conclude by discussing the implications for theory and policy. First, rate reductions are Fisherian revaluation shocks (e.g., akin to inflation and currency depreciation) that also affect behavior through the stock of debt—future payments and strategic channels—as opposed to Keynesian pure liquidity shocks that affect behavior only through current payments. Hence, interest rates get into the cracks that rescheduling policies that act on payments cannot. Forbearance and rate reductions are not substitutable—in the current context, the effects of interest rates through strategic channels provide the same reduction in delinquencies as a deferral program that reduces monthly payments by 5% of average monthly household disposable income. Second, lenders who bear the loss-given-default are incentivized by rate reductions since this is an effective way to increase recovery today by reducing strategic default. Finally, the results also provide a unifying reconciliation of what appears to be conflicting results from previous research. For deeply delinquent borrowers with very high default costs who are unable to substitute intertemporally (e.g., underwater mortgage holders who receive write-downs of long-term obligations, as in Ganong and Noel (2020)), behavior is not sensitive to future payments and liquidity drives borrower decisions—exactly the opposite of the early-cycle debt counseling restructurings of credit card holders who can more likely intertemporally substitute the small face value (e.g., as in Dobbie and Song (2020)).[3]

Layout. The paper proceeds as follows. Section 1 provides a simple conceptual framework to clarify how forbearance and interest rates affect borrower behavior through current payments as well as the present value of future payments, acting on liquidity and strategic default triggers. Section 2 describes the macroeconomic conditions and relevant

[3] Also see Scharlemann and Shore (2016), Eberly and Krishnamurthy (2014), Guren et al. (2018), Campbell et al. (2018), Piskorski and Seru (2018), Agarwal et al. (2017).

institutional features. Section 3 details the experimental design and implementation. Section 4 presents the results. Subsections 4.1, 4.2, 4.3, and 4.4 focus on solvency, liquidity, strategic, and endogenous default triggers. Section 5 concludes by discussing implications for theory and policy.

1 Conceptual Framework

Here, I provide a simple conceptual framework. First, I provide an intuitive approximation of the annuity formula to clarify how forbearance and interest rates affect current and future payments. I then describe statistical tests to distinguish solvency, liquidity, and strategic default.

Consider an intertemporal model in the spirit of Deaton (1991) and Carroll (1997) that incorporates solvency, liquidity, and strategic default constraints, as in Chatterjee et al. (2007), Livshits et al. (2007), or Campbell and Cocco (2015). In such a model, the face value of the principal owed, current payments, and future payments will all affect the borrower's decision to default differently since they capture different aspects of the intertemporal path of payments borrowers face.

The experiment considers unsecured loans with a fixed rate and fixed nominal payments. Hence triggers related to collateral values are ignored. It holds the outstanding face value at origination, henceforth FV_0, constant, and creates independent variation in rate ($R \downarrow$), term ($T \uparrow$), and forbearance (F). One way to think about how these modifications affect current payments is to consider the Taylor approximation of the annuity formula for constant amortizing payments,

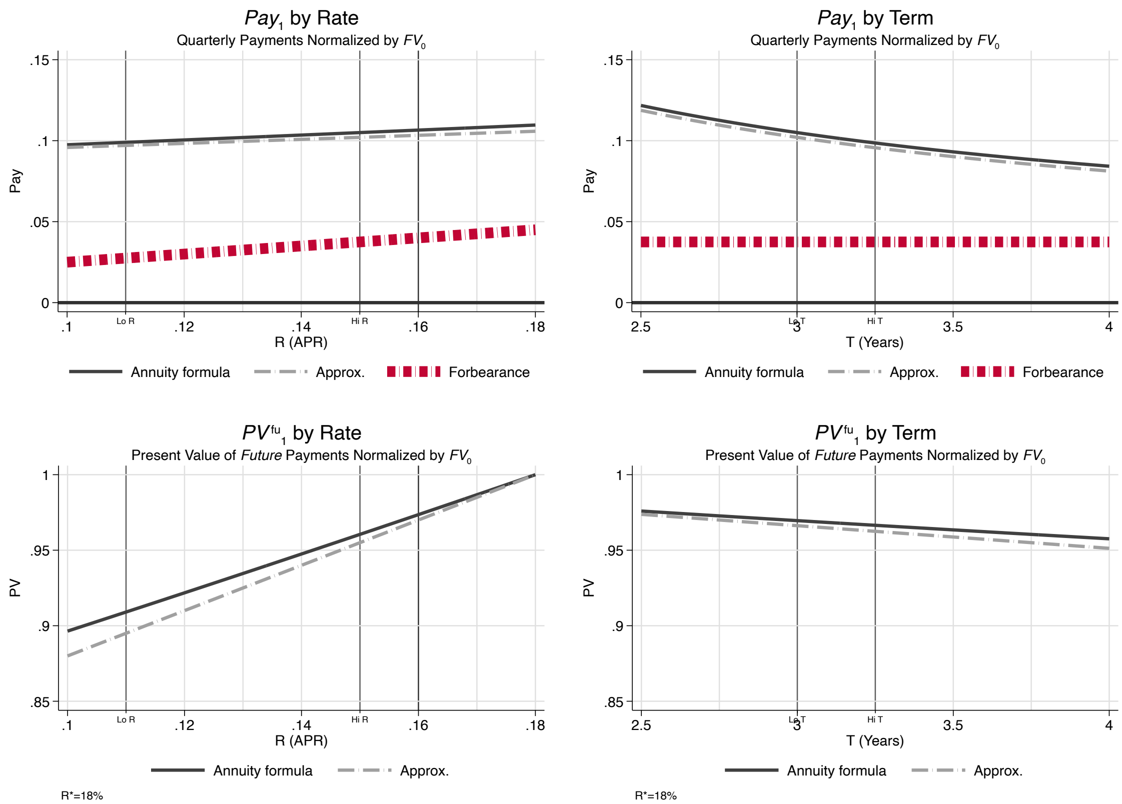
$$\begin{aligned} \text{Payment} &= FV_0 \left(\frac{1}{T} + \frac{R}{2} + \frac{R}{2T} + \frac{R^2 T}{12} - \frac{R^2}{12T} + O(R^3) \right) \\ Pay &\simeq \left(\frac{1}{T} + \frac{R}{2} \right) \end{aligned} \tag{1}$$

Henceforth Pay denotes current payments normalized by FV_0. This formula gives the relative contributions of interest and amortizing principal to payments. R has a linear effect on Pay, while T has a $\frac{1}{T}$ effect. In the current setting, the typical R is about 16% APR or 4% per quarter. The typical T is about 3 years or 12 quarters. This gives quarterly Pay of $\frac{1}{12} + \frac{4\%}{2} \simeq 10\%$ of FV_0.

Any modification affects payments. However, the relative sensitivity of payments is very skewed in favor of forbearance and much less on the interest rate. Forbearance suspends the payment of principal, keeps the term constant, and reduces Pay by 60%, from 10% to the quarterly interest rate of 4%. In contrast, a 4pp APR reduction in the interest rate (a 25% reduction off a base of 16% APR) reduces Pay by about 5%; and a 10% increase in T' (off a base of 3 years) reduces payments by about 7%. Figure 1 shows these effects.

What determines the relative merits of these policies is the effects on future payments. Suppose the borrower is discounting future payments at a discount rate R^*, in order to calculate a present value to undertake meaningful comparisons of current versus future payments. The Taylor approximation of the present value at t=0, the time of origination, is

Figure 1: Effect of Rate, Term, and Forbearance on Current and Future Payments



Note. Top panels plot Pay, current payments, using the annuity formula and the approximation in Equation 1. Bottom panels plot PV^{fu}, the present value of future payments, using the annuity formula and the approximation in Equation 2. Panels on the left hold term constant at $T = 3$ years and vary the interest rate. Panels on the right hold the interest rate constant at the high rate of $R = 15\%$ and vary the contract term.

given by

$$\text{Present Value}_0 = \text{Payment}\left(T - \frac{R^*\,T}{2} - \frac{R^*\,T^2}{2} + O(R^{*2})\right)$$
$$PV_0 \simeq \left(1 + (R - R^*)\,\frac{T+1}{2}\right) \qquad (2)$$

where the second line follows from substituting approximation (1) as Payment. Figure 1 shows these effects on PV_t^{fu}, henceforth denoting the present value of *future* payments coming *after* t, normalized by FV_0 and assuming an R^* of 18% APR.[4]

Rate reductions alter the present value of payments—the true cost of debt—despite

[4]One approach is to use the inflation rate and compare real dollar terms, which allows measurement of an increase in future payments that is equivalent to a $1 today in real terms. See real capital value in the terminology of Campbell and Cocco (2003). Another approach is to use R^* as the borrower's marginal funding cost. If the borrower can transfer resources across time at a rate of R^*, a dollar increase in current payments or the present value of future payments would lead to the *same budget constraint*, the same feasible set, hence the same set of optimal decisions. A third approach is to interpret R^* as a subjective discount rate directly tied to time preference and the marginal utility of consumption, as well as today's and tomorrow's aggregate state. In models with borrowing constraints, R^* also incorporates the shadow cost of the constraint. By arbitrage, the cost of marginal funding bounds R^* above. Interpreting R^* as a subjective discount rate allows for a measurement of present value equivalents across time, e.g., an increase in future payments in which the borrower is indifferent to a $1 increase in Pay.

keeping face value constant, which unambiguously benefits the borrower. Notably, the effects on future payments account for more or less the entire impact of interest rate changes. Hence, rate reductions are effective if households are sensitive to either current payments or future payments. Assuming a contract term of $T = 3$ years, a rate reduction ΔR of 4pp APR reduces total future payments as much as a write-down of $\frac{1}{2} \cdot T \cdot \Delta R$= 6% of FV_0.

The reduction in the payment stream due to the rate reduction could be replicated via a face value write-down. Borrowers would see an identical effect in both scenarios but with different compositions of principal and interest. However, unlike a write-down, borrowers cannot capitalize on present value effects by prepaying or calling the loan at face value. To a first-order approximation, the change through R in the present value of future payments is independent of R^*. The revaluation effect is proportional for current and future payments and hence is larger if the debt has a high duration, i.e., T is large.

In contrast, forbearance only alters the timing of payments, backloading the reduction in current payments one-for-one to future payments. Hence, forbearance is effective if households are more sensitive to current payments than future payments. Rescheduling through term extensions spreads out payments further over time.

Unlike rate reductions, forbearance and term extensions are not attractive to everyone. A reduction in payments through the term T has an ambiguous effect on the present value of future payments that depends on the path of $R - R^*$. In the knife-edge scenario $R^* \simeq R$ term extensions will not affect the present value of future payments; otherwise, the effect will be proportional to $\frac{1}{2} \cdot T \cdot (R - R^*)$.

Table 1: Competing Models

Model	What triggers default?			What reduces default?			Policy
	FV	Pay	PV^{fu}	$R\downarrow$	$T\uparrow$	F	
Solvency	✓						Write-down
Liquidity		✓		✓	✓	✓	Forbearance
Strategic			✓	✓			Rate reduction
Endogenous	✓	✓	✓	✓	✓	✓	Heterogeneous

Note. FV, Pay, and PV^{fu} stand for face value, current payments, and present value of future payments. $R\downarrow$, $T\uparrow$, and F stand for rate reductions, term extensions, and forbearance.

This leads to four models in Table 1 that are distinguished by the default trigger.

- *Solvency.* At one extreme is a classical frictionless model which emphasizes what is on the balance sheet: the borrower defaults because assets exceed liabilities, hence if the face value is too high. This model is obtained under no borrowing constraints and R^*=R; i.e., the borrower's discount rate equals the interest rate on debt. In this model, when the interest rate decreases payments also decrease, although their present value does not. The testable prediction is that changing the interest rate or the schedule of payments should not affect borrower behavior. The policy implication is that only face-value write-downs provide relief.

- *Liquidity.* At the other extreme are alternatives in which the default decision is driven only by liquidity. There is no commonly adopted definition of liquidity, which is often used interchangeably with cash flow, periodic debt service, affordability, and short-run obligations. Here, liquidity is defined as current payments—the borrower defaults because current payments are too high. For example, the borrower could have an affordability constraint and default if and only if current payments are higher than her income. Alternatively, the borrower could be extremely impatient or myopic, or may not be able to intertemporally substitute (i.e., $R^* = \infty$). The testable predictions are that the reduction in current payments determines efficacy; and beyond current payments, future payments are irrelevant. Every modification reduces payments, with forbearance reducing the most and interest rates reducing the least. Hence, forbearance will be the most effective, and rate reductions the least so.

- *Strategic.* The third class of model is one in which the default decision is driven by factors beyond solvency or liquidity. In this model, borrowers weigh the costs and benefits of default (e.g., drop in credit score and access, stigma, moral factors, recourse, postponing or preventing repayment) and trade these costs off the present value of future payments. These defaults are forward-looking and strategic; since they are independent of the amount owed and affordability, but due to news about future payments. This captures the able but won't pay—borrowers will stop making payments when it is an advantageous financial decision, even if solvent and liquid, i.e., can afford payments. The testable prediction is that beyond current payments, news about non-callable higher future payments leads to immediate changes. The policy implication is that rate reductions will be the most effective due to the large effects on future payments through strategic channels that cannot be replicated using forbearance policies.

- *Endogenous.* The final class of model is one in which whether the default is triggered by solvency, liquidity, or strategic considerations is endogenous. Although particulars differ, such models emphasize the inability to intertemporally substitute and borrow against future income leading to an inability to respond to news about future payments. In this case, the entire intertemporal path of future payments will matter for the default decision, even when liquidity is scarce, but current payments will matter most. The testable prediction is that the endogenous trigger will be heterogenous by assets, precaution, or distress, as in Campbell and Cocco (2015), McKay et al. (2016), and Kaplan and Violante (2014), respectively.

Using the experiment to create random variation in current payments versus future payments through forbearance and rate reductions to estimate average and heterogeneous treatment effects allows me to measure channels and sizes of effects through which relief policies affect behavior and characterize the shape of the default triggers to distinguish these alternative models.

