Debt Relief Without Public Spending: Corporate Debt Moratoria and Macroeconomics[1]

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Abstract

Can economic activity be stimulated in crises without additional public spending? We study corporate debt moratoria—temporary suspensions of scheduled loan payments—using Colombian administrative credit-registry data. Exploiting a sharp regulatory eligibility threshold, we show that financially distressed firms granted a moratorium obtain new credit more often and on better terms: loans are larger and interest rates are lower, and subsequent delinquency declines. These credit-market improvements translate into real effects: a full suspension of scheduled debt payments raises annual investment by 15 percent and employment by 2 percent. We then develop a quantitative model of corporate borrowing and default that is disciplined by these micro responses. The model implies that a one-off, unanticipated moratorium relaxes rollover constraints and improves welfare in the short run, whereas recurrent and anticipated moratoria can lower welfare through equilibrium pricing and portfolio substitution. Finally, we show that significant welfare gains are attained if the policy includes the forgiveness of interests accrued during debt suspension.

Keywords: Moratoria, default, regression discontinuity
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"If *it is difficult for someone to repay a debt, postpone it until a time of ease. And if you waive it as an act of charity, it will be better for you, if only you knew.*" –Qur'an 2:280

1 Introduction

How can governments stimulate economic activity during major disruptions without resorting to costly bailouts? While the design of firm-level interventions has long been debated, debt moratoria—temporary suspensions of debt repayments—remain an under-explored yet historically grounded policy tool.[1] Paradoxically, despite their deep roots, these policies only recently gained prominence, with over 70 countries implementing them during the COVID-19 crisis (see Section Appendix A). This rapid and widespread adoption stands in contrast to their limited presence in the academic literature, which has largely focused on alternative mechanisms for debt resolution and financial relief.

To fill this gap, we combine quasi-experimental evidence with a disciplined structural model. Our first contribution uses high-quality administrative credit registry data and a regression discontinuity design (RDD) to identify the causal effects of debt moratoria on firm borrowing, investment, and labor outcomes. The RDD delivers clean local estimates of an unanticipated payment suspension, but by construction it cannot address how moratoria operate once they are anticipated, priced, and embedded into long-term credit contracts, nor how firms' real decisions adjust over time. In particular, reduced-form methods are silent about the consequences of recurrent moratorium policies, their long-run effects on leverage and default incentives, and whether design features—such as suspending interest accrual versus pure payment deferral—generate welfare gains. Our second contribution develops a quantitative general equilibrium model that is disciplined by the RDD moments and extends the analysis to these dimensions. The model allows us to evaluate moratoria as equilibrium financial instruments, quantify their long-run and welfare implications, and study how policy design shapes firm behavior when payment suspensions become a foreseeable part of the credit environment as part of policy toolkit.

On the empirical front, we use Colombian firm-level credit registry data from 2018–2021 to study the effects of COVID-era debt moratoria on financially distressed firms, defined as firms with overdue loan payments. Our identification strategy exploits a sharp eligibility rule: firms qualified for the moratorium only if they were no more than 60 days past due as of February 29, 2020. Because this cutoff is predetermined and backward-looking, and because it was announced only on March 17, 2020, it is not possible that firms could

[1] For example, if a firm's final scheduled payment was due in Q1 2025 and it receives a six-month moratorium, the new final payment would shift to Q3 2025.

have manipulated their delinquency status to sort around the threshold. This institutional feature yields a credible regression discontinuity design comparing firms just below and just above the cutoff.

The data show that moratoria substantially improved the terms and availability of new credit for eligible stressed firms. Treated firms obtain larger new loans at lower interest rates and exhibit lower subsequent default, consistent with moratoria easing short-run rollover and liquidity constraints. These credit-market effects translate into real activity: treated firms expand employment and investment and experience higher operating revenues and assets. For completeness, we also study non-stressed firms using a difference-in-differences design; effects are muted or adverse, reinforcing that moratoria operate primarily by relaxing constraints for marginal, crisis-hit borrowers.

