Forbearance vs. Interest Rates:
Experimental Tests of Liquidity and Strategic Default Triggers*

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Abstract

I study a randomized debt relief experiment and present three findings regarding default triggers and how relief affects these triggers. First, liquidity is important but not the sole trigger of default: delinquencies are most responsive to a rate reduction despite entailing the smallest payment reduction. Second, compatible with strategic behavior, borrowers default in response to future payments independent of liquidity and accounting solvency. Third, the extent of strategic behavior reflects the extent of borrowing constraints. These findings align with models positing a single strategic default trigger shaped by constraints. I discuss implications for targeting relief and modeling interest rate pass-through.

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To reduce household debt defaults, lenders and policymakers need to understand what triggers default (e.g., liquidity, strategic) and how debt relief (e.g., reducing the interest rate, postponing the payment of principal) acts on these default triggers.[1] In this paper, I report the results of a large-scale field experiment with a novel design to provide new evidence on these issues.

The experiment conducted at a European bank in Türkiye randomly provides the three most commonly used debt relief (i.e., interest-only forbearance and interest rate reductions, but also term extensions) to 20,944 delinquent unsecured installment debt holders. All modifications keep the face value of the principal constant and hence do not affect accounting (technical) insolvency. However, modifications all reduce immediate payments and exhibit effects in varying directions on the present value of future payments. I use the experimental variation to investigate two classes of triggers as to why borrowers holding unsecured debt cease payments. First, borrowers may find the immediate payment too high (compared with, say, income), i.e., liquidity. Second, able borrowers may choose to default because the present value of future payments is too high (compared with net costs of default), i.e., strategic behavior.[2]

There are three distinguishing features of the current study. First, the design here varies immediate payments through different relief types, which reveals that a dollar change in payments has drastically different effects depending on the modification. Second, the design separates strategic behavior from liquidity and accounting solvency, which reveals that strategic borrowers choose to default because future payments are too high relative to the net costs of default. Third, data on balance sheets and variation in balance sheets orthogonal to relief reveals that the extent of strategic behavior depends on the extent to which households are borrowing constrained. These three novel findings as most compatible with a model in the spirit of Campbell and Cocco (2015), in which a singular strategic default trigger is shaped by constraints.

I begin the analysis by using transparent event studies to document that modifications orthogonal to the face value of the principal (and hence accounting insolvency) affect whether and when a borrower defaults. Qualitatively, three-month interest-only forbearance take-up prevents 1 in 3 defaults in the first month. However, delinquencies increase when payments increase, as forbearance only shifts the timing of the default decision. In contrast, the effect of interest rate reductions occurs instantly and persists in the long run.

I then use the novel design aspects to scrutinize previously untested implications of default triggered by liquidity and strategic behavior. I document three novel findings.

First, I focus on default triggered by liquidity—because immediate payments are too high. According to this hypothesis, modifications reduce defaults only to the extent they reduce immediate payments. This could be due to an affordability constraint (i.e., default if payments are above income), myopia (e.g., neglect of all future payments), or an inability to substitute intertemporally. In that case, the reduction in defaults should depend on the size of the reduction in payments, not the source. Interest rate reductions entail a small reduction in immediate payments and, hence, should have the smallest effect on delinquencies. In contrast, forbearance entails a very large reduction and hence should have the

[1] The answers to these questions have implications for policymaking, finance, and macroeconomics. In policymaking, the answer guides the design and targeting of debt relief. In finance, the answer distinguishes between the 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, sizes, and timing of effects through which policies affect behavior are disciplined through credibly identified moments.

[2] However, in discussing liquidity and strategic triggers, I also briefly delve into accounting insolvency—too much debt at face value—given its relevance in defining strategic behavior—unwillingness despite being solvent and liquid.

largest effect, and so on. The first contribution of the paper is to use novel design features to demonstrate the opposite.

To test this implication, the design varies immediate payments through different relief types. This analysis reveals that a dollar change in payments has drastically different effects depending on the modification. The striking pattern is that although forbearance reduces payments twice as much—and term extensions just as much—as the interest rate, delinquencies are noticeably more responsive to the interest rate reduction. Forbearance would have to reduce immediate payments *three* times to yield an impact on delinquencies similar to that of interest rate reductions. This finding challenges the notion that modifications reduce defaults only to the extent they reduce immediate payments.

Second, I focus on strategic behavior. A default is strategic if an able borrower chooses not to pay because it is an advantageous financial decision. A borrower defaulting due to accounting insolvency or inability to make immediate payments isn't acting strategically. Here, strategic unsecured borrowers default because future payments are too high relative to the net costs of default.

To test for strategic default, the design should affect future payments independent of liquidity and accounting solvency. Instead of writing down debt as previous studies do, the experiment provides this variation through unexpected interest rate reductions and forbearance—the former moves immediate and future payments in the same direction, and the latter in different directions. Using this variation and nonparametric and instrumental variables methods, I decompose the effects of immediate and future payments and provide evidence for strategic default: a dollar reduction in future payments reduces defaults by as much as a 30-cent change in immediate payments. This finding contradicts the traditional view that defaults are triggered only by face-value or immediate payments. Strategic assessment of the present value of future payments by solvent and liquid borrowers also plays a role in the decision to default.

Third, I study what determines the extent of strategic behavior. In commonly used default models (e.g., Chatterjee et al. (2007) model for unsecured debt; and Campbell and Cocco (2015) for mortgages), a single optimization problem will endogenously yield different triggers depending on the circumstances. The emphasis is on imperfections in the ability to intertemporally substitute (due to a lack of liquid assets, precautionary savings, or financial distress), which hampers the effect of future payments and strategic motives.

The third novel finding of the paper is to document that the efficacy of relief and the extent of strategic behavior reflects the extent to which households are borrowing constrained. For an unconstrained borrower, postponing the payment of principal does not have a material effect because behavior is sensitive to future payments, which renders interest rate reductions a much more powerful tool. This group is highly strategic. In contrast, for constrained borrowers (e.g., deeper delinquency, more frequently binding constraints, fewer assets), behavior is less sensitive to future payments. These groups are not strategic, which renders interest rates less and forbearance a more powerful tool.

Regarding the theory of debt default, these findings allow for informative inferences regarding the nature of the default trigger. Unconstrained borrowers who can intertemporally substitute are strategic. As constraints become more binding, a much smaller change in immediate payments can trigger a default. That is, borrowing constraints accelerate default by decreasing the liquidity equivalent of the strategic trigger level. With respect to existing models, this interpretation is most compatible with the model of Campbell and Cocco (2015).

In addition to providing new evidence on the validity of alternative default models, study findings have implications for modeling and policy, in particular, understanding the channels through which modifications affect default. Notably, decomposing the effects of immediate and future payments reveals that most of the behavioral response to interest rates is attributable to future payments and strategic channels. The less constrained a borrower, the more interest rates get into the cracks that other tools in the debt relief toolkit cannot. The effects of interest rates through strategic channels provide the same reduction in delinquencies as a monthly transfer of 5% of average household disposable income.

Related Literature. This study complements a large debt relief literature that either analyzes a single policy in isolation (e.g., Scharlemann and Shore (2016), Fuster and Willen (2017), Agarwal et al. (2017), Cherry et al. (2021), Dinerstein et al. (2022), Fiorin et al. (2022)) or compare two policies (e.g., Castellanos et al. (2018), Dobbie and Song (2020) and Ganong and Noel (2020)).[3] The incremental contribution of the paper constitutes the findings in Sections 5.1, 5.2, and 6.

First, the design varies immediate payments through different relief types. This aspect contrasts with studies that focus on credit cards (e.g., Dobbie and Song (2020) and Castellanos et al. (2018)) where immediate payments are not defined; or studies that compare two policies using *either-or* designs (e.g., Ganong and Noel (2020)) where only one policy acts on payments. This feature allows for the analysis in Section 5.1 and Figure 5, which measures the association between immediate payments and defaults. This analysis confronts the hypothesis that modifications reduce defaults only to the extent they reduce immediate payments. In contrast, I find that the elasticity of defaults to the reduction in payments is not constant but depends on the modification.

Second, to test for strategic triggers, the design affects future payments independent of factors that determine ability (e.g., liquidity and accounting solvency). This contrasts with previous work that uses write-downs, which matter in case of default and affect accounting solvency. Moreover, it does so unconditionally on behavior and unexpectedly, which mitigates the identification difficulty whereby borrowers anticipating default could strategically put themselves in a liquidity problem. These features allow for the analysis in 5.2 and Table 5. This section also contains novel identified moments quantifying the relative sensitivity of defaults to current vs. future payments and the decomposition of defaults due to liquidity vs. strategic channels.

Finally, previous studies do not speak to the why—what determines a) the efficacy of relief, b) whether a default is strategic, and c) what this means for targeting modifications. This is the material in Section 6—Tables 8 and 9; as well as Figure 6. I find that default and relief efficacy is best understood through models that endogenously yield liquidity or strategic triggers depending on the state variables (e.g., Chatterjee et al. (2007) and Campbell and Cocco (2015)).

Layout. Section 1 provides a conceptual framework. Section 2 describes the relevant institutional features. Section 3 details the experimental design and implementation. Section 4 presents the event studies. Section 5 presents the key results, with subsections 5.1, and 5.2 focusing on liquidity and strategic triggers. Section 6 studies what determines the efficacy of relief and the extent of strategic behavior. Section 7 discusses implications and generalizability.

[3] Although not debt relief studies, Ganong and Noel (2022) provide evidence that liquidity (i.e., cash flow, affordability, and short-run) and Guiso et al. (2013), Mayer et al. (2014), Gerardi et al. (2017), and Indarte (2022) that strategic considerations drive borrower default decisions. Also see Karlan and Zinman (2009), Verner and Gyöngyösi (2020), Eberly and Krishnamurthy (2014) and Campbell et al. (2018).

1 Conceptual Framework

I begin by presenting a novel approximation of the annuity formula to quantify how modifications affect immediate payments and the present value of future payments. I then explicate the link between liquidity and strategic triggers and immediate and future payments and how modifications act on and can be used to distinguish these triggers.

The experiment focuses on unsecured loans with a fixed rate and fixed payments. The intervention holds the outstanding face value at origination, D_0, constant. It creates independent variation in the interest rate (R), term (T), and forbearance (F), primarily focusing on forbearance and interest rates, motivated by the theory of optimal modifications.[4]

To think about how modifications affect payments, consider the Taylor series approximation of the payment formula around $R = 0$

$$
\begin{aligned}
Pay &= \text{Payment}/D_0 \\
&= R\left(1 - (1+R)^{-T}\right)^{-1} \\
&= \frac{1}{T} + \frac{R}{2} + \frac{R}{2T} + \frac{R^2 T}{12} - \frac{R^2}{12T} + O(R^3) \\
&\simeq \frac{1}{T} + \frac{R}{2}
\end{aligned} \tag{1}
$$

Appendix A.1 lays out this novel expansion in detail.

This formula gives the relative contributions of interest and amortizing principal to *Pay*, payments normalized by D_0. In the experimental setting, T=12 quarters and R=16% APR, yielding a quarterly *Pay* of $\frac{1}{12} + \frac{4\%}{2} \simeq 10\%$ of D_0.