2 Environment and Institutional Details

I first provide an overview of the macroeconomic conditions and relevant institutional details (e.g., unsecured loan market, consumer bankruptcy, distressed debt refinancing).

Macroeconomic Environment. The experiment was conducted, and delinquent participants were refinanced, between June 2017 and July 2018; see Figure A.1. Refinanced contracts are followed up for 15 months. In terms of broad economic conditions, the economy expanded from 2017 through 2019, except for declines in seasonally adjusted quarter-on-quarter GDP in 2018:II, 2018:III, and 2018:IV. At the onset, the annual inflation rate (CPI) was about 11%, and 4% of the aggregate face value of households was in nonperforming status. See Figure A.2 for aggregate credit and nonperforming credit growth, and Table A.2 for macroeconomic variables.

The effectiveness of various debt relief options may depend on the type of shock experienced by the economy. The macroeconomic conditions that led to these delinquencies are neither the depression type (e.g., as in the Great Recession in the U.S.—a prolonged and severe slump caused by the bursting of a housing bubble, with a lengthy recovery in both the housing and labor markets) nor the transitory type (e.g., a short-lived recession due to temporary banking liquidity or an emerging market shock, associated with short-term layoffs and disruptions in receivables). Unlike what is common in financial crises (e.g., aggressive lending, bad regulation of intermediaries, and bad central bank policy), nothing in this period suggests that banks or the government are immediately culpable. Hence the delinquencies considered here are best characterized as idiosyncratic.[5]

Unsecured Loans. The unsecured loans studied here feature fixed interest rates, terms of up to 72 months, and fixed nominal payments in local currency. These loans account for two-thirds of the total non-mortgage FV outstanding to the household sector. At initial underwriting, borrowers first declare their education level, employment title, and monthly disposable income. They then state the amount they would like to borrow and choose a contract term. Home improvements, emergency expenses, or large purchases are common reasons. Underwriting features little discretion, and evaluation is based on credit and in-house risk scores. For borrowers who can access personal loans, equilibrium credit terms vary only to a small extent with borrower risk, with only a 260 bps APR difference in interest rates between the 10th and 90th percentiles. Customers always have the free option to prepay the loan at face value.

Delinquencies. If a borrower is late on a debt payment, the bank will follow up via text messages and phone calls. Thirty days overdue will appear on the credit report. A preliminary notice is sent after two subsequent payments are overdue. Ninety days past due gives the bank right to take legal action and report nonperforming status to the credit bureau. The contract is kept in collections, often for about 90 additional days, during which the bank attempts recovery through customer contact. Suppose the borrower does not come forward with a definite plan to repay. In that case, the lender can opt for legal proceedings and sue the borrower for the loan balance plus penalties, interest due up to 30% of face value, collection costs, and legal fees. The default flag remains on the borrowers' credit history for 5 years and obstructs access to credit.

Collections. Turkey lacks a personal bankruptcy option. Moreover, the recourse loans considered here allow the lender to pursue claims on the assets of a borrower who defaults. Thus, debtors are on the hook for the loan balance regardless of whether they stop making payments. Unpaid debts are collected through an onerous and arduous process that can entail garnishment, guarantors, and sequestration. At enforcement proceedings, recovery is made through confiscating cash and other liquid assets, wage garnishing up to 25% of net income, and then confiscation of durables and real estate. If there is a guarantor, she shares all the responsibility if the debtor cannot repay: her labor income could be garnished and durables or real estate confiscated or sequestrated. This process usually takes 2 to 3 years. Hence, default postpones repayment for the typical borrower. For an unemployed borrower with no leviable bank account or confiscatable illiquid assets, recovery is not possible. Hence, default prevents recovery from some borrowers. The bank could sell the bad debt to a collection agency. There is no immediate imprisonment for a debtor who cannot pay. However, a debtor in legal proceedings who has not declared the full extent

[5] Anecdotal evidence, including refinancing phone calls, suggests that some borrowers either fell into unemployment or have temporary problems with businesses or receivables; others acknowledge that they borrowed too much.

of garnishable income or confiscatable property or made a commitment to pay the debts and failed to do so without a justifiable reason could face imprisonment for up to 3 months upon request of the creditor.

Refinancing. The market features widespread refinancing of distressed unsecured debt directly by the lender of the delinquent loan. Banks contact delinquent borrowers through an in-house call center to work out a plan for the customer to continue making debt repayments. Banks predominantly refinance borrowers for whom it is the sole creditor. These modifications are one-time. Lenders have the capability to facilitate loan modifications, such as in-house call centers to reach out to delinquent borrowers and analytics teams that optimize the refinancing process. I describe the restructuring process in detail in Section 3.

Table 2: Summary Statistics

	Unit	N	mean	s.d.	$p10$	$p50$	$p90$
Demographics							
Age	Years	20,944	38.0	9.8	26	37	52
Metro area (1m+)		20,944	0.23	0.42	0	0	1
Delinquent loan							
Loans (Consolidated)	Count	20,944	1.25	0.53	1	1	2
FV (Original)	TRY	20,944	15,281	11,172	4,546	12,298	29,081
FV (Remaining)	TRY	20,944	10,403	8,980	2,480	7,728	21,639
R	APR, %	20,944	16.3	1.1	14.8	16.4	17.4
T (Original)	Months	20,944	36.8	7.7	24	36	48
T (Remaining)	Months	20,944	23.9	11.9	10	21	43
Payment	TRY	20,944	531	375	176	434	959
Pay	% of FV	20,944	6.4	3.4	3.0	5.6	11.2
New loan							
FV_0	TRY	20,944	10,403	8,980	2,480	7,728	21,640
R'	APR, %	20,944	13.0	2.6	9.6	13.2	16.5
T'	Months	20,944	41.3	14.9	18	48	61
Forbearance (Take-up)	%	7,308	32.8	46.9	0	0	100
Payment	TRY	20,944	306	255	77	238	617
Pay	% of FV	20,944	3.3	1.6	1.5	3.0	5.6
Balance sheet							
30+		20,944	0.89	0.31	0	1	1
90+		20,944	0.30	0.46	0	0	1
Assets (Checking)	TRY	18,715	-1,022	1,778	-2,400	-792	0
Limit (Credit Line)	TRY	18,112	5,163	8,169	650	2,750	10,800
Debt (Credit Line)	TRY	18,112	4,173	8,252	0	1,653	9,890

3 Experimental Design

For the field experiment, I collaborated with a large European retail bank in Turkey.[6] The experiment provides randomized debt relief in a 2-by-2-by-2 design for borrowers who are representative of the delinquent pool. The controlled trial is conducted to understand borrower behavior in response forbearance and rate reductions. Holding constant the face value of the amount owed, the experiment refinances the old delinquent loan with a new loan. The design automatically reduces the interest rate for every participant, which

[6]The bank has a customer base that is representative of the local banked population. In addition to unsecured loans, it offers many financial products, including credit lines, checking, savings, overdraft accounts, and mortgages.

every participant strictly prefers, but deliberately varies the magnitude of the reduction by experimental assignment. The design also reschedules payments through term extensions and forbearance in a manner that combines random encouragement with borrower choice, since these decisions depend on borrower preferences. Here, I briefly describe the core features of the experiment.

3.1 Selection

Participants are preexisting borrowers who hold an unsecured loan in arrears. These borrowers are all overdue on payments and have been nudged by the bank via text messages and phone calls. One month before the refinancing, 90% are in 30+, and 30% are already in 90+ status. These participants have not previously been modified. The sample is representative of the bank's delinquent pool. The only exception is the exclusion of loans with less than 6 months remaining. Hence, participants represent a population of interest in understanding the efficacy of various forms of debt relief.

Table 2 displays summary statistics. The unit of measurement for nominal variables is the local currency, TRY. The average borrower's age is 38; the average interest rate is 16.3% APR; the average face value refinanced is about 10,000 TRY. 20% of the participants consolidate multiple loans, with 5% consolidating three. The average monthly payment is about 500 TRY. 89% of the participants have access to a checking account. Almost all participants borrow into overdraft on these checking accounts and hold negative net liquid assets, with a median checking balance of -792 TRY. 86% have access to a credit line facility. The regulatory authority caps the interest rate on credit lines or checking-linked overdraft accounts at 24% APR. This state-mandated maximum is binding for virtually all customers.

3.2 Randomization

Participants are assigned to 8 treatment legs in a 2-by-2-by-2 design. First, participants are stratified into nonoverlapping and exhaustive bins by face value and days late. Second, three random numbers—to determine the interest rate (R), the term (T), and forbearance (F)—are drawn for each participant. Third, if the random number is above a specific threshold, a participant is assigned a *high* relief designation for a particular contract feature. I denote these assignment $\mathbb{Z}_i^R$, $\mathbb{Z}_i^T$, and $\mathbb{Z}_i^F$. The threshold equals 0.5 for rate and term and 0.65 for relief. Hence, half of the participants are allocated to high vs. low legs for interest rate and term, and about one-third are offered forbearance.

3.3 Balance

This procedure gives three randomized variables for econometric evaluation, $\mathbb{Z}_i^R$, $\mathbb{Z}_i^T$, and $\mathbb{Z}_i^F$. I provide formal statistical tests for covariate balance across treatment legs using simple regressions of the form:

$$Y_i = \alpha + \gamma^R \mathbb{Z}_i^R + \gamma^T \mathbb{Z}_i^T + \gamma^F \mathbb{Z}_i^F + \epsilon_i \qquad (3)$$

Table 3 reports the results of regressions of old contract terms and customer demographic variables on the three instruments $\mathbb{Z}_i^R$, $\mathbb{Z}_i^T$, and $\mathbb{Z}_i^F$, as well as a constant term, and asks whether economically meaningful or statistically significant pre-experiment differences exist across customers in different treatment legs. The F-tests check whether covariates display statistically significant differences across the legs and do not find a statistically significant difference.

Similarly, Figure 2 displays visual evidence on dynamic pre-trends. Participants, on average, appear to exhaust checking assets before refinancing. However, there are no statistically significant differences across different treatment legs in checking assets or credit line limits.

Appendix Figure A.3 displays the kernel densities for face value at origination and monthly payments. These tables and figures show that the final assignment to high/low treatments is orthogonal to pre-experiment characteristics and the likely determinants of the default decision. Different treatment legs have statistically indistinguishable covariates before the experiment.

Table 3: Covariate Balance

		Age Years	Loans Consol. Count	FV Org. TRY	FV_0 Rem. TRY	R Org. APR, %	T Org. Months	Payment Org. TRY	Pay Org. Nm	30+ %	90+ %
	$\mathbb{Z}^R$	- 0.22 (0.13)	- 0.0002 (0.007)	- 22 (155)	34 (124)	0.003 (0.02)	0.08 (0.11)	- 1.2 (5.2)	- 0.08 (0.05)	-0.82 (0.43)	-0.31 (0.64)
	$\mathbb{Z}^T$	- 0.07 (0.13)	- 0.01 (0.007)	-3 (154)	105 (124)	0.01 (0.02)	-0.11 (0.11)	0.4 (5.2)	- 0.05 (0.05)	-0.10 (0.43)	0.67 (0.64)
	$\mathbb{Z}^F$	- 0.02 (0.14)	- 0.009 (0.008)	172 (162)	170 (130)	- 0.02 (0.02)	0.06 (0.11)	5.5 (5.4)	- 0.02 (0.05)	0.45 (0.45)	-0.03 (0.67)
Cons.		38.1 (0.13)	1.26 (0.007)	15,234 (147)	10,274 (118)	16.3 (0.02)	36.8 (0.10)	530 (4.9)	6.5 (0.05)	89.6 (0.41)	30.3 (0.60)
	N	20,944	20,944	20,944	20,944	20,944	20,944	20,944	20,944	20,944	20,944
F	p	0.40	0.33	0.77	0.48	0.60	0.58	0.78	0.28	0.19	0.72
K-S	$\mathbb{Z}^R$	0.41	1	0.59	0.46	0.92	0.91	0.74	0.18	0.88	1
	$\mathbb{Z}^T$	1	0.98	0.27	0.56	0.65	0.33	0.67	0.22	1	0.97
	$\mathbb{Z}^F$	0.77	1	0.20	0.11	0.94	1	0.12	0.41	1	1

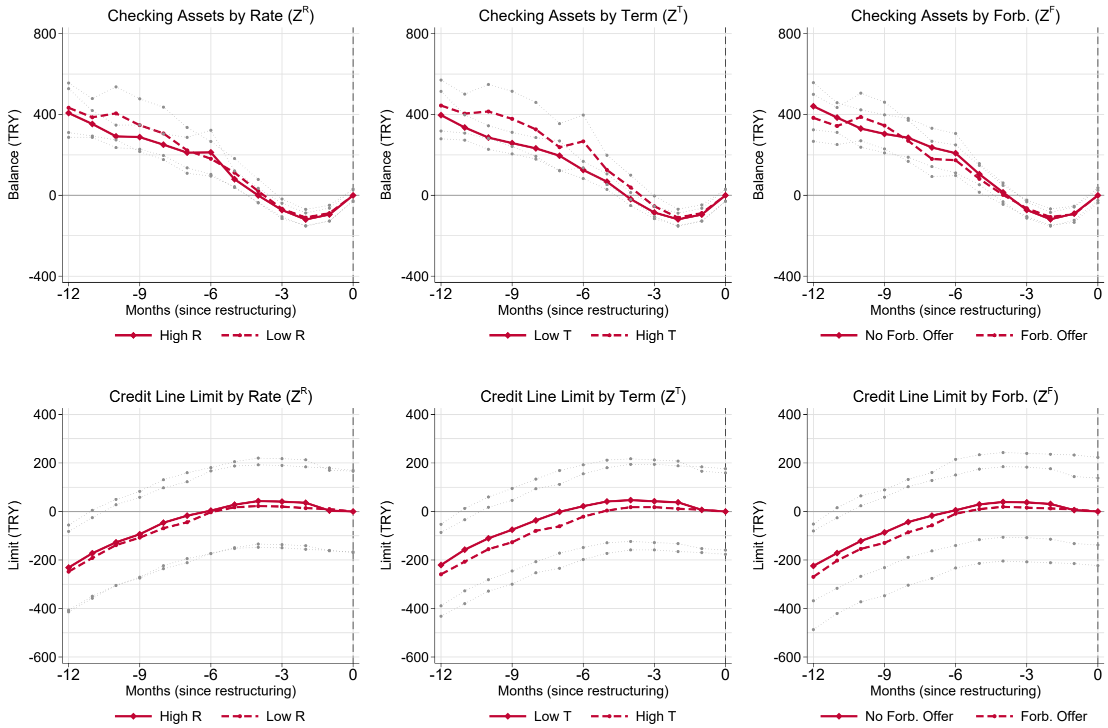
Note. Estimated coefficients from Equation 3, based on pre-experiment values. F-test p-value for the null that coefficient estimates θ^k are jointly equal to zero. Kolmogorov-Smirnov p-values for the equality of distributions by $\mathbb{Z}^R$, $\mathbb{Z}^T$ and $\mathbb{Z}^F$.