Reduced-form evidence alone, however, cannot evaluate moratoria when they become anticipated and priced into credit contracts, nor can it quantify the long-run and welfare consequences of repeated use. These issues are first-order in practice: moratoria have been repeatedly reintroduced and are now partly foreseeable, and countries differ sharply in program design—most importantly, whether interest accrues during the suspension period (as in Colombia) or is forgiven (as in Belgium). To address these questions, we develop a quantitative model of corporate borrowing and default with long-term standard debt and a state-contingent moratorium instrument. Both instruments are priced endogenously in equilibrium, and firms optimally choose their debt portfolios and real decisions (capital and labor) under aggregate financial conditions and productivity shocks. The model is disciplined by the RDD moments and serves as a policy laboratory for counterfactual program designs and regimes. A key feature of our approach is that the quantitative model is tightly disciplined by the quasi-experimental evidence. We discipline the model by targeting one key causal moment (investment response) and use the remaining RDD responses of new borrowing, interest rates, default, investment, and labour to an unanticipated payment suspension as non-targeted validation checks. In the model, we replicate the empirical environment by introducing a one-time, unexpected moratorium and choose parameters governing adjustment dynamics so that the model reproduces these local responses. This strategy ensures that the model is anchored in the same margin of variation identified in the data and that the counterfactual exercises—recurrent moratoria, alternative contract designs, and welfare analysis—are conducted in an environment that is quantitatively consistent with observed firm behaviour.

The quantitative analysis delivers three sharp lessons. First, in line with the RDD, a one-time, unexpected moratorium provides crisis-time liquidity insurance and mitigates default and real contraction at the margin. Second, when moratoria become recurrent and

anticipated, equilibrium pricing and portfolio substitution dominate: firms tilt borrowing toward moratorium-eligible instruments and pay an insurance premium in normal times, so welfare reflects an insurance–dilution trade-off under discretion. Third, once we allow for production and factor choices, a moratorium that is merely NPV-neutral—a pure deferral with interest accrual—need not raise welfare even if it improves crisis outcomes; welfare gains arise primarily when programs embed debt relief, such as interest forgiveness, because they reduce post-crisis debt burdens and default incentives.

Our quantitative model clarifies why the effects of moratoria depend critically on whether they are *one-off* or *recurrent*. In an unanticipated, one-time intervention, a payment suspension acts as emergency liquidity insurance: it relaxes constraints in the crisis state, prevents defaults, and boosts investment, output, and welfare. When moratoria are expected to recur, however, the policy is priced into credit contracts and internalized in firms' financing choices. The resulting equilibrium features persistent substitution toward moratorium-eligible borrowing and higher expected financing costs in distress states, with only muted effects on aggregate quantities and, in our calibration, lower welfare. This contrast does not imply that anticipated moratoria are irrelevant—any credible emergency trigger will be priced—but rather that welfare hinges on frequency, targeting, and contract design. In particular, rare, well-targeted interventions can deliver meaningful stabilization benefits, whereas frequent use can generate an insurance–dilution trade-off under limited commitment.

Literature Review: Debt moratorium is one of the oldest practices to address debt repayment problems, but only a handful of research exists on their effectiveness. Earlier research has mainly examined the legislative process of enacting moratorium laws, mainly related to farm foreclosures following a drought (Woodruff, 1937, Alston, 1984). More recently, Dinerstein, Yannelis and Chen (2023) evaluated the effects of the 2020 student debt moratorium, which suspended payments for student loans in the United States. Within this broader context, there exists a substantial body of influential research examining the effectiveness of various debt forbearance measures, including: refinancing, restructuring, and modifications to loan terms such as interest rates, principal, and maturity. Notable among these are the works of: Mian, Rao and Sufi (2013), Mian and Sufi (2011), and Ganong and Noel (2020) which are all concentrated on the aspect of consumer debt. Nevertheless, none of these evaluate the effects of debt suspension.

On the quantitative side, our paper also contributes to the literature on state-contingent assets associated with long-term debt and default. Building upon the framework of Hatchondo et al. (2025), which quantitatively examines the suspension of sovereign debt payments using contingent convertible bonds triggered by changes in the EMBI spread,

our quantitative model extends this framework by incorporating a production technology component. Additionally, our research aligns with studies such as Aguiar et al. (2019), Dvorkin et al. (2021), and Mihalache (2020), which delve deeply into the trade-offs between employing maturity extensions and debt forgiveness in the context of debt restructuring for the sovereign debt literature.

2 The Colombian Case

2.1 Matching Firm- and Bank-level data

We use administrative data from the Financial Superintendency (*Superintendencia Financiera de Colombia, Formato 341*) comprising the entire Colombian credit registry (at the loan level) from Q1-2018 to Q4-2021. The data (firm-bank pairs) contain over 4.4 million observations with information on all loans extended to corporates, such as interest rates, outstanding loan amounts, remaining maturity, value of the collateral for guaranteed loans, delinquency days (i.e., days past due), ex-ante probability of default, and ex-ante credit rating.[2] For clarity, while the loan data are reported quarterly, they trace the daily origination of new loans as well as non-performing days.