All modifications affect payments but to varying degrees. Forbearance (here, suspending the payment of principal) has a very large effect, and interest rates have a very small effect. Forbearance reduces *Pay* by 60%—or 6% of D_0 to the quarterly interest rate of 4%. By contrast, a large reduction in the interest rate (4 percentage points APR) reduces *Pay* by only 5%.[5] The left panel in Figure 1 shows these effects.

The modifications also affect the present value of payments. Suppose the borrower is discounting future payments at a rate R^* to calculate a present value to undertake meaningful comparisons of immediate versus future payments. The Taylor series approximation of the present value at t=0 is given by

$$
\begin{aligned}
PV_0 &= \text{Present Value}_0/D_0 \\
&= Pay\left(T - \frac{R^*\,T}{2} - \frac{R^*\,T^2}{2} + O(R^{*2})\right) \\
&\simeq 1 + (R - R^*)\,\frac{T+1}{2}
\end{aligned} \tag{2}
$$

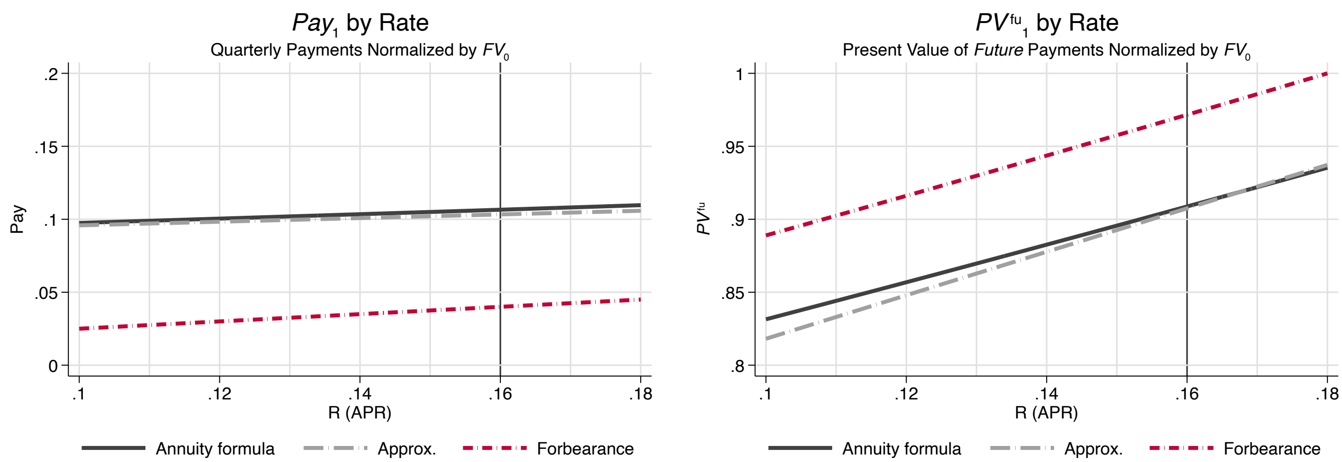
Appendix A.2 lays out this novel expansion in detail.

The right panel in Figure 1 shows these effects on PV_1^{fu}, the present value of *future*

[4] See Eberly and Krishnamurthy (2014). Forbearance and interest rate reductions are favored over face value write-downs and term extensions for two reasons. First, the modification should provide the largest liquidity up-front rather than over the life of the contract (i.e., forbearance is favored over term extension). Second, debt write-downs are expensive (and banks are averse to realizing face value losses), and a reduction in payment stream achieved through a face value reduction could exactly be replicated in present value via a change in the interest rate (i.e., an interest rate reduction is favored over write-down).

[5] Similarly, a 10% increase in T' reduces payments by about 7%. Forbearance is akin to increasing T' to ∞.

Figure 1: Effect of Rate and Forbearance on Immediate and Future Payments



Note. The left panel plots quarterly payments normalized by face value at origination, D_0, using the annuity formula (solid line) and the approximation in Equation (1) (dashed line). In the experimental setting, T=12 quarters and R=16% APR, giving a quarterly Pay of $\frac{1}{12} + \frac{4\%}{2} \simeq 10\%$ of D_0. Forbearance (red dash-dot line) reduces Pay to the quarterly interest rate and has a very large effect on immediate payments, whereas interest rates have a very small effect. The right panel plots the present value of future payments normalized by face value at origination, using the annuity formula (solid line), the approximation in Equation (2) (dashed line), and under forbearance (red dash-dot line). Interest rates have a very large effect on the present value of future payments, which account for more or less the *entire* impact of interest rate changes.

payments coming after quarter 1, normalized by D_0 and assuming an R^* of 18% APR.[6][7]

Interest rate reductions greatly alter the present value, proportional to T. This unambiguously benefits the borrower. The experimental reduction of 4 percentage point APR reduces payments as much as a write-down of $\frac{1}{2}\, T\, \Delta R \simeq 6\%$ of D_0. Notably, the effects on future payments, as opposed to immediate payments, account for more or less the *entire* impact of interest rate changes. To a first-order approximation, the change through R in the present value of future payments is independent of R^*.

Importantly, unlike a write-down, the present value effects are not wealth—borrowers cannot capitalize on present value effects by prepaying or calling the loan at face value. Hence, changes in the present value of payments through interest rates do not matter in case of default and do not affect accounting solvency.

In sum, if behavior is sensitive to the present value of future payments, interest rate reductions will be a powerful tool. To the extent that behavior is more sensitive to immediate payments than future payments, forbearance will be a more powerful tool.

This leads to three classes of models as to why borrowers default (i.e., stop making

[6] An 18% APR nominal (equivalent to 7% APR in real terms) represents the highest interest rate observed in the sample, ensuring that all participants would find it beneficial to borrow in the first place.

[7] To calculate present value, there are alternative approaches. First, use the inflation rate and compare real dollar terms. Second, use as R^* the borrower's marginal funding cost. If the borrower can transfer resources at R^*, a dollar increase in immediate payments or the present value of future payments would lead to the same feasible set and the same set of optimal decisions. A third approach is to interpret R^* as a subjective discount rate directly tied to time preference, the marginal utility of consumption, today's and tomorrow's aggregate state, and the shadow cost of the constraint. This approach 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 immediate payments).

payments). The experiment focuses on liquidity and strategic triggers; however, I begin with accounting solvency due to its role in defining strategic behavior.

Accounting Solvency. The face value of the principal D_0 is the nominal amount the borrower has agreed to repay in case of prepayment or default. In the benchmark model (i.e., accounting, technical, or balance sheet insolvency), borrowers default because the face value is too high. Hence, in this model, changing the interest rate or the schedule of payments should not reduce defaults as long as the face value is kept constant.[8]

Liquidity. If default is triggered by liquidity, borrowers default because they find the immediate payments Pay to be too high.[9] For example, the borrower could have an affordability constraint (i.e., default if payments are above income), exhibit myopia (e.g., neglect of all future payments), or may not be able to substitute intertemporally (i.e., $R^* = \infty$). Hence, modifications reduce defaults only to the extent they reduce immediate payments.

Strategic. If strategic, able borrowers default by choice because it is an advantageous financial decision. They do so after weighing the costs and benefits (e.g., drop in credit score and access, stigma, moral factors, postponing or preventing repayment). Naturally, a change in face value or immediate payments changes the borrower's ability to fulfill. Hence, strategic borrowers default because they find the present value of future payments PV^{fu} to be too high. In this case, a reduction in future payments, orthogonal to liquidity (immediate payments) and solvency (face value), leads to a reduction in defaults.

In models such as Chatterjee et al. (2007) (for unsecured debt studied here) or Campbell and Cocco (2015) (for mortgages), a single optimization problem will endogenously yield liquidity or strategic triggers, depending on the state variables, such as assets, precaution, or distress. This intuition is akin to consumption theory, where one model (e.g., buffer-stock model) delivers different behavior (e.g., hand-to-mouth vs. permanent income) depending on the state variable (e.g., liquid assets).[10] Such models emphasize strategic behavior being hampered by imperfections in the ability to intertemporally substitute and respond to future payments. Hence, whether forbearance or interest rate reductions are more effective and whether the default is strategic will depend on how constrained the borrower is.

The experiment uses unexpected forbearance offers and interest rate reductions to create variation in immediate payments versus the present value of future payments. As different policies act on different triggers, the variation allows me to provide new evidence on the validity of these alternative models.

2 Environment and Institutional Details

In this section, I overview the macroeconomic environment and the institutional details on the unsecured loan market, consumer bankruptcy, and distressed debt modification.

Macroeconomic Environment. The experiment was conducted between June 2017 and July 2018. At the onset, the annual inflation rate (CPI) was about 11% and 4% of the aggregate face value of household debt was in nonperforming status. The macroeconomic conditions that led to these delinquencies are neither the depression type nor the transitory type, with

[8] This model yields under no borrowing constraints and R^*=R. In this model, payments decrease when the interest rate decreases, although their present value does not.

[9] There is no commonly adopted definition of liquidity, which is often used interchangeably with cash flow, periodic debt service, affordability, and short-run obligations. I define liquidity as immediate payments.

[10] Hence, endogenous models are a separate theory of default, akin to buffer-stock being a separate theory of consumption compared to hand-to-mouth and permanent income.

Table 1: Competing Models

Trigger		Solvency (Accounting)	Liquidity	Strategic Partial	Strategic Endogenous	Strategic Fungibility
ϕ	=	0	>0	>0	>0	>0
ψ	=	0	0	$\in(0,\phi)$	$\in(0,\phi)$	ϕ
ϕ/ψ	=	$\cdot$	0	$\in(0,1)$	$\in(0,1)$	1
Rate $\downarrow$		×	✓	✓	✓	✓
Term $\uparrow$		×	✓	✓	✓	✓
Forbearance		×	✓	✓	✓	×
Prediction						
1	*Pay* effect depends on modification		×	✓	✓	✓
2	PV^{fu} affects defaults		×	✓	✓	✓
3	Relief efficacy and strategicness heterogeneous		×	×	✓	×

Note. ϕ and ψ denote the sensitivity of defaults to changes in *Pay* and PV^{fu} (orthogonal to face value D_0), respectively. The experiment identifies ϕ and ψ using modifications that all reduce immediate payments but have different effects on the present value of future payments. See Sections 5.1, 5.2, and 6 for tests of predictions 1, 2, and 3.

nothing suggesting that banks or the government are culpable. See Appendix B.1 for further details.

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 debt outstanding to the household sector. See Appendix B.2 for further details on underwriting.

Delinquencies. Borrowers thirty days past due are followed up via text messages and phone calls and reported to the credit bureau. Borrowers ninety days past due are reported to be nonperforming to the credit bureau, and the bank can take legal action. The contract is kept in collections for at least 90 additional days, during which the bank attempts recovery through borrower contact. The lender then can take legal action and sue the borrower for the loan balance plus penalties, collection costs, and legal fees. The default flag remains on the credit history for five years and obstructs access to credit markets until removed.