3.4 Assignment of Interest Rates, Term, and Forbearance

The three randomized dummy variables $\mathbb{Z}_i^R$, $\mathbb{Z}_i^T$, and $\mathbb{Z}_i^F$ determine the borrower's refinanced interest rate R', term offer T^{offer}, and forbearance offer.

Interest rates. The new contract features an interest rate reduction to $R' < R$. This rate is *not* negotiable and cannot be changed. This reduction is off a market rate that reflects conditions at the time of refinancing. In the study's timeframe, the market rate is, for the most part, lower than the old contract rate. Based on this market rate, participants with $\mathbb{Z}_i^R = 0$ are assigned to 60 bps, and borrowers with $\mathbb{Z}_i^R = 1$ to 540 bps APR rate reduction. If the assigned interest rate is below a minimum $\underline{R}$, roughly equal to the inflation rate, I set $R' = \underline{R}$. Hence, the rate reduction, up to 480 bps APR, is quantitatively large and a discernible change. The magnitude of the interest rate reduction conditional on the experimental assignment is not randomized. Naturally, borrowers with high preexisting interest rates receive higher rate reductions. The analysis will restrict the amount of variation used to only what is random: the assignment $\mathbb{Z}_i^R$.

Figure 2: Covariate Balance: Dynamic Pre-trends



Note. Figures plot group averages separately by $\mathbb{Z}^R$, $\mathbb{Z}^T$, and $\mathbb{Z}^F$. The x-axis indicates event time—months relative to refinancing—and t=0 corresponds to the month of refinancing. Dashed lines indicate 95% confidence intervals for the estimate of the mean.

Term. Borrowers are not constrained in the new contract term, T′. The experiment features an individualized term extension *offer*, $T^{\text{offer}} > T$, a recommendation made by the bank representative. Customers are grouped into grids of width 12 with respect to the remaining term T in months. Borrowers with less than 12 months remaining would be placed in the 12-month bin, borrowers with 13 to 24 months remaining would be placed in the 24-month bin, and so on. Name these bins with the largest element in each bin $\bar{T}_k$. The term extension offer T^{offer} is $\bar{T}_k$ times 150% to participants with $\mathbb{Z}_i^T$=0, and $\bar{T}_k$ times 200% to participants with $\mathbb{Z}_i^T$=1.

Forbearance. Borrowers with $\mathbb{Z}_i^F$=1 are *offered* forbearance. The current design suspends and postpones the payment of the principal for 3 months, keeping the term constant, and backloading the costs of the program. In contrast to *deferment*, forbearance is not free: as the borrower is responsible for the interest that accrues, forbearance increases total payments. For participants who take up forbearance, payments in the first quarter equal the interest on the principal, and amortizing payments start 4 months after refinancing.

Refinancing call. In a *typical* refinancing call, the bank contacts delinquent borrowers through an in-house call center to work out a plan for the customer to continue making debt repayments. During the call, bank employees follow a standard script. The borrower is asked about the nature of the financial distress but does not have to provide proof of hardship. The employee sees customer demographic information and information on the delinquent loan, as well as the interest rate R' and a term choice screen. The one-size-fits-all interest rate schedule is *not* negotiable and cannot be changed. The borrower is asked how much she can afford to pay each month, and is flexible in the choice of term up to $\bar{T}$. The employee then reviews the new contract and conditions and states the monthly payments and the total sum of payments. The contract is forwarded for processing if the customer accepts the new terms.

The experimental refinancing process is identical to the typical one, except for previously unavailable individually tailored interest rates, term recommendations, and the novel forbearance schedule. The individualized interest rate R' is not negotiable and cannot be changed. Under the new screen designed for the experiment, the default entry in the dropdown box is T^{offer}, with a text tag *recommended* next to it. The loan officer *encourages* the borrower toward this number. Borrowers can pick any term, including those shorter or longer than the offer T^{offer} or the remaining term on the delinquent contract.

The forbearance offer pops up for customers with $\mathbb{Z}^F = 1$ after the interest rate R' is observed and contract term T' is chosen, but before the new contract is finalized. If the customer is not offered forbearance—i.e., $\mathbb{Z}_i^F = 0$—then FV, R', and the negotiated contract term T' determine periodic payments by the annuity formula. If the customer is offered forbearance—i.e., $\mathbb{Z}_i^F = 1$—the loan officer sees a pop-up screen after the borrower and the bank representative agree on the contract term. The customer then has the option to either accept or reject the forbearance offer. If the customer rejects the forbearance offer, the payment schedule is determined by the annuity formula for $\mathbb{Z}_i^F = 0$. If the customer accepts the forbearance offer, payments in the first 3 months equal the interest on the principal only, and payments starting in month t=4 are determined by the annuity formula, given FV, $T' - 3$, and R'.

Information, anticipation, and effects on other margins. Before the controlled trial, the bank regularly offered loan modifications to delinquent borrowers. However, these modifications did not include interest rate reductions (borrowers were always given the market rate) or forbearance. Therefore, customers may anticipate the refinancing. Nevertheless, the interest rate and forbearance variation—the main levers that create variation in current and future payments—can be considered unanticipated. For the aspects of the experiment that could be anticipated, randomization ensures that treatment and control groups have similar expectations, at least until the refinancing. Using unexpected variation also mitigates the identification difficulty that borrowers who anticipate default could strategically put themselves in a liquidity problem. Importantly, there is no explicit participation choice and no lack of blinding, which ensures that participants are unaware that they are participating in a controlled trial.

The experiment is also designed to control for confounding factors and potential effects on other margins. Refinancing a loan does not trigger a flag on the credit bureau. Penalties for defaulting are not heterogeneous across different treatments. Features of other credit contracts, such as the limits and borrowing rates on credit cards and overdrafts, remain unchanged. The intervention also ensures that face value, monthly payments, and the total stream of payments, assuming no discounting, are communicated to participants in a salient manner, both verbally and in writing, to overcome any difficulty whereby borrowers find it challenging to discount future cash flows and calculate a present value. Moreover, contract features are not conditional on borrower behavior, such as the borrower's success in making some payments, and abstracts away from strategic behavior in this regard.

Why a design that unambiguously benefits the borrower? Due to ethical and regulatory considerations, the current experiment is designed to benefit participants compared with the status quo. Rate reductions entail a reduction in both current and future payments, unambiguously benefiting the borrower. Hence, the experiment pushes rate reductions for everyone, randomly varying the magnitude of rate reduction by experimental assignment. In contrast, the benefits of term extensions and forbearance depend on borrower preferences. Therefore, the experiment does not force participants into forbearance or a particular term. Instead, the design combines random encouragement with borrower choice. This approach of not forcing forbearance or term upon the borrower is due to operational and legal views. It also has two additional benefits. First, better targeting: forbearance or term is taken up by those who need it the most. Second, better external validity: in the wild, borrowers are almost never dictated a term and are free to take up forbearance. So the experiment does not create an artificial margin.

3.5 Data

The following analysis uses data on loan contracts before and after the refinancing, including contract terms (e.g., rate, term, face value, payments) and borrower behavior, such as the date the new loan reached 30+ or 90+ days late status. The former captures arrears and the latter captures defaults. The data also contain information on borrower balance sheets at the bank—credit card limits, checking assets-overdraft debt, and indicators for whether the borrower is delinquent on any other accounts at the bank. Unfortunately, there is no information on borrower incomes. Delinquency and balances are measured on the last day of the calendar month.

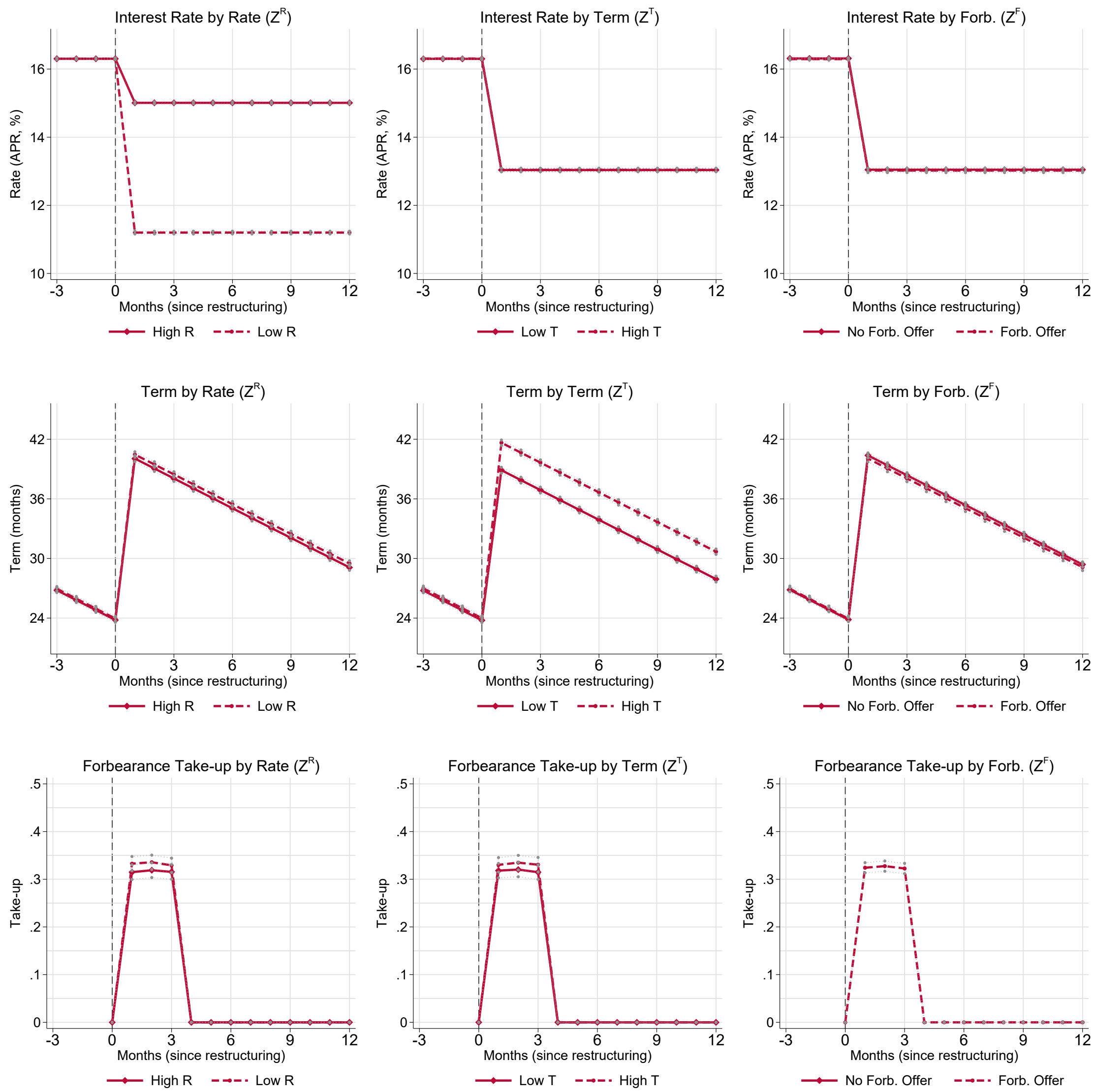
The analysis is based on the 15-month timeframe after refinancing. Hence, participants are followed for 12 months after the expiration of the forbearance. The data are monthly, and the unit of analysis is an individual. For participants who had consolidated multiple loans, accounts are matched, and variables aggregated using a unique citizenship number, then verified using a customer identification number, ensuring perfect match quality.

Table 4: First Stage Effects on Contract Terms

	R' APR, %	T' Months	F' Take-up, %	F' ($\mathbb{Z}^F$=1) Take-up, %
$\mathbb{Z}^R$	- 3.81	0.43	0.59	1.66
	(0.03)	(0.21)	(0.38)	(1.10)
$\mathbb{Z}^T$	- 0.03	2.77	0.51	1.45
	(0.03)	(0.20)	(0.38)	(1.10)
$\mathbb{Z}^F$	- 0.02	- 0.32	32.8	
	(0.03)	(0.22)	(0.40)	
Cons.	15.0	39.8	-0.56	31.2
	(0.02)	(0.19)	(0.36)	(0.96)
N	20,944	20,944	20,944	7,308
F	7,551	63	2,216	2

Note. Table reports the first stage effect on new contract rate (APR, %), term, and forbearance take-up. Also reported is the F-test p-value, which tests the null hypothesis that the coefficient estimates θ^k are jointly equal to zero.

Figure 3: First Stage: Contract Terms



Note. Figures plot group averages separately by $\mathbb{Z}^R$, $\mathbb{Z}^T$, and $\mathbb{Z}^F$. The x-axis indicates event time—months relative to refinancing—and t=0 corresponds to the month of refinancing. Dashed lines indicate 95% confidence intervals for the estimate of the mean.