We merge these data with yearly firm-level balance sheet information from the EMIS (*Emerging Markets Information System*) database to include firm-specific variables such as asset size, liabilities, profits, operating revenue, investment, and equity. We obtain data on employment from CONFECAMARAS (*Colombian Confederation of Chambers of Commerce*), although only for a reduced subset of firms as per data availability. After merging these sources, which focuses mainly on stressed firms, we match 50,152 *existing* loans (which originated before Q4-2019) provided by 37 financial entities (mostly private banks) to 23,932 firms. Given that our unit of measurement consists of new loans disbursed from bank j to firm i in quarter t, we observe close to 100,000 new loans.

The empirical analysis aims to estimate the effect of the debt moratorium on two main dimensions: new loan conditions and firm performance. In terms of the former, we use loan data for each firm-bank pair and trace any new credit disbursed after the policy (during Q1-2020 to Q4-2021). That is, for each new loan we employ the information at the quarter of origination. In terms of the latter, we employ information from firm balance sheets during 2020-2021 related to: (i) operating revenues, (ii) employment, (iii) plant

[2]The origination of each credit is assigned with a rating qualification and a probability of default by the bank. The credit rating can take values from 1 (lowest rating) to 5 (highest rating), while the probability of default assigned by the bank varies between 0 to 100%. If necessary the bank can adjust both variables each quarter.

and equipment purchases (investment), (iv) total assets, (v) total liabilities, (vi) operating profits, and (v) equity.

2.2 Financial Alleviation Measures in Colombia

In March 2020, the Financial Superintendency enacted a set of emergency measures to mitigate the effects of the COVID-19 Pandemic. Among them was the payment relief measure (*grace periods*) to performing debtors with less than or equal to 60 days past due on their credit as of February 29^{th}. While set to end on June 30^{th} of 2020, the program was extended until August 31^{st} of 2021.[3] More recently, the Financial Superintendency has been discussing the possibility of relaunching the program as of September 2023.[4]

During grace periods, which could last up to 120 days, banks could not increase interest on loans nor charge interest-on-interests. Also, loan ratings had to be temporarily frozen, and the number of days past due had to be reset. This framework allows us to rule out the potential anticipation of the policy. On the one hand, the regulation cutoff date applied to *existing* loans, meaning that most eligible loans originated before 2020. On the other hand, the first reported COVID-19 case in Colombia came after the policy, on March 6^{th}. Still, one could argue that Colombian firms could have extrapolated similar measures being undertaken in other parts of the world. Fortunately, Colombia was among the earliest countries to implement moratorium measures in response to the COVID-19 shock, as illustrated in Figure A1 of Appendix A. This timeline, for over 70 countries, underscores that the policy was not influenced by any prior knowledge or anticipation of the COVID-19 pandemic, affirming the exogeneity of the policy introduction and its impact on the variables of interest.

2.3 Identification

Our empirical analysis focuses on evaluating the effects of the moratorium policy on stressed firms. For this group, we implement a regression discontinuity design (RDD) that leverages a regulatory eligibility cutoff to identify the causal effect of the policy.

Firms are categorized as "stressed" if they had any days past due on their outstanding loans as of the cutoff date, February 29, 2020.[5] In this context, we refer to stressed firms as

[3] See regulation CE007 and CE014 (March 17^{th} and 31^{st}) of the Financial Superintendency. While regulation CE007 initially installed a criteria of 30 days past due, regulation CE014 extended the criteria to 60 days.

[4] Media posts on this announcement can be read at the following link.

[5] To measure delinquency days at the cutoff date, we use end-of-quarter data from March 31, 2020, and subtract thirty days to align with February 29.