Collections. Türkiye lacks a personal bankruptcy option. Unpaid debts may be collected through liquid assets, wage garnishing up to 25% of net income, and finally, confiscation of durables. If there is a guarantor, this person shares all the responsibility. This process usually takes 2 to 3 years. Hence, default substantially postpones repayment, something delinquent borrowers highly value. Moreover, many defaulting borrowers are unemployed or employed informally (one-third of the working population), with no leviable bank account or confiscatable illiquid assets. Hence, even in the absence of bankruptcy, default often prevents recovery and leads to a definitive relief of the debt burden.

Modifications. The market features frequent modification of distressed unsecured debt by the lender of the delinquent loan. Banks contact delinquent borrowers through an in-house call center to work out a repayment plan. Banks predominantly modify borrowers for whom it is the sole creditor. These are one-time modifications. 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 modification process. I describe the modification 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
D (Original)	TRY	20,944	15,281	11,172	4,546	12,298	29,081
D (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 D	20,944	6.4	3.4	3.0	5.6	11.2
New loan							
D_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 D	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

Table 3: Experiment Timeline

Original Contract in Arrears	$\rightarrow$	Randomization	$\rightarrow$	Modification	$\rightarrow$	New Contract
(R, T)		$\mathbb{Z}^R \times \mathbb{Z}^T \times \mathbb{Z}^F$ (2×2×2=8 groups)		$R' \mid \mathbb{Z}^R$ displayed $T^{\text{Offer}} \mid T, \mathbb{Z}^T$ offered T' decided $F \mid \mathbb{Z}^F$ offered F decided		(R', T', F)

Participants

For the field experiment, I collaborated with a large European retail bank in Türkiye. Study participants are existing borrowers who hold an unsecured loan in arrears. The bank has nudged these borrowers via text messages and phone calls. However, their loans have not previously been modified. The sample includes the entirety of the bank's delinquent modification pool, with the only exception being the exclusion of loans with less than six months remaining.

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 is about 15,000 TRY (four months of average monthly household disposable income). 20% of participants consolidate multiple loans, and 5% consolidate three loans. The average monthly payment is about 500 TRY. 89% of participants have access to a checking account. Almost all participants borrow into overdraft on these checking accounts and hence hold negative net liquid assets. 86% of participants have access to a credit line facility. Perhaps surprisingly, most participants do not borrow up to their credit line limits. 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 borrowers.

Randomization

I assign participants to 8 treatment legs in a 2-by-2-by-2 design. First, I stratify participants into nonoverlapping and exhaustive bins by face value and days late. Second, I draw three random numbers for each participant to determine the interest rate (R), term (T), and forbearance (F). Third, I assign a participant to a high relief designation for a particular contract feature if the random number is above a specific threshold. I denote these assignments as $\mathbb{Z}_i^R$, $\mathbb{Z}_i^T$, and $\mathbb{Z}_i^F$.[11]

Balance

The randomization gives three variables for econometric evaluation, $\mathbb{Z}_i^R$, $\mathbb{Z}_i^T$, and $\mathbb{Z}_i^F$. I conduct statistical tests for covariate balance across treatment legs using simple regressions of the following form:

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

Table 4 reports the results of regressions of the delinquent contract and borrower 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. These regressions allow me to test whether pre-experiment differences exist across borrowers in different treatment legs.

Similarly, Figure 2 displays visual evidence of dynamic pre-trends; and The Tables and Figures show that the final assignment to high/low treatments is orthogonal to pre-experiment characteristics and typical determinants of the default decision, and different treatment legs have statistically indistinguishable covariates before the experiment.

Contract and Modification

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

Interest rates. The modified contract features an interest rate reduction to $R' < R$. This reduction is off a market rate that reflects conditions at the time of modification. 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 interest rate reduction. Hence, the interest rate reduction, up to

[11] The threshold equals 0.5 for rate and term and 0.65 for forbearance. Hence, half of the participants are allocated to high versus low legs for interest rate and term, and about one-third are offered forbearance.

Table 4: Covariate Balance

		Age Years	Loans Consol. Count	D Org. TRY	D_0 Rem. TRY	R Org. APR, %	T Org. Months	Payment Org. TRY	Pay Org. Nm	30+ %	90+ %
	$\mathbb{Z}^R$	- 0.22	- 0.0002	- 22	34	0.003	0.08	- 1.2	- 0.08	-0.82	-0.31
		(0.13)	(0.007)	(155)	(124)	(0.02)	(0.11)	(5.2)	(0.05)	(0.43)	(0.64)
	$\mathbb{Z}^T$	- 0.07	- 0.01	-3	105	0.01	-0.11	0.4	- 0.05	-0.10	0.67
		(0.13)	(0.007)	(154)	(124)	(0.02)	(0.11)	(5.2)	(0.05)	(0.43)	(0.64)
	$\mathbb{Z}^F$	- 0.02	- 0.009	172	170	- 0.02	0.06	5.5	- 0.02	0.45	-0.03
		(0.14)	(0.008)	(162)	(130)	(0.02)	(0.11)	(5.4)	(0.05)	(0.45)	(0.67)
Cons.		38.1	1.26	15,234	10,274	16.3	36.8	530	6.5	89.6	30.3
		(0.13)	(0.007)	(147)	(118)	(0.02)	(0.10)	(4.9)	(0.05)	(0.41)	(0.60)
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 the month before modification. N=20,944. F-test p-value for the null that coefficient estimates θ^k are jointly equal to zero. Kolmogorov-Smirnov p-values are for the equality of distributions by $\mathbb{Z}^R$, $\mathbb{Z}^T$and $\mathbb{Z}^F$.

480 bps APR, is quantitatively large and a discernible change.[12] This rate is *not* negotiable and cannot be changed.

Term. The experiment features an individualized term extension *offer*, $T^{\text{offer}} > T$. This is a recommendation made by the bank representative. Borrowers are grouped into grids of width 12 with respect to the remaining term T in months,with $\bar{T}_k$ denoting the largest element in each bin. 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.

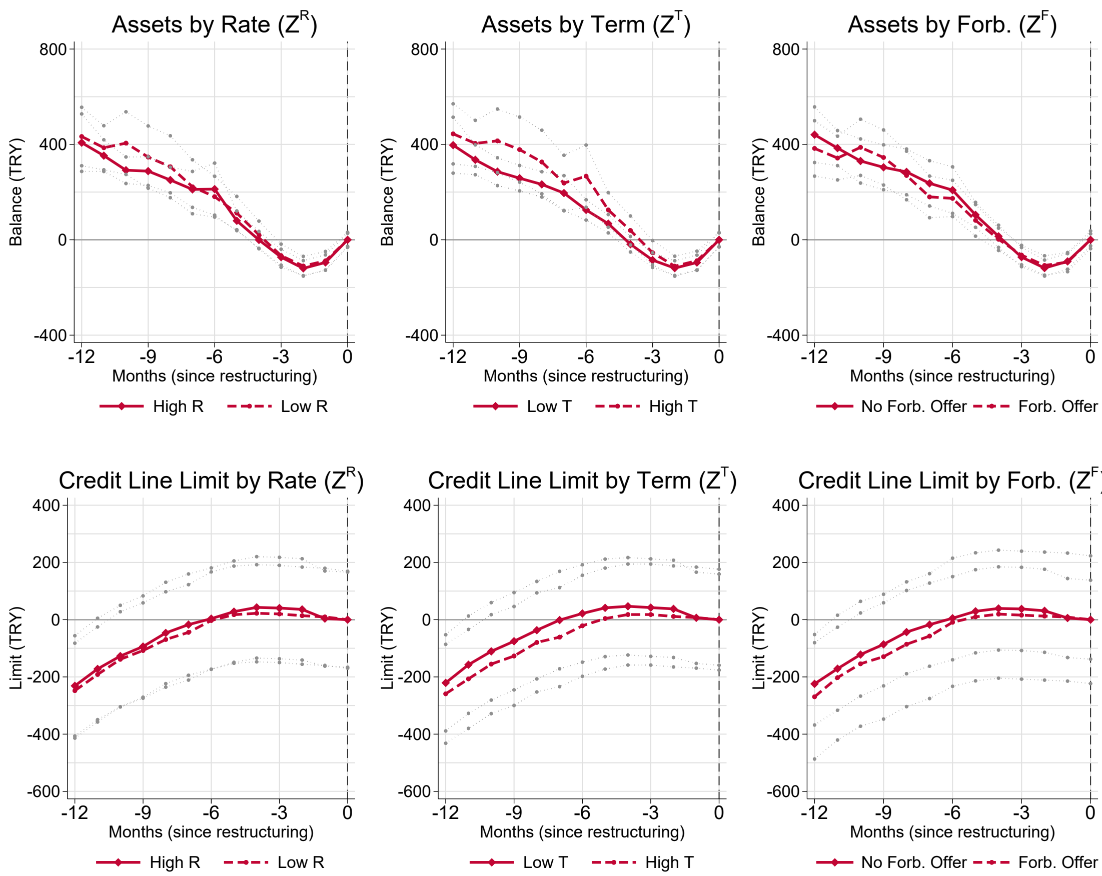
Forbearance. Borrowers with $\mathbb{Z}_i^F$=1 are offered forbearance. Forbearance suspends and postpones payment of the principal for 3 months, keeping the term constant and backloading the program's costs. Hence, for three months, the loan becomes interest-only. Forbearance is not free: The borrower is responsible for the interest that accrues, and forbearance increases total payments. For participants who take up forbearance amortizing payments start 4 months after modification.

Implementation. The bank contacts delinquent borrowers through an in-house call center. During the call, bank employees follow a standard script. The employee's screen displays information on demographics, details of the delinquent loan, as well as individually tailored interest rates and term recommendations. The individualized interest rate R' cannot be changed. The term choice drop-down box features, as the default entry, T^{offer}, with a text tag *recommended* next to it. The loan officer *encourages* the borrower toward this term; however, borrowers are free to pick any term up to 48 months.

The forbearance offer pops up for borrowers with $\mathbb{Z}^F = 1$ after the interest rate R' is

[12] If the assigned interest rate is below a minimum $\underline{R}$, roughly equal to the inflation rate, I set $R' = \underline{R}$. 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. In the analysis, I 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 modification—and t=0 corresponds to the month of modification. Dashed lines indicate 95% confidence intervals for the estimate of the mean.

observed and term T' is chosen, but before the new contract is finalized. If the borrower is not offered forbearance, then D, R', and the negotiated term T' determine periodic payments. If the borrower is offered forbearance, the loan officer similarly *encourages* the borrower toward forbearance. The borrower then has the option to either accept or reject the forbearance offer. If the borrower 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 D, $T' - 3$, and R'.

Information, anticipation, and effects on other margins. Before the controlled trial, the bank did offer loan modifications to delinquent borrowers; therefore, borrowers may anticipate the modification. However, these modifications did not include interest rate reductions or forbearance. Hence, the interest rate and forbearance variation—the main levers that create variation in immediate and future payments—can be considered unexpected.[13] Using unexpected variation also mitigates the identification difficulty whereby borrowers who anticipate default could strategically put themselves in a liquidity problem.