3.6 First Stage

Figure 3 and Table 4 report the first stage effect of the three instruments $\mathbb{Z}_i^k$ on the new contract interest rate R', term T', and take-up of the forbearance offer, using Equation 3. Figure 3 displays the event study for these first stages. Also reported in the Table is the F-test p-value, which tests the null hypothesis that all coefficients on instruments are jointly equal to zero.

The average interest rate for the old contract is 16.3% APR, which is reduced to an average of 15.0% APR for the low-rate-reduction group $\mathbb{Z}_i^R = 0$ and 11.2% APR for the high-rate-reduction group $\mathbb{Z}_i^R = 1$. The average difference in rate reduction between the low and high rate treatment is 381 bps APR. Since the interest rate is bounded below a minimum $\underline{R}$ set by the bank, the difference between treatment and control is lower than the intended 480 bps APR. The F-statistic for this first stage is 7,551.

The average remaining term at the time of refinancing is 24 months. Almost all participants (99.4%) extend the term. 62.5% of participants chose the offered term, with the remaining choosing a term below or above the recommendation (19.1% vs. 18.4%). For participants in the high-term group, $\mathbb{Z}_i^T = 1$, vs. low-term group, $\mathbb{Z}_i^T = 0$, averages are 40 and 43 months, respectively. The median term T' for the high- and low-term groups is 36 vs. 48 months. The F-statistic for this first stage is 63. There is little evidence that participants in the high-interest rate group opt to shorten the debt term.

Forbearance take-up. 35% of participants (7,308) are randomized to receive a forbearance offer. Note that forbearance is not free since interest payments continue and total payments increase. Moreover, take-up benefits depend tightly on preference parameters (i.e., impatience) and situational factors (i.e., nature of the income shocks faced), both of which are unobservable. Hence, naturally, not everyone takes it. Table A.1 discusses the decision to take up in detail.

One-third of those offered forbearance take up this offer. The F-statistic for this first stage is 2,216. Similar to term extension offers, there is little evidence that differences in interest rates compound forbearance take-up, with participants in the high-rate-reduction group $\mathbb{Z}_i^R = 1$ only 1.39% more likely to accept (p=0.19). Similarly, participants in the high-term offer group $\mathbb{Z}_i^T = 1$ are 1.08% more likely to accept forbearance (p=0.31).[7] Take-up of the forbearance offer is tightly linked to the remaining term of the old contract. For example, borrowers with an additional 12 months remaining on their existing contract are about 7% more likely to take up the forbearance offer. Intuitively, the old term is an immediate determinant of the elasticity of payments in the new term due to the $\frac{1}{T}$ effect T has on Pay. Take-up of the forbearance offer is also negatively associated with FV, with a 1% increase in FV decreasing take-up by about 2 percentage points.

4 Results

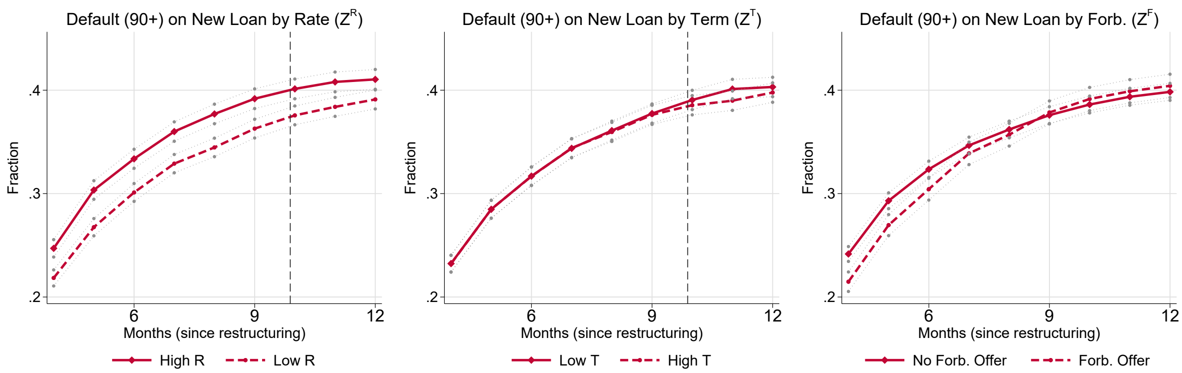
4.1 Solvency Triggers

I begin the empirical analysis by studying the effect of experimental assignments on the qualitative dynamics of defaults using event studies. I use the event studies to document that modifications orthogonal to the face value of liabilities—solvency—and other observable and unobservable determinants of the default decision (e.g., income, wealth, risk, costs of default) have discernible and distinct effects on the borrower's decision whether and when to default. I first focus on defaults (i.e., 90 days past due) at the account level. Later, I focus on other outcome variables, such as late payments (i.e., 30 days past due) and the balance sheet.

Figure 4 plots average cumulative delinquency frequencies separately by rate, term, and forbearance. In these event studies, t=0 is the month of refinancing for each participant, and the x-axis indicates the months elapsed since refinancing. The y-axis displays the cumulative fraction in each treatment leg that reaches 90+ status. Dashed lines indicate 95% confidence intervals for estimates of the mean. The panel on the left displays delinquency status by $\mathbb{Z}_i^R$—the high-rate-reduction group vs. the low-rate-reduction group. The panel

[7] In a linear probability model in which the new contract interest rate R' and term T' are used as the explanatory variables, and $\mathbb{Z}_i^R$ and $\mathbb{Z}_i^T$ are used as instruments, a pp APR change in the interest rate leads to a 0.32 percentage point drop. A 1-month change in the new contract term T' leads to a 0.34 percentage point increase in the likelihood of accepting the forbearance offer. However, neither of these effects is statistically significant.

Figure 4: Event Study



Note. Figures plot group averages of 90+ status separately by $\mathbb{Z}^R$, $\mathbb{Z}^T$, and $\mathbb{Z}^F$. The *x*-axis indicates event time—months relative to refinancing—and *t*=0 corresponds to the month of refinancing. Dashed lines indicate 95% confidence intervals for the estimate of the mean.

on the right display delinquency status by $\mathbb{Z}_i^F$—the group that received the forbearance offer vs. the group that did not.

Participants who refinance the contract are expected to make the first monthly payment in *t*=1. If the first payment due in month *t*=1 is missed, Figure 4 will show 90+ status by month *t*=4. 47% of participants miss (0+), and 30% are late (30+) on the first payment. 23% stop making payments right after refinancing and default (90+) at the first possible instance (*t*=4). The average default frequency after 6 months is 32%. After *t*=6, a gradual increase in delinquencies occurs, and long-run default frequency converges to 40% after 12 months, with no statistically significant changes in the last month.

Focusing on the left event study, the probability of falling into delinquent status shifts discernibly lower for participants in the high-rate-reduction leg than in the counterfactual low-rate-reduction leg. This difference is the causal effect of a rate reduction only. These figures corroborate the previously documented findings whereby changes in the interest rate alone can reduce the default hazard without changing the face value.[8] Importantly, the effect of interest rate reductions occurs immediately and persists throughout the experimental timeframe, leading to a decrease in long-run default probabilities.

A salient policy question is whether temporary forbearance policies are effective compared with the counterfactual in which they are not offered and whether the effects extend beyond expiration. The event study on the right plots the fraction delinquent by those who receive a forbearance offer vs. those who do not. The temporary forbearance modification provides an immediate payment reduction that is, by construction, large and targeted, and reduces payments to interest on principal only for the 3-month forbearance period for borrowers who accept. The figures show that forbearance also leads to a discernible reduction in short-run delinquencies, with an effect on 90+ status visible in period *t*=6, 90 days after expiration. However, forbearance appears to only shift the timing of the default decision, with no long-run effects. After forbearance expires, defaults increase and catch up with the group that did not receive a relief offer.

To quantify and perform statistical tests on the difference in conditional means for the different groups displayed in the event studies, I report simple intent-to-treat (ITT) linear

[8] See Fuster and Willen (2017) and Di Maggio et al. (2017).

probability regressions of the form:

$$Y_i = \theta^R \mathbb{Z}_i^R + \theta^T \mathbb{Z}_i^T + \theta^F \mathbb{Z}_i^F + f_t + \varepsilon_i \quad (4)$$

where i stands for an individual, f_t stands for calendar-month fixed effects, and Y_i is the delinquency indicator. The error ε_i accounts for delinquencies due to other factors, such as shocks to income, wealth, risk, and other default costs. The explanatory variables are three binary instruments $\mathbb{Z}_i^k$ that indicate assignment to different treatment legs.

These intent-to-treat estimates quantify differences in the delinquency rates between the treatment group and the control group at various points in time using ordinary least squares (OLS) and focusing on purely exogenous differences. Sampling and randomization ensure orthogonality between $\mathbb{Z}_i^k$ and all other variables, particularly potential omitted variables and the residual ε_i. The objects of interest are then θ^R, θ^T, and θ^F—the intent-to-treat effects of the assignment to a high-relief leg concerning a particular contract feature on delinquencies at a given time.

Table 5: Intent-to-treat Effects

$$Y_i = \sum^{k \in R,T,F} \theta^k \mathbb{Z}_i^k + f_t + \varepsilon_i$$

	Short-run			Long-run		
	$4m$	$5m$	$6m$	$9m$	$12m$	$15m$
Base	23%	28%	32%	38%	40%	40%
$\mathbb{Z}^R$	- 2.78	- 3.51	-3.15	-2.79	-1.85	-2.13
	(0.58)	(0.62)	(0.64)	(0.66)	(0.67)	(0.67)
$\mathbb{Z}^T$	- 0.02	0.01	-0.02	-0.13	-0.54	-0.82
	(0.58)	(0.62)	(0.64)	(0.66)	(0.67)	(0.67)
$\mathbb{Z}^F$	-2.69	-2.37	-1.96	0.24	0.56	-0.35
	(0.61)	(0.65)	(0.67)	(0.70)	(0.71)	(0.70)
$\mathbb{P}(\theta^R = 0)$	<0.001	<0.001	<0.001	<0.001	0.006	0.002
$\mathbb{P}(\theta^T = 0)$	0.98	0.99	0.98	0.85	0.42	0.22
$\mathbb{P}(\theta^F = 0)$	<0.001	<0.001	0.004	0.73	0.43	0.62

Note. The left-hand-side variable is a 90+ indicator at t, multiplied by 100.

Results are reported in Table 5. As before, $\mathbb{Z}_i^R$, $\mathbb{Z}_i^T$, and $\mathbb{Z}_i^F$ stand for a high-rate-reduction dummy, a high-term-encouragement dummy, and a forbearance offer dummy. The first three columns focus on the short run, within the 90 days of forbearance expiration, and accordingly use 90+ status after 4, 5, and 6 months as the left-hand-side variable. The last three columns focus on the long run and use 90+ status after 9, 12, and 15 months as the left-hand-side variable.

The group receiving higher rate reductions see their probability of defaulting by month t=6 reduced by 3.15 (0.6) percentage points off a base of 32%, or by 10% relative to the mean delinquency rate. The effect is immediate, and the cumulative response of the high-rate-reduction group does not exhibit a catch-up with the low-rate-reduction group. Longer-run results indicate that the effect of rate reductions is detected after 15 months, and the response is highly statistically significant (p=0.002).

Offering forbearance for the first quarter reduces the likelihood of default by month t=4 by 2.69 (0.6) percentage points and the likelihood of default by month t=6 by 1.96 (0.7) percentage points (p <0.001 and p=0.004). Estimating the effect of forbearance take-up on compliers as the ratio of the estimated intent-to-treat effect of a forbearance offer and the estimated proportion of compliers yields $\frac{2.69}{.328} = 8.2$ and $\frac{1.96}{.328} = 6.0$ percentage points. Therefore, taking the forbearance offer decreases delinquencies relative to the mean delinquency rate by 35% by month t=4 (90 days after the first month of forbearance) and by 19% by month t=6 (90 days after the last month of forbearance). However, there are no statistically significant long-run differences in defaults for participants who were offered forbearance (p=0.73, 0.43, and 0.62 after 9, 12, and 15 months).

The second row reports the difference in defaults for the treatment leg that receives a higher term offer. These borrowers are encouraged to address their persistent liquidity constraints by spreading payments further over time and providing more drawn-out relief. Point estimates of the effects of term extensions are negligible in magnitude compared with those of rate and forbearance. Participants who receive a longer-term recommendation do not exhibit discernible or statistically significant differences in delinquencies. In the long run, the effect of term extensions becomes somewhat more pronounced but nevertheless remains statistically insignificant (p=.22 after 15 months). These patterns are broadly incompatible with solvency being the sole driver of borrower decisions.

4.2 Liquidity Triggers

If liquidity drives decisions, borrowers default only because current payments are too high. The novel current research design, which builds on previous *either-or* research designs that either reduce payments or don't, varies current payments for similar participants differently. This feature allows for direct tests of the association between current payments and delinquencies, as predicted by theories that emphasize liquidity.

To better understand the relationship between liquidity and the default decision, Table 6 reports the first stage effect of experimental assignment on current payments separately by rate, term, and forbearance legs. These first stage estimates quantify the exogenous differences in payment flow between the treatment and control groups using OLS. The first column focuses on the quarter before the expiration of the forbearance. The second column focuses on the quarter after the expiration of forbearance.

All modifications reduce current payments. Rate reductions, reported in the first row, entail a similar effect on payments compared with the effect of term extension encouragements, reported in the middle, and a much smaller effect on payments compared with forbearance offers, reported at the bottom—equivalent to 96 cents, 88 cents, and $1.92 for each $100 of face value, respectively. As payments are relatively more sensitive to term compared to the interest rate, the small difference in term between treatment and control creates a reduction payments similar to that of rate reductions. The reduction in payments entailed by forbearance, 1.92% of face value, is due to a reduction in the quarterly payments from about 10% of face value to interest on the principal of 4% of face value for the one in three who take up.