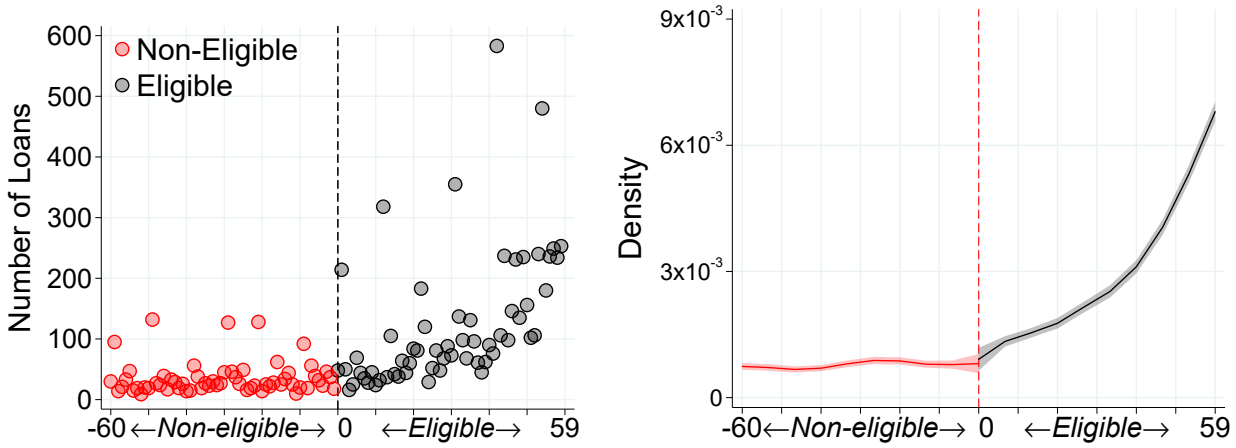
"defaulting," although not necessarily in full default. Rather, these are borrowers who had entered a state of delinquency—typically the early stages of repayment difficulty—making them eligible for moratorium relief. Hence, borrowers close to the threshold are ex-ante similar across key financial dimensions and differ mainly in receiving treatment.

For completeness, and to strengthen the connection between the short-run empirical evidence and the quantitative model, we extend our analysis to include non-stressed firms—those without arrears as of the cutoff date. This additional analysis employs a difference-in-differences (DiD) approach and is presented in Appendix C.

The distribution of eligible and non-eligible loans is plotted in Figure 1. Panel (a) shows the frequency (histogram) of corporate loans for a given number of delinquency days (our running variable, centered at zero henceforth). That is, eligible loans lie on the positive support of the x-axis, and non-eligible loans lie on the negative support. To clarify, -1 and 0 on the x-axis refer to observations with 61 and 60 days of delinquency on their loans as of February 29^{th}, respectively. Likewise, $+59$ refers to loans with only one day of delinquency as of February 29^{th}. Thus, the increased number of loans towards the right end of the figure is not surprising: it simply depicts a greater number of loans with fewer delinquency days, as is common in most loan balances. To exemplify, note that firms' delinquency records drop out as they are paid (i.e., not every loan that starts with one delinquency day will remain in delinquency until default). Therefore, it is typical to observe a higher number of loans that have a few days of delinquencies in their accounts. This behavior is also clearly observed in Figure B2 (Appendix B) , which plots the same chart but covers the pre-treatment period of 2019Q2. The visuals are equivalent if we use 2019Q3 or 2019Q4.

Notably, the policy was announced weeks after the triggering cutoff date to prevent any potential "manipulation" of the running variable. To formally test for this, panel (b) statistically evaluates if there are bunching of observations around the cutoff value (zero-valued vertical line), as proposed by McCrary, 2008. Intuitively, the test separately estimates the density of the running variable (i.e., *existing* loan's past due days) on either side of the cutoff point and provides a Wald estimate in which the null corresponds to the non-existence of a discontinuity at the threshold. The resulting p-value, of 0.819, indicates a lack of manipulation of the running variable.

Figure 1: Eligible and Non-Eligible Loans



(a) Treatment Distribution

(b) McCrary's Test

Panel (a) shows the histogram of eligible versus non-eligible corporate loans along the running variable which we center at zero around the cutoff date, 29^{th} of February 2020. Namely, all non-eligible loans (red) are to the left of the cutoff. Panel (b) statistically evaluates if there is a bunching of observations around the cutoff value (McCrary, 2008). The p-value (0.8195) does not reject the null, indicating a lack of manipulation of the running variable.

Next we proceed to formulate the RDD empirical strategy focusing on the the impact of treatment (i.e. receiving a moratorium on *existent* debt) on new lending conditions.[6] We note that there was imperfect compliance among eligible borrowers, meaning that for reasons such as lack of information or costs associated with a time-consuming process, some eligible firms were not compliant with the government policy. For this reason, we correct treatment compliance with a fuzzy instrumental variables *Regression Discontinuity Design* (**RDD**) specification (see Imbens and Lemieux, 2008).

Formally, let X_{ij} be our assignment variable representing the difference between the 60 days cutoff rule and the number of past-due days (as of February 29th, 2020) of firm's "j" *existing* loan with bank "i". Moreover, let $\tilde{D}_{ij}$ be an indicator variable denoting the debt moratorium eligibility of that loan. Given the regulatory conditions of the policy, We know that $\tilde{D}_{ij}$ is determined by the the assignment variable X_{ij}, as follows:

$$\tilde{D}_{ij} = \mathbf{1}\{X_{ij} \geq 0\} \tag{1}$$

To clarify, treatment assignment D_{ij} takes the value of one if the *existing* loan received the policy at some point during 2020 and zero otherwise.