[13]For aspects of the experiment that could be anticipated, randomization ensures that treatment and control groups have similar expectations at least until the modification. Importantly, there is no explicit participation choice and 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. Modifying 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 face value, monthly payments, and total payments are communicated to participants in a salient manner. The contract is not conditional on behavior (e.g., success in making some payments or commitment to not using overdrafts), abstracting away from strategic behavior in this regard.

Ethics

Due to ethical and regulatory considerations, the experiment cannot force participants into forbearance or a particular term they do not prefer.[14] Instead, the design combines random encouragement with borrower choice. This approach has two additional benefits. First, better targeting: Forbearance or a high term is taken up by those who need it the most. Second, better external validity: In the wild, borrowers are not dictated a term and are free to take up forbearance.

Data

In the following analysis, I use data on loan contracts before and after the modification, including the contract (e.g., rate, term, face value, payments) and borrower behavior, such as the date the new loan became 30+ or 90+ days overdue. The data also contain information on borrower balance sheets, such as credit card balances and limits, checking assets-overdraft debt, and indicators for whether the borrower is delinquent on any other accounts at the bank. There is no information on borrower income. Delinquency and balances are measured on the last day of the calendar month.

My analysis is based on the 15-month timeframe after modification. Hence, participants are followed for 12 months after the expiration of the forbearance. The data are monthly, and the unit of analysis is at the individual level. For participants who consolidated multiple loans, I match the accounts and aggregate the variables using a unique borrower identification number, which ensures perfect match quality.

First Stage

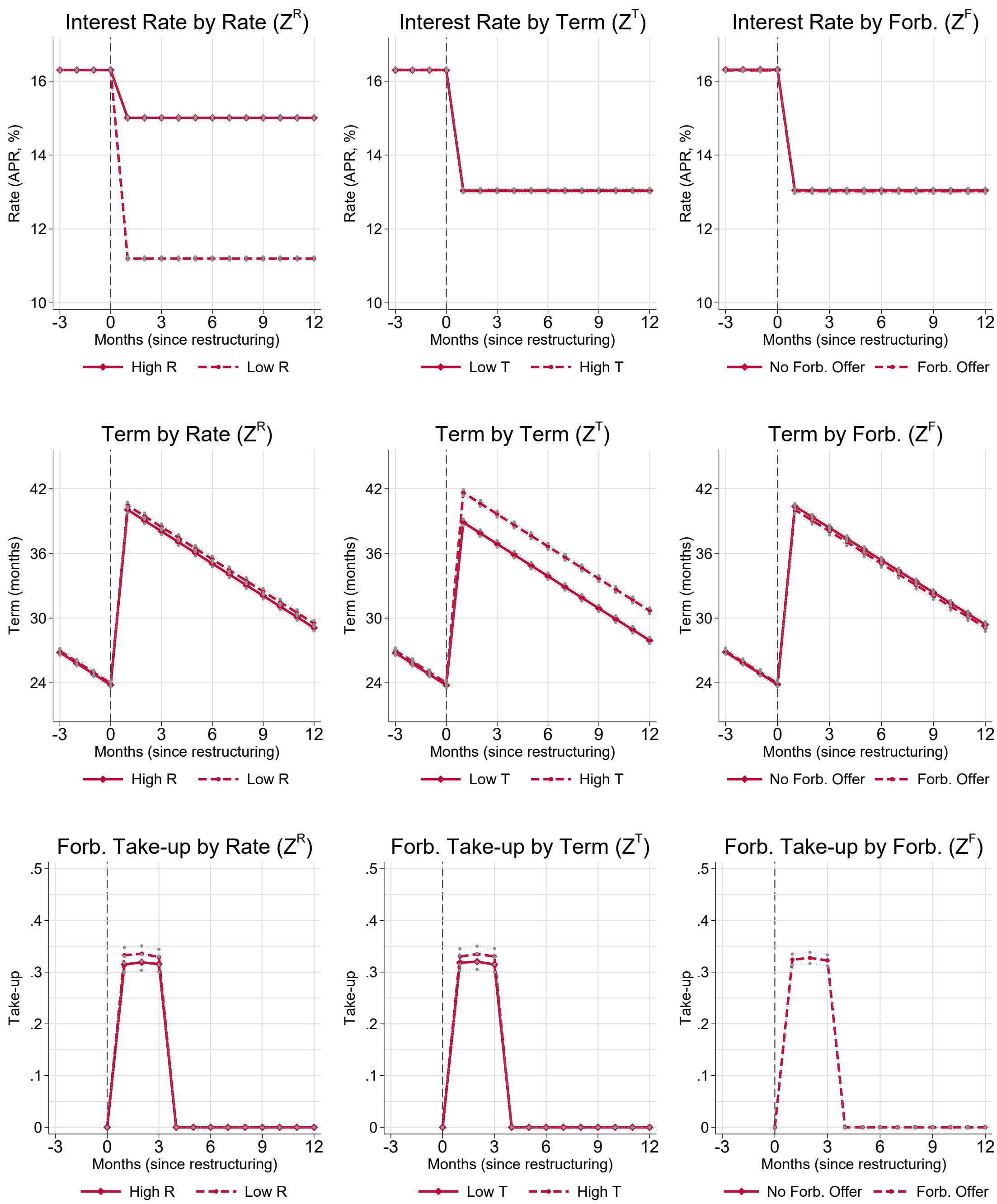
Figure 3 displays event studies for the first stage effect of the three instruments $\mathbb{Z}_i^k$ on the new contract interest rate R', term T', and take-up of the forbearance. In the event studies, t=0 is each participant's modification month. The x-axis indicates the months elapsed since modification. For brevity, I delegate the table that reports the first-stage effect estimates and the F-test p-values, Table 11, to Appendix C

The average interest rate for the original contract is 16.3% APR, which is reduced to an average of 15.0% APR for the high rate group $\mathbb{Z}_i^R = 0$ and 11.2% APR for the low rate group $\mathbb{Z}_i^R = 1$. The average difference in interest 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 the treatment and control groups 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 modification is 24 months. Almost all participants (99.4%) extend the term. 62.5% of participants choose the offered term. The remain-

[14]Fielding an experiment that does not benefit participants compared with the status quo is not possible. The benefits of term extensions and forbearance depend on borrower preferences, such as the discount rate R^*. In contrast, interest rate reductions unambiguously benefit the borrower. Hence, the experiment pushes interest rate reductions for everyone, randomly varying the magnitude of interest rate reduction by experimental assignment.

Figure 3: First Stage: Contract



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 modification—and t=0 corresponds to the month of modification. Dashed lines indicate 95% confidence intervals for the estimate of the mean.

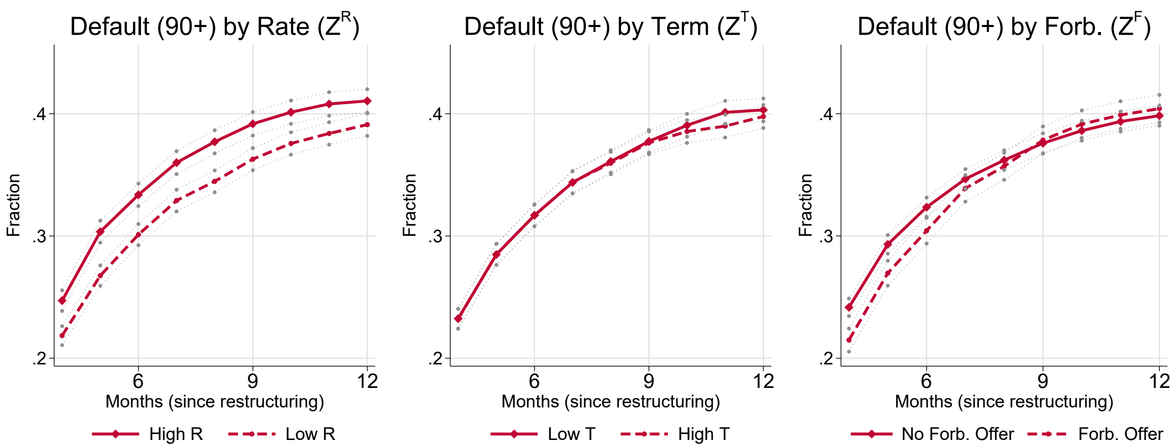
ing are about equally likely to choose a term below or above the recommendation (19.1% versus 18.4%). The average (median) term T' for the high-and low-term groups is 40 (36) versus 43 (48) months. The F-statistic for this first stage is 63.

35% of participants (7,308) are randomized to receive a forbearance offer. One-third of those offered forbearance take up this offer. The F-statistic for this first stage is 2,216. I discuss the take-up decision in detail in Table 14.[15]

4 Event Study

I begin by studying the effects of experimental assignments on the dynamics of defaults using event studies. 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 other accounts.

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 modification—and t=0 corresponds to the month of modification. Dashed lines indicate 95% confidence intervals for the estimate of the mean. Participants who modify the contract are expected to make the first monthly payment at t=1. If the first payment due in month t=1 is missed, Figure will show 90+ day delinquent status in month t=4.

Figure 4 plots average cumulative delinquency frequencies by $\mathbb{Z}^R$, $\mathbb{Z}^T$, and $\mathbb{Z}^F$. In the event studies, t=0 is each participant's modification month. The x-axis indicates the months elapsed since modification. The y-axis displays the cumulative fraction in each treatment leg that reaches 90+ day delinquent status. Dashed lines indicate 95% confidence intervals for estimates of the mean.

To quantify and perform statistical tests on the difference in conditional means for the different groups displayed in the event studies in Figure 4, I also report simple reduced form or intent-to-treat (ITT) linear probability regressions of the form:

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

For brevity, I relegate these estimates to Appendix D.

Participants who modify the contract are expected to make the first monthly payment at t=1. If the first payment due in month t=1 is missed, Figure 4 will show 90+ day delinquent

[15] In an environment where borrowers can substitute intertemporally without any constraints, we would expect those with lower interest rates to be more likely to extend loan terms or take up forbearance. There is indeed some evidence that participants in the high-interest rate group opt to shorten the debt term (by about half a month or 1%). There is no evidence to suggest that differences in interest rates or term encouragements compound forbearance take-up. As discussed later, this is likely because liquidity constraints counteract the forces of intertemporal substitution.

status in month t=4. 47% of participants miss (0+), and 30% are late (30+) on the first payment. 23% stop making payments right after modification 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 in Figure 4, the probability of falling into delinquent status shifts discernibly lower for participants in the low rate leg than in the counterfactual high rate leg. The probability of defaulting by month t=6 is reduced by 3.15 (s.e. 0.6) percentage points off a base of 32%, or by 10% relative to the mean delinquency rate. Importantly, the effect of interest rate reductions is immediate and persistent, decreasing long-run default probabilities (p=0.002).

The event study in the middle displays the effects of partially postponing the payment of principal through term extensions. This effect is smaller in magnitude compared with rate and forbearance in the short run. However, as I discuss later, it becomes more pronounced in the long run.