To visualize the contemporaneous relationship between payments and the decision to default, Figure 5 superimposes the first stage differences reported in Table 4 (in gray) on the intent-to-treat estimates reported in Table 5 (in red). To capture the concurrence, the left-hand-side variable of the intent-to-treat specification is the 3-month forward of 90+ status. Regarding timing, the borrower observes the current quarter *Pay* and then decides whether to stop making payments. Once she stops making payments in any given quarter, 90+ status is reached 3 months later. The left axis displays the reduction in delinquen-

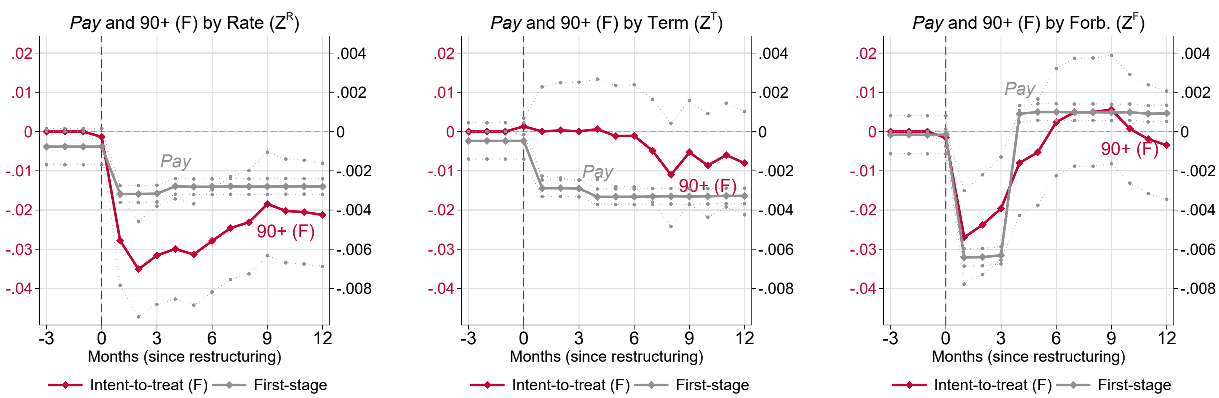
Table 6: First Stage Effects on Current and Future Payments

	Pay_1 Current	Pay_2 Current	PV_1^{fu} Future	PV_2^{fu} Future
$\mathbb{Z}^R$	- 0.96	- 0.85	- 6.28	- 5.74
	(0.07)	(0.06)	(0.08)	(0.12)
$\mathbb{Z}^T$	- 0.88	- 1.01	0.49	1.59
	(0.07)	(0.06)	(0.08)	(0.12)
$\mathbb{Z}^F$	- 1.92	0.29	1.66	1.63
	(0.07)	(0.06)	(0.09)	(0.13)
Cons.	11.6	11.8	92.9	85.2
	(0.06)	(0.06)	(0.08)	(0.12)
N	20,944	20,944	20,944	20,944
F	401	160	2,128	816

Note. Table reports the first stage effects on current payments in quarter t, Pay_t, and the present value of future payments coming after quarter t, PV_t^{fu}. Both are normalized by and expressed as a percentage of face value at the time of refinancing, FV_0. Also reported is the F-test p-value, which tests the null hypothesis that coefficient estimates are jointly equal to zero.

cies. The right axis displays the reduction in payments as a percentage of the face value at origination.

Figure 5: First Stage and Intent-to-treat Effects



Note. Red line plots the coefficients from the linear probability intent-to-treat specification, where the left-hand-side variable is the three-month forward of 90+ status. Gray line plots the coefficients from the first stage specification, where the left-hand-side variable is *Pay*. The x-axis represents months relative to refinancing, and t=0 corresponds to the month of refinancing for each participant. Dashed lines indicate the 95% confidence intervals for the estimate of the mean.

Qualitatively, Figure 5 visually corroborates key dynamics from the event studies in Figure 4. Focusing on the left, interest rate reductions lead to an immediate decrease in defaults that persists in the long run. Focusing on the right, offering forbearance also leads to a decrease in defaults, with the 90+ status picking up in the last month before the expiration of forbearance. The delinquency rate rises sharply after the expiration of the forbearance period when payments resume and rise. Forbearance only shifts the timing of the default decision. This is compatible with the view that forbearance leaves the borrower with more debt that becomes a drag in the long run.The effect of term extensions becomes more pronounced in the final months but remains economically and statistically insignificant.[9]

Quantitatively, Figure 5 shows that the reduction in payments entailed by a modification has a weak association with the decision to default. Forbearance targets those who need the most and reduces payments, on average, by twice as much that of rate reductions. Similarly, term extension encouragements are also targeted and reduce payments in a similar magnitude and persistence as rate reductions. Strikingly, delinquencies are noticeably more responsive to interest rate reductions.

Let ϕ denote the sensitivity of defaults to current payments. To quantify this sensitivity, I study a specification of the form:

$$Y_i = \phi Pay_i + f_t + \varepsilon_i \tag{5}$$

where Pay is the quarterly payment (flow) normalized by face value. f_t stands for calendar month fixed effects. The error ε_i accounts for delinquencies due to other factors, such as income and wealth shocks. As in Figure 5, the left-hand-side variable is the three-month forward of 90+ status. This specification uses data on only the cross-section in the first quarter for the $N =$20,944 participants.

Estimating Equation (5) by OLS would identify ϕ from variation that includes that in the magnitude of changes in Pay. However, the variation in the magnitude of the change in $Pay_i|\mathbb{Z}_i^k$—although possibly uncorrelated with the error ε_i— is not randomized. Therefore, the coefficient ϕ is estimated using 2SLS, where either $\mathbb{Z}_i^R$, $\mathbb{Z}_i^T$, or $\mathbb{Z}_i^F$ are used as instruments. Randomization ensures that the experimental assignment is orthogonal to all other variables by construction, in particular, potential omitted variables and the residual ε_i; and generate variation in current payments, as shown in Table 6.

Panel A in Table 7 reports the results. The first column restricts variation to $\mathbb{Z}_i^R$, akin to studies that use naturally occurring interest rate shocks (e.g., adjustable mortgage rate resets) to estimate the sensitivity of defaults to periodic payments. The second and third columns restrict variation to $\mathbb{Z}_i^T$ and $\mathbb{Z}_i^F$, respectively.

These estimates give the instrumental variables 2SLS estimate of the local average treatment effect (LATE) of an increase in current payments (equivalent to 1% of face value) on the probability of default in percentage points. This LATE is for compliers induced by the instruments to see a change in the value of the endogenous regressors. Hence when a different subset of instruments is used for identification the compliers and treatment effects change.[10]

Point estimates indicate that a dollar change in payments has drastically different effects if delivered through forbearance, term extension, or rate reduction. When payments are reduced by 1% of face value ($1 increase for every $100 of principal) through a rate

[9]Consider a borrower who has uncertain income who defaults if payments are above income. Then the differences in defaults should increase over time as affordability shocks hit. Compatible with this interpretation, the effects of term extension become more pronounced over time. In contrast to this interpretation and compatible with strategic behavior, the effects of rate reductions are immediate.

[10]The design automatically lowers the interest rate, and compliance is perfect. Hence, the instrument $\mathbb{Z}_i^R$ yields an average treatment effect (ATE). This is an advantage since the PV effect ψ is identified mainly from the variation in $\mathbb{Z}_i^R$. In contrast, compliance with respect to the instruments $\mathbb{Z}_i^T$ and $\mathbb{Z}_i^F$ is imperfect because the design only *offers* forbearance and only *encourages* borrowers to postpone payments. Using $\mathbb{Z}_i^F$ and $\mathbb{Z}_i^T$ as the instrument yields a treatment effect that is the local average for participants who take up the forbearance and extend term, the most relevant subpopulations. Since participants with $\mathbb{Z}_i^F = 0$ do not receive forbearance offers, with respect to this instrument, there are only never-takers and compliers; hence monotonicity is automatically satisfied. The identifying assumption in the LATE interpretation is that borrowers with $\mathbb{Z}_i^F = 1$ who are encouraged to take up a longer-term do not, in contrast, take up a shorter one than that would prevail.

reduction, the incidence of defaults decreases by 3.31 percentage points (p <0.001). In contrast, when payments are reduced by 1% of face value through forbearance, defaults only decrease by 1.03 percentage points (p=0.004). Hence, forbearance would have to reduce current payments by more than three times to obtain an impact on delinquencies similar to that of rate reductions. Payment reductions through term extensions do not affect defaults (p=0.99). These patterns are broadly incompatible with liquidity being the sole driver of borrower decisions.

Table 7: Treatment Effects of Current and Future Payments

	Panel A: Sensitivity $Y_i = \phi \text{Pay}_i + f_t + \varepsilon_i$				*Panel B: Decomposition* $Y_i = \phi \text{Pay}_i + \psi PV_i^{fu} + f_t + \varepsilon_i$			
Pay	3.31	-0.007	1.03	*Pay*	1.11	1.29	1.21	3.11
Current	(0.72)	(0.74)	(0.35)	Current	(0.29)	(0.32)	(0.29)	(0.80)
				PV^{fu}	0.33	0.31	0.36	0.92
				Future	(0.10)	(0.10)	(0.10)	(0.29)
Instrument				Instrument				
$\mathbb{Z}^R$	✓			$\mathbb{Z}^R$	✓	✓	✓	✓
$\mathbb{Z}^T$		✓		$\mathbb{Z}^T$	✓		✓	✓
$\mathbb{Z}^F$			✓	$\mathbb{Z}^F$	✓	✓	✓	✓
							Controls	IV Probit
				$\mathbb{P}(\phi = \psi = 0)$	<0.001	<0.001	<0.001	<0.001
$\mathbb{P}(\phi = 0)$	<0.001	0.99	0.004	$\mathbb{P}(\phi = 0)$	<0.001	<0.001	<0.001	<0.001
				$\mathbb{P}(\psi = 0)$	0.001	0.003	<0.001	0.001
				$\mathbb{P}(\phi = \psi)$	0.017	0.007	0.008	0.015
				ψ/ϕ	0.30	0.24	0.30	0.29

Note. The left-hand-side variable is the 3-month forward of the 90+ indicator at $t = 3$. In the probit model, *Pay* and PV^{fu} are projected onto the instruments in the first stage.

4.3 Strategic Triggers

Strategic defaults are due to announced but not yet realized future payments, holding constant solvency (ability to meet total liabilities in face value) and liquidity (ability to meet current payments). The novel design here separates strategic behavior from the face value of debt, and allows for a direct investigation of strategic default triggered by news about non-callable future payments before they act through the budget constraint and affordability.

The smoking gun of the strategic effects acting through the news about future payments is the immediate and large reduction in delinquencies for borrowers in the high rate reduction group. This effect is due to changes in the intertemporal path of payments beyond current payments, since rate reductions reduce payments, on average, just as much as term extensions (which have a relatively negligible effect on defaults) and only by half as much as with forbearance (which have a lesser effect on defaults).

Recall that what distinguishes these debt relief policies is their effects on future payments. Columns three and four in Table 6 reports this first stage effect of experimental assignment on PV_t^{fu}—the present value of payments that come after a quarter t. This present value is calculated using the annuity formula assuming a discount rate R^* of 18% APR. Later, I report alternative specifications in which the discount rate R^* varies.

Forbearance moves current and future payments in different directions: it reschedules payments by backloading. The short-term reduction in payments is repaid with an approximately one-for-one increase in the present value of future payments; hence, reducing defaults due to a liquidity effect and increasing defaults due to a strategic effect. Let ψ denote the sensitivity of defaults to PV_t^{fu}. Reduction in delinquencies due to forbearance then reflects the difference in the sensitivity to current versus future payments, roughly ϕ - ψ.

In contrast, interest rate reductions move current and future payments in the same direction; hence, reducing defaults due to both a liquidity effect and a strategic effect. The effect on current payments is small, and the effect on the present value of future payments is much larger—equivalent to $6.28 for each $100 of face value.

In specifications that use naturally occurring data and variation to study the effects of rate reductions, as in Equation (5) (e.g., downward rate reset designs), the present value of future payments is an omitted variable. These research designs cannot observe, distinguish, or decompose liquidity vs. the strategic effects entailed by changes in interest rates. The experimental variation here shifts current and future payments in a different direction, which allows for the identification of their relative contributions to borrower decisions.

A naive and nonparametric decomposition of the strategic effects can be obtained by comparing the intent-to-treat effects of $\mathbb{Z}^R$ and $\mathbb{Z}^F$ on defaults in the first quarter reported in Table 5 (-3.15 and -1.96 percentage points) with the first stage effects of $\mathbb{Z}^R$ and $\mathbb{Z}^F$ on current payments and the present value of future payments in the same period reported in Table 4. Solving the exactly identified system of two equations and two unknowns given by

$$-3.15 = -0.96\,\phi - 6.28\,\psi$$
$$-1.96 = -1.92\,\phi + 1.66\,\psi$$

the relative contributions of current payments and the present value of future payments to defaults, ϕ and ψ, yield 1.28 and 0.31. Hence, defaults are triggered by both current and future payments but are more sensitive to current payments. Moreover, news about a dollar increase in the present value of future payments increases defaults by as much as a ψ/ϕ =24-cent increase in current payments—a strategic effect.

Using this identification strategy, I decompose the effect of current payments, Pay, from the present value of future payments, PV^{fu}, using a linear probability model of the form

$$Y_i = \phi Pay_i + \psi PV_i^{fu} + f_t + \varepsilon_i \tag{6}$$

In this specification, Pay is the payment (flow) in the *current* quarter and PV^{fu} is the present value of *future* payments coming after a quarter (stock), calculated using the annuity formula from the perspective of a quarter. These variables are normalized by face value at origination, FV_0. The error ε_i accounts for delinquencies due to other factors, such as income shocks.