[6] An equivalent approach is conducted for the RDD estimates on firm-level outcomes related to performance, the only difference being that the variables in the analysis are firm-specific and not firm-bank specific.

Notice that in a *sharp* setting with full compliance, the treatment assignment is always deterministically determined by the running variable. However, in our case, there is some degree of *fuzziness*, in the sense that our eligibility rule does not perfectly predict treatment (i.e., $D_{ij} \neq \tilde{D}_{ij}$). This is a common case in the RDD literature, where there is still a large and discontinuous jump in the probability of being treated (captured by X_{ij} crossing the threshold), but is does not jump from zero to unity, as in the case of a *sharp* design. In order to correct for the imperfect treatment compliance in our RD design, we employ the standard fuzzy two-stage approach based on the following local non-parametric linear regressions:

$$1^{st} \text{ stage:} \qquad \arg\min_{\boldsymbol{\theta}} \sum_{ij=1}^{I \times J} \left[D_{ij} - \theta_0 + \theta_1 \tilde{D}_{ij} + \theta_2 X_{ij} + \theta_3 X_{ij} \times \tilde{D}_{ij} \right]^2 K\left(\frac{X_{ij}}{h}\right) \tag{2}$$

$$2^{nd} \text{ stage:} \qquad \arg\min_{\boldsymbol{\delta}} \sum_{ij=1}^{I \times J} \left(Loan_{ij} - \delta_0 + \delta_1 \hat{D}_{ij} + \delta_2 X_{ij} + \delta_3 X_{ij} \times \hat{D}_{ij} \right)^2 K\left(\frac{X_{ij}}{h}\right) \tag{3}$$

where $Loan_{ij}$ denotes the several outcomes related to the conditions of new loans that were disbursed after the policy. Our baseline specification controls for bank, quarter of origination and firm's two-digit industry code. For the outcome variables of loan amount and interest rate, we also control for the outstanding balance previous to the policy and the interest rate of the existing loan at the end of 2020Q1, respectively. This improves the precision of the RDD estimates although our results are robust to excluding these controls.[7] The term $K(\cdot)$ denotes a triangular kernel with optimal bandwidth "h" as described in Calonico, Cattaneo and Titiunik (2014). We include the term $\hat{D}_{ij} \times X_{ij}$ to allow for different specifications of how the running variable affects the outcome, at either side of the cutoff.

Intuitively, in the first stage (equation 2) we estimate the predicted probability of treatment, –intent-to-treat–, and use it to instrument compliant observations in the second stage (equation 3). Consequently, the fuzzy RDD estimand can be formulated as:

$$\delta_1 = \frac{\lim_{x \downarrow 0} \mathbb{E}[Loan_{ij} | X_{ij} = x] - \lim_{x \uparrow 0} \mathbb{E}[Loan_{ij} | X_{ij} = x]}{\lim_{x \downarrow 0} \mathbb{E}[D_{ij} | X_{ij} = x] - \lim_{x \uparrow 0} \mathbb{E}[D_{ij} | X_{ij} = x]} \tag{4}$$

which represents the ratio between the jump in the outcome variable and the share of compliant observations (those that are triggered by the rule and receive treatment).

[7] Figure D4 (Appendix Appendix D) compares our baseline fuzzy RD estimates with specifications that omit covariates. Results remain robust, though including controls improves precision.