The event study on the right in Figure 4 shows the fraction delinquent for those who receive a forbearance offer versus those who do not. The figures show that forbearance also leads to a discernible reduction in short-run delinquencies, with an effect on 90+ day delinquent status visible in period t=6, 90 days after the expiration of forbearance. However, forbearance only shifts the timing of the default decision, with no long-run effects.

Offering forbearance reduces the likelihood of default by month t=4 and t=6 by 2.69 (0.6) and 1.96 (0.7) percentage points, respectively ($p < 0.001$ 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 $\frac{2.69}{0.328} = 8.2$ and $\frac{1.96}{0.328} = 6.0$ percentage points. Therefore, accepting the forbearance offer decreases delinquencies relative to the mean delinquency rate by 35% by month t=4 and by 19% by month t=6. After forbearance expires, defaults increase and catch up with the group not receiving a forbearance offer (p=0.73, 0.43, and 0.62 after 9, 12, and 15 months, respectively).

These patterns indicate that modifications orthogonal to face value affect whether and when a borrower defaults; hence are incompatible with accounting solvency being the sole trigger.

5 Results

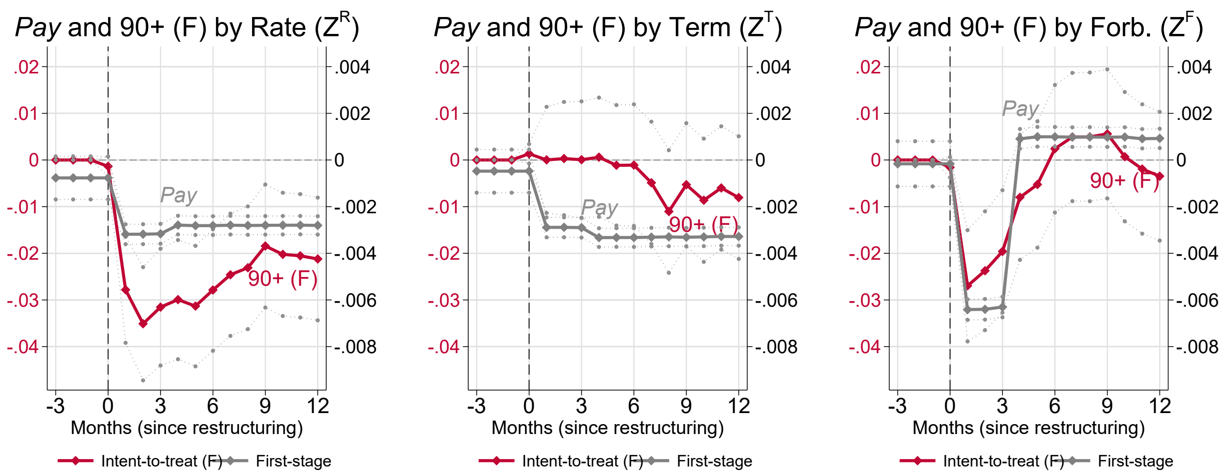
5.1 Liquidity Triggers

I now study the relationship between liquidity—immediate payments—and the default decision. I show that the elasticity of defaults to the reduction in payments is not constant but depends on the modification. In other words, a dollar in liquidity has different effects depending on the source. To test this implication, the novel design varies immediate payments for similar participants through different relief types.

To visualize the contemporaneous relationship between payments and the borrower's decision to default, Figure 5 superimposes the first stage differences reported in Table 11 (in gray) on the intent-to-treat estimates reported in Table 13 (in red). As previously, I juxtapose interest rate reductions, term extensions, and forbearance for contrasting effect. The left axis displays the reduction in delinquencies. The right axis displays the reduction in payments as a percentage of the face value at origination.

Regarding timing, the borrower observes *Pay* and then decides whether to stop making payments. Once she stops making payments in any given quarter, 90+ day delinquent status is reached 3 months later. To capture the concurrence between the decision to default and payments, the left-hand-side variable of the intent-to-treat specification is the 3-month-forward of 90+ day delinquent status.

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



Note. Estimates use Equation (4) $Y_i = \theta^R \mathbb{Z}_i^R + \theta^T \mathbb{Z}_i^T + \theta^F \mathbb{Z}_i^F + f_t + \varepsilon_i$ and superimposes the first stage on the intent-to-treat estimates. The x-axis represents months relative to modification, and t=0 corresponds to the month of modification for each participant. The red line and the left axis display the reduction in defaults from the linear probability intent-to-treat specification, where the left-hand-side variable is the three-month forward of 90+ status. The gray line and the right axis display the reduction in payments from the first stage specification, where the left-hand-side variable is *Pay*, payments normalized by the face value at origination. 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. Interest rate reductions lead to an immediate decrease in defaults that persists in the long run. Offering forbearance also leads to a decrease in defaults, with the 90+ day delinquent status picking up in the last month before forbearance expiration. However, the delinquency rate rises sharply when the payment of principal resume. Eventually, forbearance only shifts the timing of default.[16]

Quantitatively, Figure 5 shows that the reduction in payments entailed by a modification has a weak association with the borrower's default decision. Forbearance offers are targeted to and are taken by those who need liquidity the most and reduce payments, on average, twice as much as interest rate reductions. Similarly, term extension reduce payments by a magnitude and persistence similar to rate reductions. However, strikingly, delinquencies are noticeably more responsive to interest rate reductions.

Let ϕ denote the sensitivity of defaults to immediate payments, i.e., the liquidity effect. The Wald estimator of this sensitivity can be visually calculated as the ratio of these superimposed intent-to-treat (red) and first stage (gray) effects. To quantify this sensitivity ϕ and perform statistical tests, I study a specification of the following form:

[16] As the duration of forbearance is not matched to that of the economic shock, the focus is less on the long-run effects and more on its relative efficacy in the short-run compared with alternative policies.

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

where Pay is the quarterly (sum of three months) payment (flow) normalized by the face value. f_t denotes calendar month fixed effects. The error term ε_i accounts for delinquencies due to other factors, such as shocks to income, wealth, health, liabilities, risk, and other default costs. In this specification, I use data on a single cross-section in the first quarter for the 20,944 participants.

A borrower who observes Pay in the first quarter and decides to stop making payments at $t = 3$ will show up as 90+ at $t = 6$. Hence, as in Figure 5, the left-hand-side variable is the three-month-forward of 90+ status at $t = 3$ (which equals 90+ status at $t = 6$).

Estimating Equation (5) using OLS would identify ϕ from the variation that includes that in the magnitude of changes in Pay. However, variation in the magnitude of the change in $Pay_i|\mathbb{Z}_i^k$—although possibly uncorrelated with the error term ε_i— is not randomized. Therefore, the coefficient for ϕ is estimated using 2SLS, where either $\mathbb{Z}_i^R$, $\mathbb{Z}_i^T$, or $\mathbb{Z}_i^F$ are used as instruments, similar to Parker et al. (2013) and Aydin (2022). Randomization ensures that the experimental assignment is orthogonal to all other variables by construction; in particular, potential omitted variables and the residual ε_i.

Panel A in Table 5 reports the results. In the first column I restrict variation to $\mathbb{Z}_i^R$, akin to studies that use naturally occurring interest rate shocks (e.g., adjustable mortgage rate resets). In the second and third columns, I 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). This effect is of a marginal change in immediate payments equivalent to 1% of face value on the probability of default in percentage points.

The LATE is for participants induced by the instruments to see a change in the value of the endogenous regressors. The design automatically lowers the interest rate, and compliance is perfect. Hence, the instrument $\mathbb{Z}_i^R$ yields an average treatment effect (ATE). 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. Naturally, forbearance is taken by those who need liquidity the most. For the instrument, $\mathbb{Z}_i^T$, compliers are not observable. However, those who need liquidity the most (least) would take the highest (lowest) possible term—hence, compliers are likely positioned in the middle of the need distribution.[17]

A dollar change in payments has drastically different effects depending on the modification. When payments are reduced by 1% of face value through an interest rate reduction, the incidence of defaults decreases by 3.31 percentage points (p <0.001). By 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 immediate payments by more than three times to achieve an impact on delinquencies similar to that of rate reductions.

These patterns are incompatible with liquidity being the sole trigger of default and counter the notion that modifications reduce defaults only to the extent they reduce immediate payments.

[17]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. For $\mathbb{Z}_i^T$, monotonicity requires that borrowers with $\mathbb{Z}_i^T = 1$ do not choose a term shorter than what would prevail under $\mathbb{Z}_i^T = 0$.

Table 5: Treatment Effects of Immediate and Future Payments

Panel A: Sensitivity $Y_i = \phi Pay_i + f_t + \varepsilon_i$

Instrument			
$\mathbb{Z}^R$	✓		
$\mathbb{Z}^T$		✓	
$\mathbb{Z}^F$			✓
Pay	3.31	-0.007	1.03
Immediate	(0.72)	(0.74)	(0.35)

Panel B: Decomposition $Y_i = \phi Pay_i + \psi PV_i^{fu} + f_t + \varepsilon_i$

Instrument				
$\mathbb{Z}^R$	✓	✓	✓	✓
$\mathbb{Z}^T$	✓		✓	✓
$\mathbb{Z}^F$	✓	✓	✓	✓
			Controls	IV Probit
Pay	1.11	1.29	1.21	3.11
Immediate	(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)
$\mathbb{P}(\psi = 0)$	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. Panel A use Equation (5). Panel B uses Equation (6). N =20,944. The left-hand-side variable is the 3-month forward of the 90+ indicator.

5.2 Strategic Triggers

If strategic, able borrowers default by choice because it is an advantageous financial decision. They do so after weighing the costs and benefits with future payments, holding constant the ability to meet immediate payments (liquidity) and face value (accounting solvency). The novel design here allows for an investigation of strategic default triggered by (non-callable) future payments before they act through the budget constraint and affordability.

The smoking gun of the strategic effect is the instant and large reduction in delinquencies for borrowers in the low rate group. This effect can't be attributed solely to changes in immediate payments since interest rate reductions reduce payments the least and reduce delinquencies the most.

Recall that what distinguishes these debt relief policies is their effects on future payments. Forbearance moves immediate and future payments in different directions: the short-term reduction in payments is repaid with an approximately one-for-one increase in the present value of future payments. Thus, forbearance reduces defaults due to a liquidity effect and increases defaults due to a strategic effect, reflecting the difference in the sensitivity to immediate versus future payments. By contrast, interest rate reductions move immediate and future payments in the same direction, and thereby reduce defaults due to both a liquidity effect and a strategic effect. The effect on immediate payments is very small, and the effect on the present value of future payments is much larger.

In using naturally occurring data and variation to study the effects of forbearance and interest rate reductions, as in Equation (5), the present value of future payments, which is perfectly collinear with immediate payments, is an omitted variable. Hence, these research designs cannot distinguish the liquidity versus the strategic effects of changes in interest rates. The experimental variation shifts immediate and future payments in different directions, allowing for the identification of their contributions to the default decision.

Let ψ denote the sensitivity of defaults to PV_t^{fu}, i.e., the strategic effect. I first obtain a naive and nonparametric estimate of ψ using a *bivariate Wald* estimator. I do this by comparing the intent-to-treat and first-stage effects of $\mathbb{Z}^R$ and $\mathbb{Z}^F$.