Regarding timing, the borrower observes the current quarter Pay and the PV^{fu} of the payments coming after. She then decides whether to stop making payments or not. Once she stops making payments, 90+ status is reached 3 months later. This specification uses data on only the cross-section in the first quarter for the $N = 20{,}944$ participants.

The objects of interest are the coefficients ϕ and ψ, which give the instrumental variables estimate of the local average treatment effects (LATE) for participants who see changes in current payments induced by $\mathbb{Z}_i^k$. These coefficients measure the effect of an increase in periodic Pay and PV^{fu} equivalent to 1% of face value on the probability of default in percentage points.

As described earlier, estimating Equation (6) by OLS would identify ϕ and ψ from variation in the assignment to a particular treatment leg $\mathbb{Z}_i^k$, as well as the magnitude of changes in Pay and PV^{fu}. However, variation in the magnitude of the changes, $\text{Pay}_i|\mathbb{Z}_i^k$ and $\text{PV}_i|\mathbb{Z}_i^k$—although possibly uncorrelated with the error ε_i— is not random. Therefore, ϕ and ψ are estimated using 2SLS and the three $\mathbb{Z}_i^k$ are used as instruments.

The additional identifying assumption for the LATE interpretation is that there is no effect of experimental assignment on defaults, on average, that does not operate via the experimental assignment's impact on payments. This assumption is violated for the sensitivity estimates in Panel A of Table 7—due to the omitted PV^{fu} term—which the decomposition design here overcomes.

The first column in Panel B uses variation in all three instruments.[11] The point estimates for ϕ indicate that an increase in Pay corresponding to 1% of the face value of debt increases defaults by 1.11 percentage points. In comparison, an increase in PV^{fu} corresponding to 1% of the face value of debt increases defaults by only 0.33 percentage points. The second column in Panel B uses variation in only $\mathbb{Z}_i^F$ and $\mathbb{Z}_i^R$. In this case, the specification is exactly identified, and these estimates numerically overlap with the naive *bivariate Wald* estimator discussed earlier.

At the bottom of Table 7 I calculate an identified moment ψ/ϕ. This wedge summarizes the sensitivity to future payments relative to current payments and hence the relative strength of the strategic motive compared with liquidity. If future payments had no effect, ψ/ϕ would yield 0. Under fungibility, ψ/ϕ would yield 1. If current payments had no effect, ψ/ϕ would yield ∞. A dollar change in the present value of future payments has a similar effect on delinquencies as a 30-cent increase in quarterly payments. This is a key moment that will be studied in more detail in the following sections.

The bottom rows report the results of statistical tests for the four classes of reduced-form hypotheses discussed in Section 1 and Table 1 that make different predictions about the determinants of default.

In the classical solvency model, neither reducing payments nor changing the interest rate affects borrower behavior: $H_0 : \phi = \psi = 0$. Unsurprisingly, this hypothesis is decisively rejected, with $\mathbb{P}(\phi = \psi = 0) < 0.001$. Similarly, in models emphasizing liquidity, the default decision is driven by current payments. The hypothesis that liquidity is *not* a driver of borrower decisions, $H_0 : \phi = 0$, is also decisively rejected, with $\mathbb{P}(\phi = 0) <0.001$.

If liquidity is the sole driver of borrower decisions, the other testable implication is that borrowers should behave identically whether the reduction in current payments is accompanied by a dollar increase or decrease in payments tomorrow. Hence, a reduction in future payments should have no effects, corresponding to the null hypothesis $H_0 : \psi = 0$. This hypothesis is also decisively rejected, with $\mathbb{P}(\psi = 0)$=0.001. Treatment effect estimates imply that the borrowers default in response to announced but not yet realized changes

[11] Using many instruments simultaneously produces a weighted average of the causal effects of instrument-specific compliant populations, in which the weights depend on the relative strength of each instrument in the first stage; see Imbens and Angrist (1994).

in future payments when it enters their information sets before the payments take effect through cash flow or affordability constraints. This is compatible with models emphasizing strategic behavior, in which the default decision is driven by news about future payments after current payments are accounted for. Note that as forbearance and rate reductions are unanticipated, the analysis here mitigates the difficulty that borrowers who anticipate default could strategically put themselves in a liquidity problem.

A special and knife-edge case of the strategic model that is of particular interest is that with perfect intertemporal substitution—*fungibility*. In this case, a dollar increase in current payments should have the same effect on borrower behavior as a dollar change in the present value of future payments—$H_0 : \phi = \psi$. This hypothesis is also rejected, with p=0.017. Hence, the effects of future payments are less pronounced compared with the dollar-for-dollar benchmark the perfect intertemporal substitution model predicts. Rejection of fungibility acknowledges behavior is sensitive to current and future payments and tests for a different interpretation of liquidity constraints—that behavior is relatively *more* sensitive to current payments.

4.3.1 Further Analysis

Table 8: Balance Sheet Effects

	Panel A: Late Payments				*Panel B: Other*	
	0+	30+	120+	150+	30+	90+
Base	58%	38%	30%	30%	4%	1%
$\mathbb{Z}^R$	-3.58 (0.68)	-3.53 (0.67)	-3.00 (0.63)	-3.17 (0.63)	-0.11 (0.25)	-0.01 (0.14)
$\mathbb{Z}^F$	-3.80 (0.71)	-3.08 (0.70)	-1.87 (0.66)	-1.62 (0.66)	0.84 (0.27)	0.28 (0.14)
Pay Current	1.81 (0.31)	1.69 (0.31)	1.07 (0.29)	1.00 (0.29)	-0.26 (0.12)	-0.09 (0.06)
PV^{fu} Future	0.29 (0.11)	0.30 (0.11)	0.31 (0.10)	0.35 (0.10)	0.06 (0.04)	0.02 (0.02)
$\mathbb{P}(\psi = 0)$	0.008	0.004	0.002	<0.001	0.13	0.43
$\mathbb{P}(\phi = \psi)$	<0.001	<0.001	0.02	0.04	0.014	0.11
ψ/ϕ	0.16	0.18	0.29	0.35	<0	<0

Balance sheet effects. Panel A in Table 8 reports effects on late payments. These metrics reflect different types of borrower decisions. In terms of timing, a borrower who decides to stop making payments in any given quarter shows up as 0+ status in that quarter, 30+ status one month later, and 60+ status two months later. Accordingly, the left-hand variable is either a 0+ indicator, one month forward of 30+ status, two months forward of 60+ status, and so on. This specification uses data on only the cross-section in the first quarter for the N =20,944 participants. For brevity, I omit $\mathbb{Z}_i^T$, which is economically and statistically insignificant in every case.

Early-cycle delinquencies (e.g., 0+ and 30+ status) are noticeably more sensitive to forbearance and current payments—i.e., driven by liquidity. In contrast, late-cycle delinquencies are relatively more sensitive to rate reductions and future payments—i.e., driven by strategic considerations. The effect of future payments and strategic effects, ϕ/ψ, become pronounced when 120+ and 150+ status is used as the left-hand-side variable (0.29 and 0.35, compared to 0.16 and 0.18). However, strategic effects remain pronounced at all lateness metrics (p <0.01).

Panel B in Table 8 reports effects on other accounts at the bank. These accounts represent credit line and overdraft accounts. The literature often interprets being current on a secondary account (e.g., credit card, overdraft) but not on the primary account as an indication of strategic behavior. The increase in defaults comes predominantly through an increase in the refinanced loan contract. Rate reductions do not have statistically significant effects on delinquencies on other accounts. However, borrowers who are offered forbearance tend to default more on other accounts, compatible with the interpretation that borrowers now need the liquidity provided by these other accounts less.

Table 9: Effect on Delinquencies: Discounting

R^*	0%	Old R_i	24%	48%	$\beta = 0.9$	$\beta = 0.8$	$\mathbb{E}[PV]$
Pay Current	1.15 (0.29)	1.12 (0.29)	1.10 (0.30)	1.07 (0.30)	1.11 (0.29)	1.11 (0.29)	1.79 (0.33)
PV^{fu} Future	0.25 (0.07)	0.32 (0.10)	0.35 (0.11)	0.38 (0.15)	0.37 (0.11)	0.41 (0.13)	0.71 (0.22)
$\mathbb{P}(\psi = 0)$	<0.001	<0.001	0.002	0.017	0.001	0.001	0.001
$\mathbb{P}(\phi = \psi)$	0.003	0.015	0.026	0.078	0.025	0.040	<0.001
ψ/ϕ	0.22	0.29	0.32	0.36	0.33	0.37	0.40

Discounting. As discussed in Section 1, the change in the present value of future payments, to a first-order approximation, is independent of the rate at which the borrower discounts the future. The previous analysis calculates present-value equivalents assuming a discount rate of R^* of 18% APR. Table 8 reports the results from alternative specifications in which the discount rate R^* is varied.

The first column uses the nominal sum of future payments assuming no discounting (R^*=0). This is the number read aloud and communicated in writing to the borrower. The second column uses the old contract interest rate, allowing individuals to discount the future differently. The old contract interest rate likely reflects the borrower's pre-experiment discount rate. The third column uses the marginal funding cost of 24% APR. This number corresponds to the (capped hence constant) interest rate on credit card and overdraft accounts, the relevant cost of funds at which borrowers can intertemporally substitute and discount future payments. The fifth and sixth columns assume quasi-hyperbolic discounting—where initial payments are heavily weighted. In each of these assumptions about the discount rate, I reject the null hypothesis that strategic effects are absent and liquidity is the sole driver of borrower decisions.

Forward-looking borrowers may anticipate default and base their decision on the payments they expect to make before defaulting. The *expected* present value of future payments could be calculated using the predicted values obtained from the instrumental variables probit model reported in Table 7, and weighing two scenarios—loan defaults or loan cures. If the borrower defaults, he stops making payments. In the case in which the loan cures, the present value is calculated in the usual way. Under this specification, the strategic effects due to future payments become even more pronounced.

4.4 Endogenous Triggers

In debt default models that feature incomplete markets and incorporate solvency, liquidity, and strategic default constraints, triggers will be endogenous and heterogeneous.

Previous debt relief studies that use either-or designs focus on average treatment effects, either due to limitations in data or research designs. The current study features data on balance sheets; and also variation in balance sheets that, by construction, is orthogonal to the experimental variation. This aspect allows for an investigation of mechanisms not yet tested.

Although particular frictions differ—distress, precaution, lack of assets to perform substitution—the implications for these approaches for the shape of the default trigger are very similar. Naturally, default is more attractive for a distressed borrower because it has the benefit of reducing current payments, as in Campbell and Cocco (2015). Moreover, precautionary saving against the risk of hitting a borrowing constraint effectively shortens the planning horizon and renders irrelevant strategic considerations due to news about payments that occur after hitting the constraint, similar to McKay et al. (2016). Finally, kinks in the budget constraint may hamper intertemporal substitution and the ability to respond to news about future payments before they act through the budget constraint, similar to Kaplan and Violante (2014).

I analyze heterogeneity by baseline balance sheet metrics that capture these mechanisms—the degree of distress, the number of times credit constraints bind, and checking account balances. I perform sample splits based on pre-experiment (month prior to refinancing) values for each variable and place participants into three bins. I then report in Table 10 and Table 11 heterogeneous intent-to-treat and treatment effect estimates, as in Equation (4) and (6).

Table 10: Intent-to-treat Effects on Delinquencies: Heterogeneity

	Panel A: by Distress Days Late			*Panel B:* by Precaution Times Binding			*Panel C:* by Assets Checking Balances		
	(A1)	(A2)	(A3)	(B1)	(B2)	(B3)	(C1)	(C2)	(C3)
	90+	31 - 90	< 30	∅	High	Low	∅	Low	High
Frac.	0.30	0.59	0.11	0.14	0.43	0.43	0.10	0.45	0.45
Base	32%	36%	11%	28%	35%	29%	30%	32%	32%
$\mathbb{Z}^R$	- 4.72	- 2.41	- 1.50	- 5.43	- 2.04	- 3.38	- 3.27	- 2.47	- 3.72
	(1.16)	(0.86)	(1.29)	(1.68)	(1.00)	(0.95)	(1.93)	(0.96)	(0.95)
$\mathbb{Z}^F$	- 4.55	- 1.29	0.53	- 3.52	- 1.74	- 1.63	- 3.58	- 1.89	- 1.67
	(1.21)	(0.90)	(1.36)	(1.75)	(1.05)	(1.00)	(2.04)	(1.00)	(1.00)
$\mathbb{P}(\theta^R = 0)$	<0.001	0.005	0.25	0.001	0.04	<0.001	0.09	0.01	<0.001
$\mathbb{P}(\theta^F = 0)$	<0.001	0.15	0.70	0.045	0.10	0.10	0.08	0.06	0.10

Note. Table reports the results from the intent-to-treat specification (4). The left-hand-side variable is the three-month forward of 90+ status at $t = 3$.

In these Tables, Panel A reports the results by the degree of delinquency in the month before refinancing. Participants 90+ days late (30%) are in the first bin. This group represents deeply delinquent debt restructuring. Participants who were fewer than 30 days late (11%) are in the last bin. This latter group can be thought of as mimicking regular non-delinquent refinancing. Panel B reports results based on the frequency with which credit limits bind (i.e., credit card debt-to-limit ratio of above 75%). Participants without a credit line (14%) are in the first bin. Participants with a credit line are split using a cutoff equal to the median number of times constraints bind in the year before the intervention, 5. Panel C reports results based on checking balances. 90% (18,715) of participants have access to a checking account. Participants without a checking account at the bank are in the first bin. Similarly, participants with a checking account are split using a cutoff equal to the median balances.

First, I focus on the intent-to-treat effects in Table 10. The first row reports the fraction of participants in each bin. The second row reports the baseline 90+ rate at $t = 6$, 90 days after the expiration of forbearance. The following two rows report the intent-to-treat effects of rate reductions and forbearance during the first quarter, estimated using OLS.