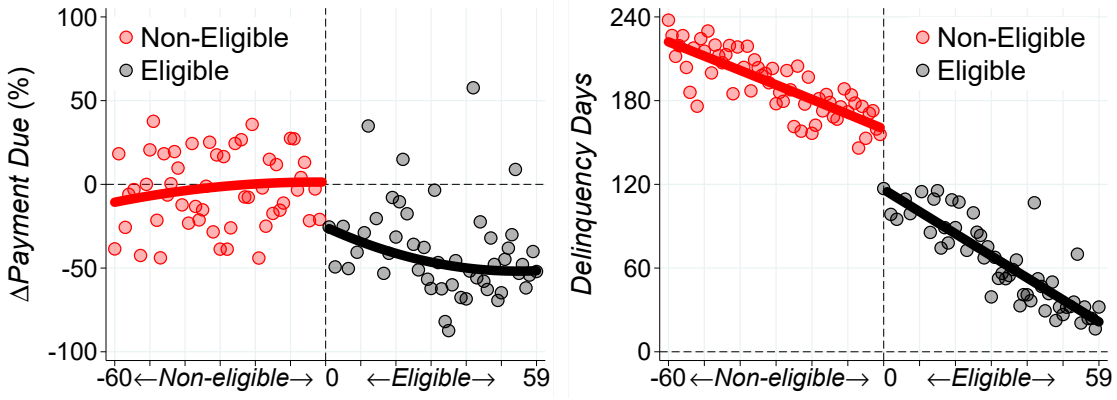
3 Results

While we investigate the impact of the policy on a variety of financial and real variables, our central emphasis pertains to three key indicators: the amount of new loans, and the corresponding interest and default rates. These variables play a pivotal role as transmission mechanisms, affecting firm output, including investment and labor, thereby potentially inducing macroeconomic effects. Moreover, we use these variables to discipline our quantitative model.

3.1 Loan Conditions

As an initial step, we corroborate that the policy had the intended effect on existing loans, regarding the (i) suspension of debt repayments and (ii) reset of delinquency days. In other words, we first test whether our data on eligible and treated loans match the characteristics of the policy enforcement during grace periods. Figure 2 shows: (a) the change in payments due and (b) delinquency days, both measured in the quarter of potential treatment. We observe a large and negative discontinuous jump in both outcomes at the eligibility threshold, with eligible loans (black dots) experiencing a sharp reduction in payment obligations and a decline in delinquency days relative to ineligible loans (red dots).

Figure 2: Debt Moratorium on Existent Loans



(a) Change in Payment Due (b) Delinquency Days

The figure shows the effect of the debt moratorium policy on existing loans by comparing loans just below (non-eligible, red dots) and just above (eligible, black dots) the regulatory cutoff used to determine eligibility. Panel (a) plots the change in expected debt payments, measured as percentage growth relative to 2020Q1. Panel (b) shows the level of delinquency days. Both outcomes are measured in the quarter of potential treatment (2020Q2–Q4 for treated loans, and 2020Q2 for others). Each dot represents the mean within a bin of the running variable, constructed using the quantile-spaced mimicking variance approach in Cattaneo, Idrobo and Titiunik (2019). Quadratic fits are shown on each side of the cutoff.

These patterns are consistent with the implementation of the moratorium policy. However, it is important to note that within the group of eligible loans, we are averaging over both treated and non-treated loans. Only the treated loans experienced the suspension of payments and the automatic reset of delinquency days. As such, the observed effects in the figure are attenuated relative to what would be expected if we only plotted eligible treated loans. Nonetheless, the discontinuities remain visible and statistically meaningful, reinforcing that eligibility strongly predicts exposure to the policy—consistent with the fuzzy RD framework we implement in our empirical strategy.

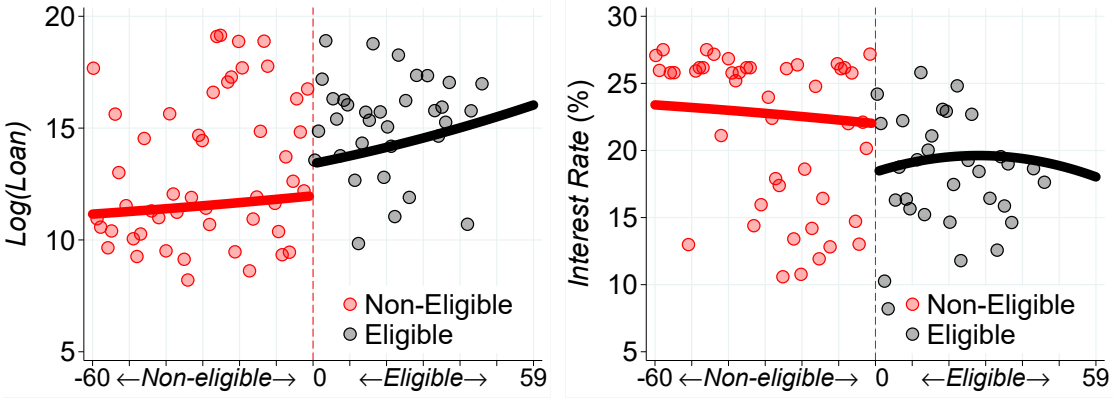
In particular, we find that (see Online Appendix B) during the quarter of treatment: (i) loan payments were reduced by approximately 90%,[8] and (ii) days past due decreased, on average, by 108 days showing not only a successful reset of days past due buts also

[8]There are two reasons why we do not observe an exact reduction of 100%. The first is that existing loans received benefits at some point during the quarter, while we can only observe the quarterly sum of payments (in some cases, we only observe payments in the quarter before the policy). Second, some companies did not wait until the end of the suspension period. They paid their dues earlier.

an increase in delinquency days for non-treated loans that barely missed the eligibility cutoff.[9]

We next present our results on *new loan conditions* (i.e., for a given firm, loans that originated after the policy). Our main findings indicate that stressed firms receiving a moratorium borrowed larger amounts (*intensive margin*), and paid lower interest rates compared to otherwise similar firms just above the eligibility cutoff. These effects are visualized in Figure 3, which shows clear discontinuities at the threshold: an upward jump in loan amounts in panel (a) and a downward shift in interest rates in panel (b).