The intent-to-treat effects of $\mathbb{Z}^R$ and $\mathbb{Z}^F$ on defaults in the first quarter are reported in Table 13 (-3.15 and -1.96 percentage points). The first stage effects of $\mathbb{Z}^R$ and $\mathbb{Z}^F$ on immediate quarterly payments (-0.96 and -1.92 of D_0) and the present value of future payments (-6.28 and -1.66 of D_0) reported in Table 12. I then solve the exactly identified system of two equations and two unknowns:

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

The relative contributions of immediate payments and the present value of future payments to defaults, ϕ and ψ, yield 1.28 and 0.31. Hence, defaults are triggered by immediate and future payments but are more sensitive to immediate payments. Moreover, a dollar change in the present value of future payments reduces defaults by as much as a ψ/ϕ =24-cent change in immediate payments—a strategic effect.

Using this identification strategy, I then decompose the effect of immediate payments, Pay, from the present value of future payments, PV^{fu}, using a linear probability model of the following 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 *immediate* 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 the face value at origination, D_0.

The present value is calculated assuming a discount rate of R^* of 18% APR (equivalent to 7% APR in real terms). 18% represents the highest interest rate observed in the sample, ensuring that all participants would find it beneficial to borrow in the first place. Later, I report results from alternative specifications in which the discount rate R^* varies. Heterogenous or higher discount rates do not materially affect the results.

Regarding timing, the borrower observes the current quarter Pay and the PV^{fu} of the payments that come after. The borrower then decides whether to stop making payments. Once she stops making payments, 90+ day delinquent status is reached 3 months later. In this specification, I use data on a single cross-section in the first quarter for the 20,944 participants.

The objects of interest are the coefficients ϕ and ψ, which give the instrumental variables estimate of the LATE for participants who see changes in immediate 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—all estimates include the variation in $\mathbb{Z}_i^T$.

The additional identifying assumption for the LATE interpretation is that the experimental assignment has no effect 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 5 (e.g., using rate reset as an instrument for immediate payments) due to the omitted PV^{fu} term, which the decomposition design here overcomes.

These estimates are reported in Panel B of Table 5. The first column provides estimates that use variation in all three instruments.[18] The point estimates for ϕ indicate that a decrease in Pay corresponding to 1% of the face value of debt decreases defaults by 1.11 percentage points. In comparison, a decrease in PV^{fu} corresponding to 1% of the face value of debt decreases 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 estimator discussed earlier.

Liquidity Equivalent of the Strategic Trigger

In Table 5, I display the liquidity equivalent ψ/ϕ that summarizes the sensitivity to future payments relative to immediate payments. This identified moment distinguishes between alternative models in ways that differ from the commonly estimated sensitivity of behavior to immediate payments.

If future payments have no effect, ψ/ϕ would yield 0. In a model with fungibility (i.e., indifference between \$1 today and \$1+R^*tomorrow) ψ/ϕ would yield 1. If immediate payments had no effect, ψ/ϕ would yield ∞. I estimate ψ/ϕ to be 0.3—a dollar change in the present value of future payments affects delinquencies similar to that of a 30-cent change in quarterly payments. This key moment also captures the strategic motive's relative strength. I examine this liquidity equivalent in more detail in the following sections.

Statistical Tests of Models

The models discussed in Section 1 make different predictions about the determinants of default. The bottom rows of Table 5 report the results of statistical tests of these models.[19]

In models in which liquidity is a trigger of default, borrowers default because immediate payments are too high. 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.

However, borrowers do not behave identically whether the reduction in immediate payments is accompanied by an increase or decrease in payments tomorrow, corresponding to the null hypothesis $H_0 : \psi = 0$. This hypothesis is also decisively rejected, with $\mathbb{P}(\psi = 0)$=0.001. The treatment effect estimates imply that the borrowers are strategic: They reduce defaults in response to announced but not yet realized reductions in future payments.

A special and knife-edge case of the strategic model is *fungibility*, which acknowledges that behavior is sensitive to immediate and future payments, and tests whether behavior is relatively *more* sensitive to immediate payments. In this case, a dollar change in immediate payments should have the same effect on borrower behavior as a dollar change in the present value of future payments—$H_0 : \phi = \psi$. The hypothesis of fungibility is also rejected, with p=0.017. In contrast, future payments are much less pronounced than the dollar-for-dollar benchmark with a liquidity equivalent of 30 cents.

[18]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). Hence, the PV effect ψ is identified mainly from the variation in $\mathbb{Z}_i^R$.

[19]In the *straw man* accounting solvency model, borrowers default because the face value of liabilities is too high. Hence, reducing immediate or future payments does not affect borrower behavior: $H_0 : \phi = \psi = 0$. Unsurprisingly, this hypothesis is decisively rejected, with $\mathbb{P}(\phi = \psi = 0) < 0.001$.

These results imply that an increase in immediate payments has about three times the impact of an increase in the present value of future payments. However, as interest rates have a very large effect on the present value of future payments, most of the defaults are attributable to future payments and strategic channels—see Section 7 for a discussion.

Finally, as a validation exercise, we can use the decomposition to estimate what the term effect *should* be. Remember that $\mathbb{Z}_i^T$ reduces payments just as much as $\mathbb{Z}_i^R$, and one-third of the effect of $\mathbb{Z}_i^R$ is due to the *Pay* effect. Analyzing the intent-to-treat effects in Table 13, the term effect is indeed about one-third of the rate effect (-1.85 vs. -0.54 after 12 months and -2.13 vs. -0.82 after 15 months).

Table 6: Balance Sheet Effects

		Panel A: Late Payments				*Panel B: Other*	
		0+	30+	120+	150+	30+	90+
	Base	58%	38%	30%	30%	4%	1%
Intent-to-treat	$\mathbb{Z}^R$	-3.58	-3.53	-3.00	-3.17	-0.11	-0.01
(OLS)		(0.68)	(0.67)	(0.63)	(0.63)	(0.25)	(0.14)
	$\mathbb{Z}^F$	-3.80	-3.08	-1.87	-1.62	0.84	0.28
		(0.71)	(0.70)	(0.66)	(0.66)	(0.27)	(0.14)
Treatment Effect	Pay	1.81	1.69	1.07	1.00	-0.26	-0.09
(2SLS)	Immediate	(0.31)	(0.31)	(0.29)	(0.29)	(0.12)	(0.06)
	PV^{fu}	0.29	0.30	0.31	0.35	0.06	0.02
	Future	(0.11)	(0.11)	(0.10)	(0.10)	(0.04)	(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

Note. Intent-to-treat estimates use Equation (4). Treatment effect estimates use Equation (6) on a single cross-section (N =20,944) in the first quarter, where the left-hand-side variable is the 3-month forward of the 90+ indicator at $t = 3$.

Further Analysis

Balance sheet effects. Panel A in Table 6 reports the effects on late payments. 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 20,944 participants.

The estimates in Panel A in Table 6 indicate that early-cycle delinquencies (e.g., 0+ and 30+ day delinquent status) are noticeably more sensitive to forbearance and immediate payments (i.e., liquidity-driven). By contrast, late-cycle delinquencies are relatively more sensitive to interest rate reductions and future payments (i.e., driven by strategic considerations). However, strategic effects remain pronounced at all lateness metrics, including 0+ and 30+ day delinquent status (p <0.01).

The literature often interprets being on-time on a secondary account (e.g., credit card, overdraft) but not on the primary account as an indication of strategic behavior. Panel B in Table 6 reports the effects on other accounts at the bank. These accounts represent credit line and overdraft accounts. Interest 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 have less need for the liquidity provided by these other accounts.

Table 7: Robustness: Discounting

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

Note. Estimates use Equation (6) on a single cross-section (N =20,944) in the first quarter, where the left-hand-side variable is the 3-month forward of the 90+ indicator at $t = 3$.

Discounting. In the previous analysis, I calculate present value equivalents assuming a discount rate of R^* of 18% APR.[20] Table 7 reports the results from alternative specifications in which the discount rate R^* varies.

In the first column, I calculate the present value of future payments as the nominal sum, assuming no discounting (R^*=0). This is the number read aloud and communicated in writing to the borrower. In the second and third columns, I use a discount rate of 24% and 48% APR, respectively. The 24% APR corresponds to the capped, and 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. In the fourth and fifth columns, I assume quasi-hyperbolic discounting, in which initial payments are heavily weighted. In the sixth column, I use the original contract interest rate, which allows individuals to discount the future differently. The original contract interest rate likely reflects the borrower's pre-experiment risk and discount rate. In each of these assumptions about the discount rate, I decisively reject the null hypothesis that strategic effects are absent and liquidity is the sole trigger of default. Heterogenous or higher discount rates do not materially affect the results.

Finally, forward-looking borrowers may anticipate default and base their decision on the payments they expect to make before defaulting. In the seventh column, I use the *expected* present value of future payments.[21] Under this specification, the strategic effects due to future payments become even more pronounced.

6 What Determines Relief Efficacy and Strategic Behavior?

I now turn to the why—what determines the relative efficacy of one type of relief over the other and whether a default is strategic? The central insight of modern debt default

[20]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.

[21]I calculate this expected present value using the predicted values obtained from the instrumental variables probit model reported in Table 5. I weigh two scenarios: loan defaults or loan cures. If the borrower defaults, payments are no longer made. In the case in which the loan cures, the present value is calculated in the usual way.

models (e.g., Chatterjee et al. (2007), Livshits et al. (2007), or Campbell and Cocco (2015)) is that a single optimization problem will endogenously yield different triggers depending on the circumstances. Hence, what relief works for whom and the extent of strategic behavior will be heterogeneous. Although the frictions invoked (e.g., distress, precaution, lack of assets) differ, all models emphasize the inability to perform intertemporal substitution, with similar implications for the shape of the default trigger.[22]

These implications have not previously been tested due to a lack of data on balance sheets and a lack of variation in balance sheets (say, around the discontinuity that identifies the treatment effects).

To test these implications, I examine the heterogeneity using baseline balance sheet metrics. These metrics proxy for state variables that capture the extent to which a borrower is constrained: the degree of distress, the number of times credit constraints bind, and checking account balances.

Table 8 and Table 9 report the estimates. In these tables, columns are ranked by borrowers' intertemporal substitution capacity. Panel A splits by the degree of delinquency—number of days late; Panel B by the frequency with which credit limits bind (i.e., credit card debt-to-limit ratio above 75%);and Panel C by checking balances.

Table 8: Heterogeneity: Forbearance vs. Interest Rates

	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	$\emptyset$	High	Low	$\emptyset$	Low	High
Fraction	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
	$\leftarrow$ Constrained			$\leftarrow$ Constrained			$\leftarrow$ Constrained		

Note. Estimates use Equation (4) $Y_i = \theta^R \mathbb{Z}_i^R + \theta^T \mathbb{Z}_i^T + \theta^F \mathbb{Z}_i^F + f_t + \varepsilon_i$ on a single cross-section (N =20,944) in the first quarter, where the left-hand-side variable is the 3-month forward of the 90+ indicator at $t = 3$. Columns are ranked by borrowers' intertemporal substitution capacity. Panel A reports results by the degree of delinquency one month before modification. Panel B reports results based on the frequency with which credit limits bind. Panel C reports results based on checking balances.