Participants are not equally affected, and the absolute and relative effects of forbearance and interest rates depend on borrower balance sheets. Forbearance reschedules payments by backloading to future payments. Therefore forbearance should only have an effect if intertemporal substitution is imperfect, and the effect should be larger if the difference in the sensitivity to current versus future payments is large. Focusing on Panel A, for early-cycle delinquencies (<30 days late), offering forbearance is not effective and leads to a 5% *increase* in defaults. Naturally, borrowers who are not in default do not find forbearance attractive because it only alters the timing of repayment. In contrast, for participants who were already in default, offering forbearance leads to a 14% decrease in defaults (4.55 percentage point reduction off of a base 32%), with take-up leading to $\frac{-4.55}{0.34} = 13.6$, a 43% decrease in defaults. Focusing on Panel B, the efficacy of forbearance is strictly increasing in the number of times credit constraints bind. For example, take-up of forbearance prevents one in three defaults ($\frac{3.52}{0.37}$ off a base of 28%) for participants without a credit line, but only one in six ($\frac{1.63}{0.33}$ off a base of 29%) for participants whose credit limits bind infrequently. Similarly, focusing on Panel C, take-up of forbearance prevents one in three defaults ($\frac{3.58}{0.36}$ off a base of 28%) for participants without a checking account, but only one in six ($\frac{1.67}{0.33}$ off a base of 29%) for participants who have high checking balances.

In contrast to forbearance, rate reductions unambiguously benefit the borrower and should decrease defaults for all subgroups. Rate reductions are associated with a statistically significant reduction in delinquencies for all subgroups except participants with no checking account (p=0.09) and participants who were not late (p=0.25)—the two subgroups that contain about 10% of participants each. Hence the inability to reject the null likely reflects the low number of observations in these bins.

Focusing on relative effects, the point estimate of the effect of forbearance is lower, and the estimates are less statistically significant for all subgroups. The only exception is participants with no checking account (10%) for whom rate reductions and forbearance have economically and statistically similarly significant effects. For borrowers who can better intertemporally substitute, interest rates are a substantially more powerful tool for providing relief than forbearance. Comparing the effect of forbearance on interest rates, rate reductions are noticeably more effective (twice as much or more) for participants who can intertemporally substitute—current participants whose borrowing constraints bind less frequently and participants holding higher liquid checking assets.

Next, I focus on treatment effect estimates that decompose the effect of current and future payments, reported in Table 11. Compatible with the intent-to-treat effect estimates of forbearance, delinquencies are most sensitive to current payments for the lowest liquidity groups (2.40 for 90+, 2.19 for no credit line, 2.10 for no checking account). For current refinancers in Panel A3, the sensitivity of defaults to current payments is very close to zero

Table 11: Treatment Effects of Current and Future Payments: Heterogeneity

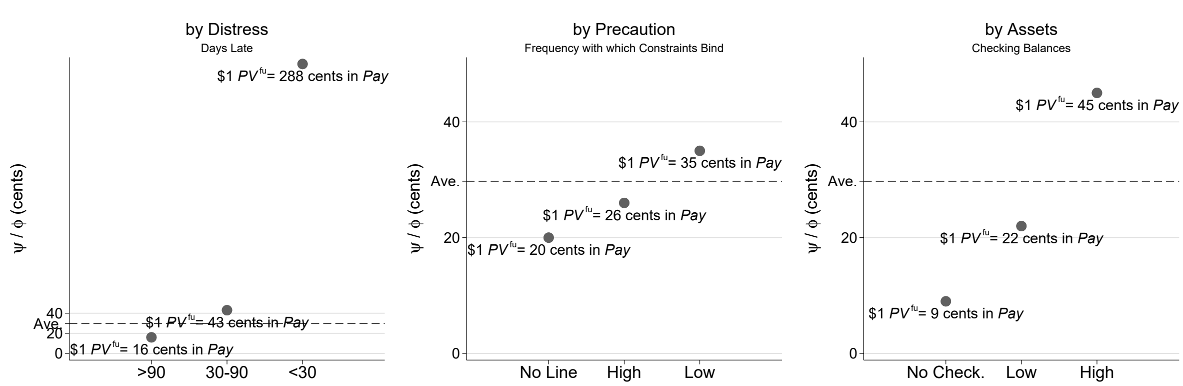
	Panel A: by Distress Days Late			*Panel B:* by Precaution Times Binding			*Panel C:* by Assets Checking Balances		
	(A1)	(A2)	(A3)	(B1)	(B2)	(B3)	(C1)	(C2)	(C3)
	90+	31 - 90	< 30	∅	High	Low	∅	Low	High
Frac. in Bin	0.30	0.59	0.11	0.14	0.43	0.43	0.10	0.45	0.45
Pay Current	2.40 (0.55)	0.66 (0.38)	0.08 (0.70)	2.19 (0.87)	0.79 (0.46)	1.09 (0.42)	2.08 (0.91)	1.04 (0.45)	0.97 (0.43)
PV^{fu} Future	0.39 (0.18)	0.28 (0.14)	0.23 (0.22)	0.43 (0.25)	0.20 (0.17)	0.39 (0.15)	0.19 (0.30)	0.23 (0.16)	0.44 (0.15)
$\mathbb{P}(\psi = 0)$	<0.001	0.08	0.91	0.012	0.08	0.009	0.02	0.02	0.02
$\mathbb{P}(\psi = 0)$	0.03	0.04	0.29	0.078	0.22	0.01	0.53	0.15	0.003
$\mathbb{P}(\phi = \psi)$	<0.001	0.38	0.85	0.071	0.26	0.13	0.06	0.12	0.26
ψ/ϕ	0.16	0.43	2.88	0.20	0.26	0.35	0.09	0.22	0.45
Strategic	0.55	0.73	0.98	0.58	0.63	0.73	0.47	0.57	0.77

Note. Table reports the results from the treatment effect specification (6). The left-hand-side variable is the three-month forward of 90+ status at $t = 3$.

(p=0.91).

Figure 6 displays ψ/ϕ, the sensitivity to future payments relative to current payments. Similar to intent-to-treat effects, the relative sensitivity of behavior to current vs. future payments also depends on distress, precaution, and assets. For all balance sheet metrics, the relative effect of future payments is monotonically increasing. The relative sensitivity ϕ/ψ is smallest, at 9 cents, for borrowers without a checking account (10%) and highest at \$2.88 for participants who were current (11%). Focusing on Panel B, the relative sensitivity ϕ/ψ is smallest, at 20 cents, for borrowers without a credit line (14%) and highest at 35 cents for participants whose credit lines bind less frequently. Hence, the precautionary savings effect that countervails forces of intertemporal substitution grows stronger as the number of times constraints bind increases. Focusing on Panel C, the higher the checking balances, the higher the default sensitivity to news about future payments: the relative sensitivity ϕ/ψ is smallest, at 9 cents, for borrowers without a checking account (10%) and highest at 45 cents for participants with high checking account balances.

Figure 6: Relative Sensitivity to Future Payments: Heterogeneity



These heterogeneous effect estimates allow for informative inferences regarding the shape of the default trigger. For borrowers not in immediate financial distress, defaults are sensitive to future payments but not current payments: hence every default is strategic. For all other subgroups, all defaults are accounted for by a combination of liquidity and strategic effects—behavior is sensitive to current and future payments but relatively *more* sensitive to current payments. Distress, precaution, and assets are all key state variables that determine the location of the liquidity trigger. In a commonly invoked dual-trigger model, both strategic (e.g., the face value of debt lower than the home value) and liquidity (e.g., income shocks, affordability problems, financial distress) triggers are required for a default. Here, neither liquidity nor strategic considerations are necessary, but both are sufficient to trigger a default. In sum, every default is triggered by strategic considerations, with the location of the trigger threshold being influenced by liquidity and financial distress. In future work, it would be valuable to ask whether commonly used calibrations of intertemporal models are qualitatively compatible with the shape of the default region and quantitatively compatible with these heterogeneous treatment effect estimates here.

5 Discussion

5.1 Liquidity vs. Strategic Effects of Interest Rates

Since Fisher (1933)'s debt deflation analysis of the Great Depression, macroeconomists have appreciated the importance of revaluation shocks on borrower behavior. For more recent work on inflation and currency devaluation, see Campbell and Cocco (2003) and Verner and Gyöngyösi (2020).

Such revaluation shocks, despite entailing a small cash flow effect through current payments, are shocks to the stock of debt and affect behavior through strategic channels and future payments.[12] As discussed in Section 1, a 2% reduction in the interest rate will entail a revaluation effect approximately equaling a $\frac{1}{2}\,T\,\Delta R = 10\%$ writedown for a borrower holding a 10-year mortgage, with more or less the entire impact happening through future payments. Nevertheless, rate reductions (e.g., refinancing a mortgage) are often interpreted as a cash flow shock, acting through current payments and the liquidity channel only. This interpretation is due to the limits of research designs that can overcome the violation of exclusion restriction and identify elasticities credibly.

The experiment allows for a decomposition of the effects of interest rates through liquidity vs. strategic channels:

$$\frac{\Delta Y}{\Delta R} = \underbrace{\underbrace{\frac{\Delta Y}{\Delta Pay}}_{\hat{\phi}=1.11} \underbrace{\frac{\Delta Pay}{\Delta R}}_{0.96\%\ FV_0}}_{\text{Liquidity}\approx\frac{1}{3}} + \underbrace{\underbrace{\frac{\Delta Y}{\Delta PV^{fu}}}_{\hat{\psi}=0.33} \underbrace{\frac{\Delta PV^{fu}}{\Delta R}}_{6.28\%\ FV_0}}_{\text{Strategic}\approx\frac{2}{3}}$$

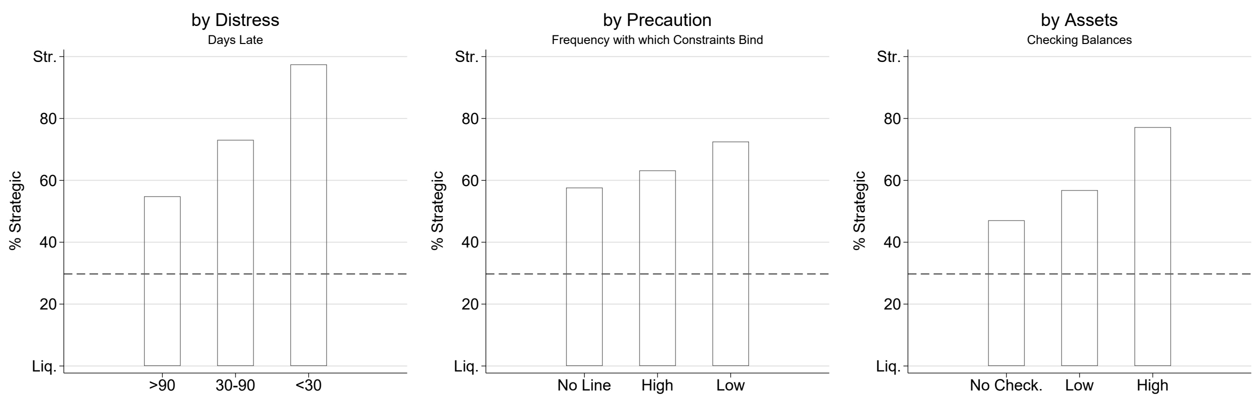
where 1.11 and 0.33 are estimates of the sensitivity of behavior to current and future payments, ϕ and ψ, and 0.96% and 6.28% are the corresponding first stage effect of rate reductions. Only one-third of the effect of rate reductions on delinquencies is due to liquidity effects (current payments), with the remaining two-thirds (67%) due to strategic effects

[12] For example, a Hungarian household that borrowed in Swiss francs will see the face value of debt in local currency go up by 10% if the Hungarian forint depreciates by 10% relative to the franc. Similarly, a U.S. household holding nominal debt with a fixed rate will see the real value of debt decline by 10% if U.S. dollar inflation is 10%.

(future payments).

These estimates imply that the benefits of interest rate changes through future payments are equivalent, in the sense of providing the same reduction in delinquencies, to a deferral program that reduces monthly payments by 5% of average monthly household disposable income.[13] These effects of interest rate changes on future payments are not replicable by term extensions and forbearance. In this regard, interest rates get into the cracks that rescheduling policies that act on payments cannot. To compensate, a forbearance program should reduce current payments by about three times what rate reductions do to obtain a similar impact on delinquencies; see Table 7. Evaluating the performance of models that simulate monetary policy based on their ability to quantitatively capture the effect of payment reductions leads to an incomplete picture regarding the channels and sizes of effects through which interest rates affect behavior.

Figure 7: Heterogeneity



The bottom row in Table 11 and the red bars in Figure 7 decompose liquidity vs. strategic effects of interest rate changes for different balance sheet groups. The liquidity effects of interest rates are more pronounced for borrowers unable to perform the perfect intertemporal substitution. The strategic effects of interest are more pronounced for borrowers who can intertemporally substitute. For early-cycle delinquencies, 98% of the effects of interest rates is through strategic channels. Hence, for a typical refinancing in which a current borrower reduces the interest rate on the debt contract, the effects on future payments account for more or less the entire impact of interest rate changes. Even for participants who are the least able to substitute intertemporally, strategic effects account for no less than 50% of the total effect provided. Hence, the findings are incompatible with a simple two-agent calibration with stylized heterogeneity.

5.2 Generalizability

How would the results differ if the experiment were replicated in different settings?

First, the analysis of heterogeneous triggers in Section 4.4 suggests that the key state variable that determines the efficacy of alternative forms of debt relief is baseline balance sheets—distress, precaution, and assets. These variables determine whether forbearance or rate reductions are more effective and govern heterogeneity in the sensitivity of behavior to

[13] This number is obtained as $0.30 \times 6.28\% \times \frac{10{,}403}{3{,}844}$—the revaluation effect on the present value of future payments equals 6.28% of 10,403 TRY; ϕ/ψ=0.30 is the relative sensitivity, and Y=3,844 TRY the mean monthly household disposable income; see Appendix A.

current payments versus the news about future payments, ϕ, and ψ. They also determine how much of the defaults are due to liquidity vs. strategic considerations.