Figure 3: Loan amount and interest rates for eligible and non-eligible observations



(a) Log(Loan) (b) Interest rate

The figure shows the impact of the policy on loan conditions along the running variable. Panel (a) shows the loan amount (in logs of COP). Panel (b) shows the interest rate. We employ data on new loans at the quarter of origination during 2020Q1-2021Q4. Each dot represents the mean of the outcome variable within a bin of the running variable. The number of bins and specific location are determined using a quantile-spaced mimicking variance approach (see Cattaneo, Idrobo and Titiunik (2019)).

More formally, Table 1 reports our benchmark fuzzy RDD results. In general, we find that the debt moratorium policy alleviated the debtors' new loan conditions. Specifically, the policy on stressed firms increased the new loan amount by 16.44%, which is in line with our theoretical predictions. As a reminder, our model accounts for the fact that firms demand larger loans when moratorium is in effect.

[9]To understand why the latter is true, lets compare the delinquency days of an existent loan with 60 and 61 days past due on February 28th, 2020. Assume the former receive a moratorium in Q2-2020. For the treated loan the reset in delinquency days implies that at the end of Q2-2020 the past due days is greater or equal to zero but lower than 60 days. If we assume that the ineligible loan is delinquent at the end of Q2-2020, then its past due days at least 90 days but no more than 181 days. Therefore, the reduction in delinquency days for the loan receiving a moratorium relative to the ineligible loan is always within the interval $[-181, -30]$ which is consistent with the magnitude of our estimate.

Table 1 also shows that the policy increased the probability of obtaining a new loan by 1.04 pp (*extensive margin*), and lowered interest rates by 0.35 pp. One factor contributing to this decline is banks' expectation of a reduced likelihood of default. This is in line with Ganong and Noel (2020), who show that maturity extensions for household debt obligations, which reduce payments in the short term, significantly reduce default rates. In our data, the ex-ante probability of default is assessed by each bank at the origination of the loan (in column 7, we observe a 1.17 pp decrease). When we examine the ex-post outcomes, we find that stressed firms that received the policy defaulted 2.32 pp less frequently compared to their counterparts who barely missed qualifying for the policy. This confirms that banks' ex-ante assessments were indeed accurate. Our quantitative model also provides the following intuition for this outcome: moratorium policy reliefs firms and mitigates concerns of default triggered by adverse shocks. By mitigating liquidity concerns, moratoria make indebtedness more attractive. However, our quantitative model predicts that this increase in debt, while reducing the likelihood of default in the short run, will lead to slightly higher default risk in the long run unless future moratorium policies are accompanied by debt forgiveness.

Finally, the policy also increased loan maturity by 5.59 years and improved the loan rating by approximately four categories. However, it also increased the amount of loan collateral requirements by 1.1 pp.[10]

Results for non-stressed firms, reported in Appendix Appendix C, suggest tighter but economically minor changes in loan conditions, consistent with the idea that financially unconstrained firms benefit less from such relief.[11]

3.1.1 Financial Sector

We now highlight a few points about the potential impact of the policy on banks. The costs of the policy appear to be imposed on banks ex-ante. By forcing banks to delay the collection of their claims during the suspension periods and not subsidizing these costs, it can be argued that banks have borne the toll of the policy. This may be particularly relevant as the debt moratorium was applied during a period when lenders would value cash more.

[10] For comparability purposes, in Appendix E we show summary loan statistics for stressed firms (Table E3) and non-stressed firms (Table E4).

[11] An interpretation of this finding is that future policies could target only vulnerable firms to maximize social welfare, as firms in our DID setting were not considered stressed. This approach is currently practiced by banks in the EU, which now offer payment holidays to borrowers experiencing hardship (see HM Government, 2022).