[22] For example, precautionary saving shortens the effective planning horizon and renders irrelevant strategic considerations due to news about payments after hitting the constraint. Similarly, a lack of assets may hamper the borrower's ability to respond to news about future payments before they act through the budget constraint.

Heterogeneity: Forbearance vs. Interest Rates

Table 8 reports heterogeneous intent-to-treat effects as in Equation (4). The absolute and relative effects of modifications are quite heterogeneous, with two discernible patterns. First, focusing on absolute effects, interest rate reductions decrease defaults for all subgroups, but forbearance does not. This is because forbearance only alters the timing of payments and is only effective if the behavior is more sensitive to immediate payments than future paymentsSecond, focusing on relative effects, interest rate reductions are more effective than forbearance for all subgroups and substantially more effective (twice as much or more) for the unconstrained. This is because behavior is sensitive to future payments for unconstrained borrowers, which renders interest rate reductions a much more powerful tool.

The third column in Panel A focuses on early-cycle delinquencies (<30 days late). For this group, 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 (a 4.55 percentage point reduction off 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 participants without a credit line (column B1), take-up of forbearance prevents 1 in 3 defaults ($\frac{3.52}{0.37}$ off a base of 28%). In contrast, for participants with a credit line and whose credit limits bind infrequently (column B3), take-up of forbearance prevents only 1 in 6 defaults ($\frac{1.63}{0.33}$ off a base of 29%). Similarly, focusing on Panel C, take-up of forbearance prevents 1 in 3 defaults ($\frac{3.58}{0.36}$ off a base of 28%) for participants without a checking account (column C1) but only 1 in 6 ($\frac{1.67}{0.33}$ off a base of 29%) for participants who have high checking balances (column C3).

In contrast to forbearance, interest rate reductions unambiguously benefit the borrower and reduce defaults for all subgroups. Moreover, forbearance is relatively less effective than interest rate reductions for all subgroups. However, interest rate reductions are substantially more effective (twice as much or more) for participants who can intertemporally substitute more. These are participants who are non-delinquent, whose borrowing constraints bind less frequently, and who hold higher liquid checking assets (A3, B3, and C3).

Heterogeneity: Liquidity vs. Strategic Triggers

Table 9 reports heterogeneous treatment effects, as in Equation (6). Compatible with the intent-to-treat effects, the sensitivity of defaults to immediate versus future payments also depends on distress, precaution, and assets.

Delinquencies are most sensitive to immediate payments (i.e., liquidity triggered) for the most constrained groups (90+ in A1, no credit line in B1, no checking account in C1). Notably, for non-delinquent borrowers (A3), the sensitivity of defaults to immediate payments is very close to zero (p=0.91).

Figure 6 displays the heterogeneity in the liquidity equivalent ψ/ϕ. For all metrics, the relative effect of future payments is monotonically increasing in borrowers' intertemporal substitution capacity. The liquidity equivalent is smallest, at 9 cents, for borrowers without a checking account (C1) and borrowers without a credit line (B1). This is compatible with checking balances facilitating intertemporal substitution and precautionary behavior countervailing intertemporal substitution.

Table 9: Heterogeneity: Liquidity vs. Strategic

	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	$\emptyset$	High	Low	$\emptyset$	Low	High
Fraction	0.30	0.59	0.11	0.14	0.43	0.43	0.10	0.45	0.45
Pay Immediate	2.40	0.66	0.08	2.19	0.79	1.09	2.08	1.04	0.97
	(0.55)	(0.38)	(0.70)	(0.87)	(0.46)	(0.42)	(0.91)	(0.45)	(0.43)
PV^{fu} Future	0.39	0.28	0.23	0.43	0.20	0.39	0.19	0.23	0.44
	(0.18)	(0.14)	(0.22)	(0.25)	(0.17)	(0.15)	(0.30)	(0.16)	(0.15)
$\mathbb{P}(\psi = 0)$	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
	← Constrained			← Constrained			← Constrained		

Note. Estimates use Equation (6) $Y_i = \phi Pay_i + \psi PV_i^{fu} + f_t + \varepsilon_i$ on a single cross-section (N =20,944) in the first quarter, where the left-hand-side variable is the 3-month forward of the 90+ indicator at $t = 3$. Columns are ranked by borrowers' intertemporal substitution capacity. Panel A reports results by the degree of delinquency one month before modification. Panel B reports results based on the frequency with which credit limits bind. Panel C reports results based on checking balances. The liquidity equivalent ψ/ϕ summarizes the sensitivity to future payments relative to immediate payments.

Characterizing the Trigger

The heterogeneous effect estimates in Figure 6 allow for informative inferences regarding the shape of the single strategic default trigger. For an unconstrained borrower, a dollar change in future payments should affect defaults just as much as a dollar change in immediate payments. However, binding constraints make a much smaller change in immediate payments sufficient to trigger a default. That is, constraints accelerate default by decreasing the liquidity equivalent of the strategic trigger level. This intuition is best captured by a model in the spirit of Campbell and Cocco (2015).

7 Discussion

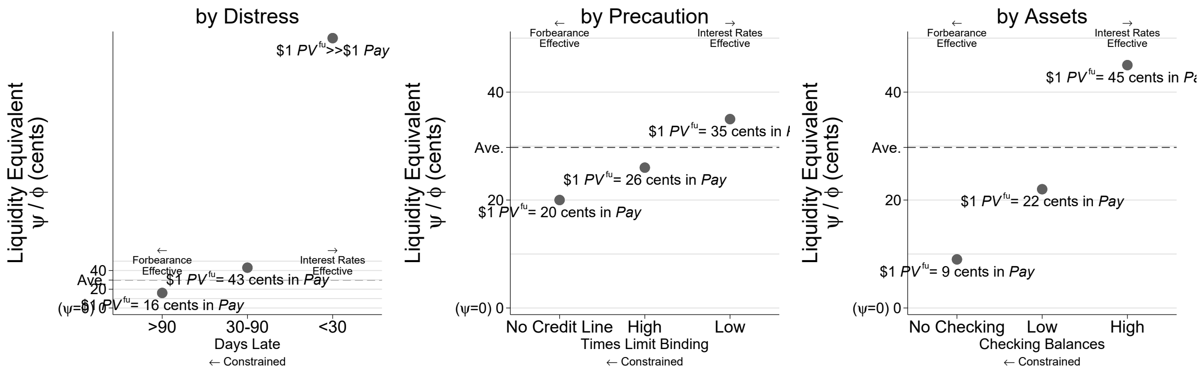
Interest Rate Pass-through

Interest rate reductions (e.g., refinancing a mortgage) are often interpreted in modeling and policy as a liquidity shock that affects behavior to the extent it affects immediate payments. However, the findings suggest that the effects on future payments and strategic channels account for most of the impact of interest rate changes.

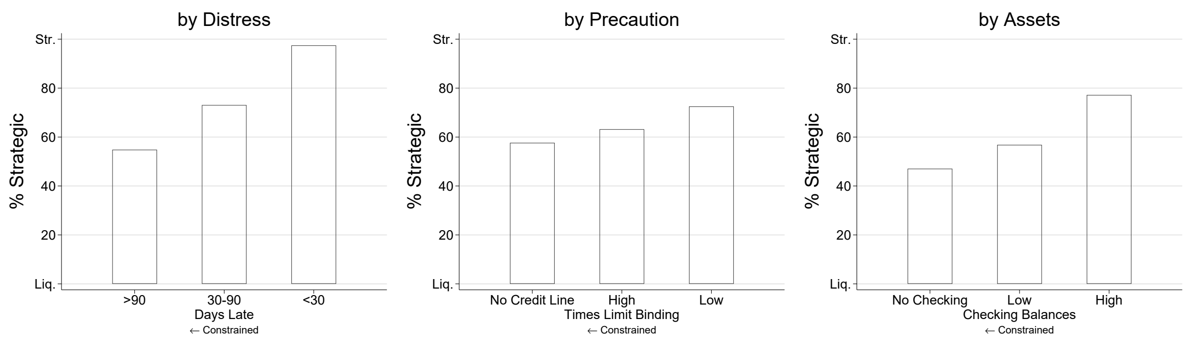
The experiment allows for the following decomposition of the share of the behavioral

Figure 6: Heterogeneity

Panel A: Liquidity Equivalent of the Strategic Trigger



Panel B: Liquidity versus Strategic Effects of Interest Rates



Note. Panel A plots the ratio ψ/ϕ—liquidity equivalent of the strategic trigger level—from the treatment effect specification Equation (6) by bin, as reported in Table 9. The Figure informs regarding the shape of the default trigger—binding constraints cause a much smaller change in immediate payments sufficient to trigger a default. Panel B displays the share of the behavioral response to interest rates that is attributable to a strategic effect (as opposed to a liquidity effect), as calculated in Equation (7).

response to interest rates that is attributable to a strategic effect:

$$\frac{\Delta Y}{\Delta R} = \underbrace{\underbrace{\frac{\Delta Y}{\Delta Pay}}_{\hat{\phi}=1.11} \underbrace{\frac{\Delta Pay}{\Delta R}}_{0.96\%\ D_0}}_{\text{Liquidity}\approx\frac{1}{3}} + \underbrace{\underbrace{\frac{\Delta Y}{\Delta PV^{fu}}}_{\hat{\psi}=0.33} \underbrace{\frac{\Delta PV^{fu}}{\Delta R}}_{6.28\%\ D_0}}_{\text{Strategic}\approx\frac{2}{3}} \tag{7}$$

where 1.11 and 0.33 are estimates of the sensitivity of behavior to immediate and future payments, ϕ and ψ, respectively, and 96 cents and \$6.28 per \$100 of D_0 are the corresponding first stage effect of interest rate reductions. Hence, one-third of the effect of interest rate reductions on delinquencies is due to liquidity effects (immediate payments), with two-thirds due to strategic effects (future payments).

The strategic effects of interest rate changes through future payments are economically large and provide a reduction in delinquencies as much as a reduction in payments equal to 5% of average monthly household disposable income:

$$\frac{\phi}{\psi} \times \gamma^R \times \frac{D_0}{Y} = \frac{0.33}{1.11} \times 6.28\% \times \frac{10,403}{3,844} = 0.051$$

In other words, a debt relief needs to transfer a borrower 5% of the average monthly household disposable income to replicate the strategic effects of interest rate changes that are due to future payments. [23] These strategic effects are unique to interest rates and are not replicable by postponing or rescheduling the payment of principal. To compensate, a forbearance program should reduce immediate payments by about three times what interest rate reductions do to obtain a similar impact on delinquencies; see Table 5. This demonstrates that interest rate reductions get into the cracks that modifications that postpone or reschedule payments cannot.

Targeting: Which Modification for Whom

The heterogeneous effect estimates in Table 8 and 9 inform regarding the targeting of policies. In particular, the analysis shows a direct connection between the relative efficacy of a policy and the ability to substitute—distress, precaution, and assets. These factors determine whether a) forbearance or interest rate reductions are more effective; b) behavior is sensitive to immediate versus future payments; and c) defaults are triggered by liquidity versus strategic considerations.