Table 12: Previous Debt Relief Studies

Study	ψ/ϕ	Distress	Write-down Account	Size	Default Costs
Dobbie and Song (2020)	∞ *Pay* has no effect	Early-cycle Counseling	Credit Card Balances Easy to monetize	Small	Lower
Ganong and Noel (2020)	0 Only *Pay* has an effect	Late-cycle In default	Underwater Home Equity Difficult to monetize	Large	Very High Moving, family, stigma, deadweight

The analysis here is based on delinquent borrowers with little to no assets who frequently face binding borrowing constraints. On a sample of regular or early-cycle delinquent refinancings—the typical context for interest rate pass-through in which borrowers refinance non-delinquent debt—the analysis of heterogeneity in Section 4.4 indicates that the effects of future payments would be more pronounced, which renders standard monetary policy an even more powerful relief tool. Similarly, background policies that ease constraints and allow for better intertemporal substitution (e.g., fiscal stimulus payments) would also render interest rates more powerful. Quantifying these channels for typical, nondelinquent refinancing is crucial for understanding monetary policy and requires further measurement and understanding.

Second, borrowers default due to strategic considerations—that is, they stop making payments even when they can afford to when it is a more advantageous financial decision than continuing to pay—if the present value of future payments is higher than the costs associated with default. Hence, an increase in the costs associated with default (e.g., an irreversible decision such as moving, deadweight loss, recourse, stigma, etc.) will hamper the attractiveness of default due to the strategic motive.

Finally, the results here offer a reconciliation to what appears as disagreeing results from previous debt relief studies, providing a unifying explanation as to under what conditions liquidity versus solvency/strategic behavior in response to a debt write down triggers default. Dobbie and Song (2020) and Ganong and Noel (2020) use either-or designs in which one group receives a write-down, and another receives a payment reduction. Focusing on average effects, the former study finds that payment reductions have no effect on defaults, whereas the latter study finds that only current payments determine defaults. Hence, the implied relative sensitivity of future payments to current payments, ψ/ϕ, is ∞ and 0, respectively. In the former study, participants are early-cycle delinquent borrowers in debt counseling who are given relatively small write-downs on credit cards with which they can intertemporally substitute. This is precisely what I find for early-cycle delinquencies. In the latter study, participants are deeply delinquent mortgagors facing very high default costs (e.g., moving, family, stigma, deadweight loss) who are given large writedowns of underwater home equity; hence they are much less likely to be able to monetize these long-run obligations.

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Online Appendix
Forbearance vs. Interest Rates

Figure A.1: Experiment Timeline

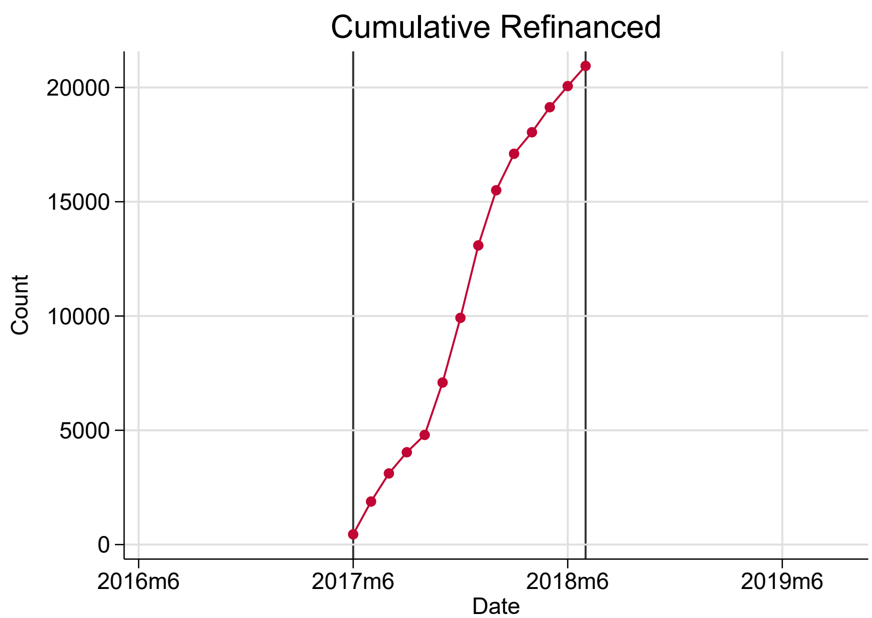


Figure A.2: Macroeconomic Environment

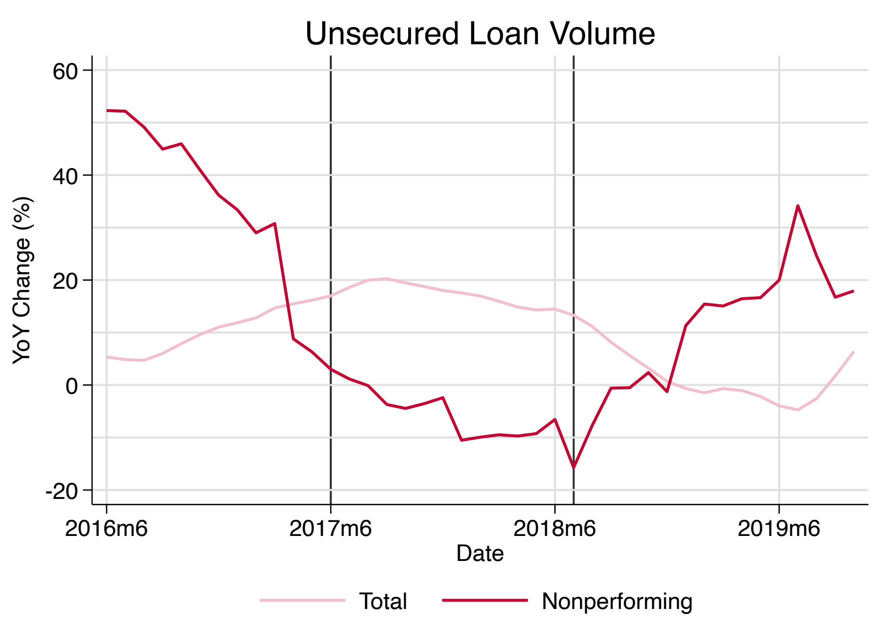
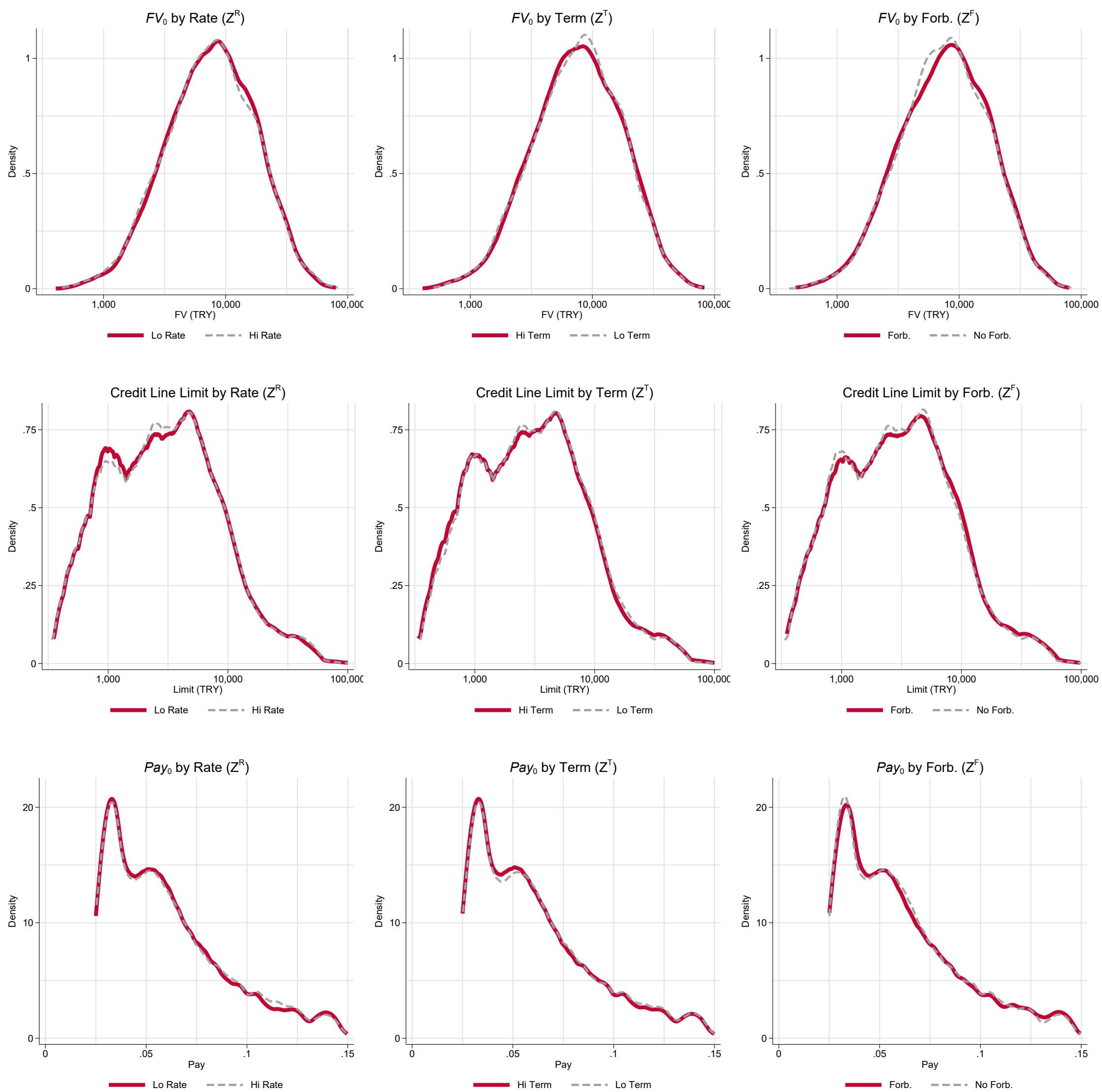


Figure A.3: Covariate Balance: Kernel Densities



Note. Figures plot the kernel densities for FV_0 (top panel, log base 10), credit card limit (log base 10) and *Pay* (bottom panel), separately by $\mathbb{Z}_i^R$, $\mathbb{Z}_i^T$ and $\mathbb{Z}_i^F$.

Table A.1: Forbearance Take-up

$\mathbb{Z}^R$		1.39		1.24		1.25		0.039	
		(1.06)		(1.05)		(1.05)		(0.031)	
$\mathbb{Z}^T$		1.08		0.92		0.93		0.030	
		(1.06)		(1.05)		(1.05)		(0.031)	
R' (APR, %)			-0.32		-0.30		-0.30		-0.003
			(0.28)		(0.28)		(0.28)		(0.008)
T'			0.34		0.33		0.33		0.011
			(0.34)		(0.38)		(0.38)		(0.011)
T				0.63	0.46	0.64	0.46	0.019	0.013
				(0.06)	(0.21)	(0.06)	(0.21)	(0.002)	(0.007)
$\log(FV)$				-2.27	-3.44	-2.47	-3.61	-0.074	-0.12
				(0.78)	(1.65)	(0.78)	(1.61)	(0.024)	(0.05)
Cons.	32.8							-0.59	-0.28
	(0.55)							(0.30)	(0.34)
	OLS	OLS	2SLS	OLS	2SLS	OLS	2SLS	Probit	Probit
f_t		✓	✓	✓	✓	✓	✓	✓	✓
$X_i\beta$						✓	✓	✓	✓
N	7,308	7,308	7,308	7,308	7,308	7,308	7,308	7,308	7,308
p^R		0.19	0.26	0.24	0.29	0.23	0.28	0.21	0.73
p^T		0.31	0.31	0.38	0.39	0.38	0.38	0.33	0.30

Note. This table uses data from 7,308 participants (35% of the full sample) with $\mathbb{Z}_i^F = 1$. The left-hand-side variable is an indicator for accepting the forbearance offer. Columns (A) to (G) report the results of simple linear probability models, and the left-hand-side variable is multiplied by 100. Columns (H) and (I) report the results of probit models. In Columns (C), (E), (G) and (I) the new interest rate R' and contract term T' are instrumented using $\mathbb{Z}_i^R$ and $\mathbb{Z}_i^T$. Columns (F) to (I) also add demographic controls.

A Data Appendix

- Banking Regulation and Supervision Agency (BDDK) reports aggregate outstanding balances of different types of household debt, see bddk.org.tr. The data is available by month and year. The total balance of household debt at the onset of the experiment (June 2017) is 452 billion TRY, with 180 million TRY of this accounted by short term unsecured loans, 180 billion TRY accounted by mortgages, 84 billion TRY accounted by credit cards, with auto loans accounting for a negligible 7 billion TRY. Non-performing loans accounted for 18 billion TRY, which is roughly 4% of total household debt.
- Turkish Statistical Institite (TUIK) reports the Income and Living Conditions Survey, see data.tuik.gov.tr. Mean annual household disposable income for 2017 was 46,131 TRY.

Table A.2: Macroeconomic Variables

Nominal GDP (TL, billions)	3,111
Nominal GDP (USD, billions)	859
Nominal GDP Per Capita (USD)	10,629
GDP Per Capita Based on PPP (2021 USD)	28,242
GDP Per Capita Based on PPP (EU28=1)	0.66
Population (millions)	81
Unemployment rate (%)	10.2
Inflation (CPI, %)	10.9
Exchange Rate (TL/$)	3.52
2-Year Benchmark Rate (%)	11.10
10-Year Benchmark Rate (%)	10.5
5-Year CDS Rate (bps)	194

Note. GDP and population variables based on 2017 values. The remaining variables based on June 2017 values. Source: Turkey Data Monitor, IMF, Bloomberg, Turkstat, and Worldbank.

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