Behavior is sensitive to future payments for unconstrained borrowers, which renders interest rate reductions a much more powerful tool. This group is highly strategic. In contrast, for constrained borrowers (e.g., deeper delinquency, more frequently binding constraints, fewer assets), behavior is less sensitive to future payments, which renders interest rates a less and forbearance a more powerful tool. These groups are not strategic.

At one extreme, in a typical (non-delinquent) refinancing scenario (i.e., A3 in Tables 8 and 9), forbearance is not effective; 98% of the behavioral response to interest rates is attributable to a strategic effect. In this scenario, the effects on future payments account for more or less the entire impact of interest rate changes.[24]

At the other extreme, for the most constrained groups (e.g., deeper delinquency, more frequently binding constraints, fewer assets: A1, B1, and C1 in Table 8 and 9) behavior is less sensitive to future payments (and less strategic), which renders interest rates a less and forbearance a more powerful tool. In sum, the less constrained a borrower, the more interest rates get into the cracks that rescheduling policies that act on payments cannot.

Generalizability

How would the results differ if the experiment were replicated for different samples, circumstances, or settings?

In terms of the sample, the participants primarily consist of delinquent borrowers who hold little to no assets and frequently face binding borrowing constraints. If the experiment were replicated across a broader population (who can better substitute: i.e., non-delinquent refinancing, as in A3 of Table 9), we would expect that forbearance is ineffective, and interest rate reductions are the more powerful relief tool.

[23] In this calculation, ϕ and ψ are the sensitivity of defaults to Pay and PV_t^{fu}, obtained from Equation (6); γ^R is the first-stage effect of $\mathbb{Z}^R$ on PV^{fu} estimated using Equation (4); D_0 is the nominal face value of the principal in local currency, reported in Table 2; and Y is the average monthly household disposable income in local currency. Hence, the effect of interest rates on the present value of future payments equals 17% of average monthly household disposable income, and the liquidity equivalent of this number is calculated by multiplying by 0.30.

[24] Even for participants who are the least able to substitute intertemporally, strategic effects account for no less than 50% of the total effect. Hence, the findings are incompatible with a simple two-agent calibration with stylized heterogeneity.

In terms of circumstances, background policies that ease constraints and allow for better intertemporal substitution (e.g., fiscal stimulus payments), as well as those that reduce background risk—and hence precautionary behavior—would also complement and render interest rates more powerful.

The costs and benefits associated with default (e.g., deadweight loss, stigma, postponing or preventing repayment, etc.) will be a key determinant of behavior. Borrowers default due to strategic considerations when it is a more advantageous financial decision if the present value of future payments is higher than the costs associated with default. On the benefit side, default substantially postpones (2 to 3 years). It also often prevents recovery, as many borrowers are unemployed or employed informally (one-third of the working population) or have no leviable bank account or confiscatable illiquid assets. Hence, even in the absence of bankruptcy, default often prevents recovery and leads to a definitive relief of the debt burden. On the cost side, default obstructs access to credit markets for five years. An increase in such costs (or a decrease in benefits) will hamper the attractiveness of default due to the strategic motive, which will render interest rates less and forbearance a more powerful tool.

Finally, the results offer a reconciliation of conflicting results from previous studies and provide a unifying explanation regarding the conditions under which liquidity versus strategic behavior triggers default. Dobbie and Song (2020) and Ganong and Noel (2020), estimate ψ/ϕ, as ∞ 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 that 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

A Approximations to Payments and Present Value

A.1 For Pay

For $x = R$ and $f(x) = x[1-(1+x)^{-T}]^{-1}$, the Taylor series at $x = 0$ is given by:

$$
\begin{aligned}
f(x) &= f(a) + \frac{f'(a)}{1!}(x-a) + \frac{f''(a)}{2!}(x-a)^2 + \frac{f'''(a)}{3!}(x-a)^3 + \dots \\
&= \frac{x}{1-(1+x)^{-T}}\bigg|_{x=0} + \frac{1-(1+x)^{-T} - xT(1+x)^{-T-1}}{(1-(1+x)^{-T})^2}\bigg|_{x=0} + \dots
\end{aligned}
$$

Applying L'Hôpital's rule to $f(0)$, $f'(0)$, and $f''(0)$

$$
\lim_{x\to 0} f(x) = \lim_{x\to 0} \frac{1}{T(1+x)^{-T-1}} = \frac{1}{T}
$$

$$
\begin{aligned}
\lim_{x\to 0} f'(x) &= \lim_{x\to 0} \frac{T(T+1)x(x+1)^{-T-2}}{2T(x+1)^{-2T-1}((x+1)^T - 1)} \\
&= \lim_{x\to 0} \frac{-T(T+1)(x+1)^{-T-3}((T+1)x-1)}{-2T(x+1)^{-2T-2}((x+1)^T + T((x+1)^T-2)-1)} \\
&= \frac{T(T+1)}{2T^2} \\
&= \frac{T+1}{2T}
\end{aligned}
$$

$$
\lim_{x\to 0} f''(x) = \frac{(T^2-1)}{12T}
$$

which gives:

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

A.2 For PV^{fu}

Let $g(x) = x^{-1}\cdot[1-(1+x)^{-T}]$, the Taylor series at $x = 0$ is given by:

$$
g(x) = \frac{1-(1+x)^{-T}}{x}\bigg|_{x=0} + \frac{Tx(x+1)^{-T-1} + (x+1)^{-T} - 1}{x^2}\bigg|_{x=0} + \dots
$$

Applying L'Hôpital's rule to $g(0)$, $g'(0)$, and $g''(0)$

$$\lim_{x\to 0} g(x) = \lim_{x\to 0} \frac{T(1+x)^{-T-1}}{1} = T$$

$$\lim_{x\to 0} g'(x) = \frac{T(T+1)}{2}$$

$$\lim_{x\to 0} g''(x) = \frac{T(T+1)(T+2)}{6}$$

$$\begin{aligned}
PV_0 &= \text{Present Value}_0/FV_0 \\
&= Pay \cdot \left(T - \frac{T(T+1)}{2}R^* + \frac{T(T+1)(T+2)}{6}R^{*2} + O(R^{*3})\right) \\
&= \left(\frac{1}{T} + \frac{(T+1)}{2T}R + \frac{(T^2-1)}{12T}R^2 + O(R^3)\right)\left(T - \frac{T(T+1)}{2}R^* + \frac{T(T+1)(T+2)}{6}R^{*2} + O(R^{*3})\right) \\
&= 1 - \frac{(T+1)}{2}R^* + \frac{(T+1)}{2}R + \frac{(T+1)(T+2)}{6}R^{*2} - \frac{(T+1)^2}{4}RR^* \\
&\quad + \frac{(T+1)^2(T+2)}{12}RR^{*2} + \frac{T(T^2-1)}{12}R^2 + \frac{(T^2-1)(T+1)}{24}R^2R^* \\
&\quad + \frac{(T^2-1)(T+1)(T+2)}{72}R^2R^{*2} \\
&\simeq 1 + (R - R^*)\,\frac{T+1}{2}
\end{aligned}$$

The last line focuses only on the first-order terms.

B Institutional Details

B.1 Macroeconomic Environment

Table 10: 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: Türkiye Data Monitor, IMF, Bloomberg, Turkstat, and Worldbank.

The effectiveness of debt relief 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), nothing during this period suggests that banks or the government are culpable.

B.2 Unsecured Loans: Underwriting

At initial underwriting, applicants first declare their education level, employment title, and monthly disposable income. They then state the amount they want to borrow and choose a 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. Credit is rationed. For borrowers who can access personal loans, equilibrium credit terms vary slightly with borrower risk, with only a 260 bps APR difference in interest rates between the 10th and 90th percentiles. Borrowers have the free option to prepay the loan at face value without a penalty.

C First Stage Effects

Table 11 reports 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 4. Also reported in the Table is the F-test p-value, which tests the null hypothesis that all coefficients on instruments $\mathbb{Z}_i^k$ are jointly equal to zero.

Table 11: First Stage Effects on Contract

	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. F-test p-value is for the null hypothesis that the coefficient estimates θ^k are jointly equal to zero.

The first stage effect of forbearance offers is reported in columns three and four in Table 11. The results in column 4 are for participants offered forbearance ($\mathbb{Z}^F$=1). [25] Take-up

[25] In a linear probability model in which the new contract interest rate R' and term T' are used as the explanatory

of the forbearance offer is tightly linked to the remaining term of the original contract. For example, borrowers with an additional 12 months remaining on their original 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 D, with a 1% increase in D decreasing the take-up by about 2 percentage points.

C.1 Payments and Present Value

Table 12 reports the first stage effect of experimental assignment on immediate payments separately by $\mathbb{Z}^R$, $\mathbb{Z}^T$, and $\mathbb{Z}^F$. These first stage estimates quantify the exogenous differences in payment flow between the treatment and control groups using OLS. The first column focuses on payments in the quarter before the expiration of the forbearance. The second column focuses on payments in the quarter after the expiration of forbearance.

Table 12: First Stage Effects on Immediate and Future Payments

	Pay_1 Immediate	Pay_2 Immediate	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)
F	401	160	2,128	816

Note. Table reports the first stage effects on immediate payments in quarter t, Pay_t, and the present value of future payments coming after quarter t, PV_t^{fu}. N=20,944. Both are normalized by and expressed as a percentage of face value at the time of modification D_0. F-test p-value is for the null hypothesis that coefficient estimates are jointly equal to zero.

All modifications reduce immediate payments. Interest rate reductionsentail a similar effect on payments compared to the effect of term extension encouragements, reported in the middle row, and a much smaller effect on payments compared to forbearance offers, reported at the bottom row—equivalent to 96 cents, 88 cents, and $1.92 for each $100 of face value, respectively. As payments are relatively more sensitive to term than the interest rate, the small difference in terms between the treatment and control groups creates a reduction in payments similar to the interest rate reductions. The reduction in payments entailed by forbearance offers (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.

variables, and $\mathbb{Z}_i^R$ and $\mathbb{Z}_i^T$ are used as instruments, a percentage point APR change in the interest rate leads to a 0.32 percentage point drop. A 1-month change in the new 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.

D Intent-to-treat Effects

In Equation (4), the error ε_i accounts for delinquencies due to other factors, such as shocks to income, wealth, health, liabilities, 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 13: Intent-to-treat Effects

	$Y_i = \theta^R \mathbb{Z}_i^R + \theta^T \mathbb{Z}_i^T + \theta^F \mathbb{Z}_i^F + f_t + \varepsilon_i$					
	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. N=20,944.

The first three columns focus on the short run, within the 90 days of forbearance expiration. Accordingly, use 90+ day delinquent 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+ day delinquent status after 9, 12, and 15 months as the left-hand-side variable.

Table 14: 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)
$\log(D)$				-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 term T' are instrumented using $\mathbb{Z}_i^R$ and $\mathbb{Z}_i^T$. Columns (F) to (I) also add demographic controls.