Table 1: RD Benchmark results: new loans

	Intensive	Extensive	Interest	Maturity	Collateral	Rating	Default Prob.	
	Log(Loan)	$\mathbb{1}\{\text{loan}\}$					Ex-ante	Ex-post
Fuzzy-RD	16.44***	1.04*	-0.35***	5.59*	1.10***	4.07*	-1.17*	-2.32***
	(4.8)	(0.6)	(0.1)	(2.9)	(0.6)	(2.2)	(0.7)	(0.8)
	First Stage							
D_{ij}	0.19***	0.15*	0.34***	0.15***	0.20***	0.16***	0.16***	0.14***
	(0.0)	(0.1)	(0.1)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)
Observations	35,072	70,764	35,072	35,072	35,072	35,072	35,072	68,901
BW (in days)	15.3	13.0	7.5	11.9	13.3	19.9	20.5	17.8

Authors' calculations. Table shows the estimates for the effect of the debt moratorium on new loan conditions for stressed firms. Estimates in the first row correspond to Fuzzy RD coefficient δ_1 in equation (4). The second row shows the first stage estimates for the probability of treatment (D_{ij}), as described in equation (2). The last row report the bandwidth (BW) in days used to compute the local RD estimate. We employ data on new loan conditions during 2020Q1-2021Q4. Robust Bias-corrected standard errors in parentheses, *, **, ***, indicate significance at the 10%, 5%, and 1% respectively. To capture the intensive margin for new loans, we use the amount (in logs of COP) at the quarter of origination. The extensive margin of new loans is captured by a dummy taking the value of one in the quarter of origination. Maturity is denoted in number of years, collateral is expressed as percentages of the loan amount, credit rating is a categorical variable from 1-5 where 5 is the highest rating, ex-ante default represents the expected default probability assigned to the loan by the bank, and ex-post default is a dummy variable that takes the value of one if the loan has more than thirty days of delinquency at the end of each quarter. The interest rate, maturity, collateral, rating of new loans, and ex-ante default are measured only at the quarter of origination of the loan. All columns control for bank, quarter, and two-digit industry code fixed effects. For the intensive margin (first column) and the interest rate (third column), we control for the balance of the existing loan and its interest rate at the end of Q1-2020, respectively.

Our analysis leads us to infer that banks may not necessarily be worse off with the introduction of the policy, and in fact, may even be better off. The ex-ante "Default Prob" column of Table 1 shows that stressed firms that received the policy defaulted 2.3 pp less than their counterparts who narrowly missed qualifying for the policy. This is also consistent with our findings in the quantitative section, as the policy almost completely eliminates liquidity-driven defaults.

In the Colombian context, loan interests continue to accrue during the suspension period. Consequently, banks were not compelled to accept a reduction in the value of their claims. Instead, they ended up receiving more than they would have without the policy because firms that narrowly missed the program's eligibility experienced a higher rate of default. Taken together, these patterns suggest that while the policy imposed upfront costs on banks—mainly in the form of delayed claim collections—the observed reduction in firm defaults and the associated preservation of loan values could have mitigated these costs. We stop short of concluding a net benefit for the banking sector, as we do not directly measure impacts on banks' profitability. However, the direction of the effects we document is consistent with findings in related contexts.[12]

[12]See Guler et al. (2024) for quantitative and empirical evidence in the mortgage market suggesting that moratorium policies may benefit lenders through improved loan performance and reduced default risk.

3.2 Real Sector (Firm-Balances)

We next evaluate whether the effects on new loan conditions translate into end-of-year firm balances. To do so, we control for firm-sector and firm-size fixed effects. Our firm-level dependent variables consist of: employment, investment rate, operational revenue, liabilities, assets, profits, and equity. All variables, except investment rate, are expressed in percentages symmetric growth rate changes.

Table 2 reports the RDD estimates for firm-level outcomes among stressed firms. We find that access to the moratorium led to statistically significant improvements across several dimensions: investment increased by 0.05 pp, while employment, operating revenues, assets, liabilities, profits, and equity rose by 1.8 pp, 3.8 pp, 1.7 pp, 1.95 pp, 2.5 pp, and 0.85 pp, respectively. We illustrate some of these results in Figure 4. The rationale behind these positive macroeconomic outcomes can be attributed to two key mechanisms in our quantitative model. First, the policy effectively averts defaults that would have otherwise resulted in efficiency losses for employment and output. Second, there is a noteworthy impact via the interest rate channel. With working capital, loans become more affordable for firms that had limited access to the policy, and can therefore allocate resources more efficiently.

In contrast, for non-stressed firms, we find limited effects on real outcomes. As shown in Table C2 (Appendix C), the DID estimates indicate small declines in employment, assets, and liabilities—none of which appear economically meaningful. These muted responses are consistent with the idea that financially unconstrained firms were less exposed to shocks and had less to gain from the moratorium.

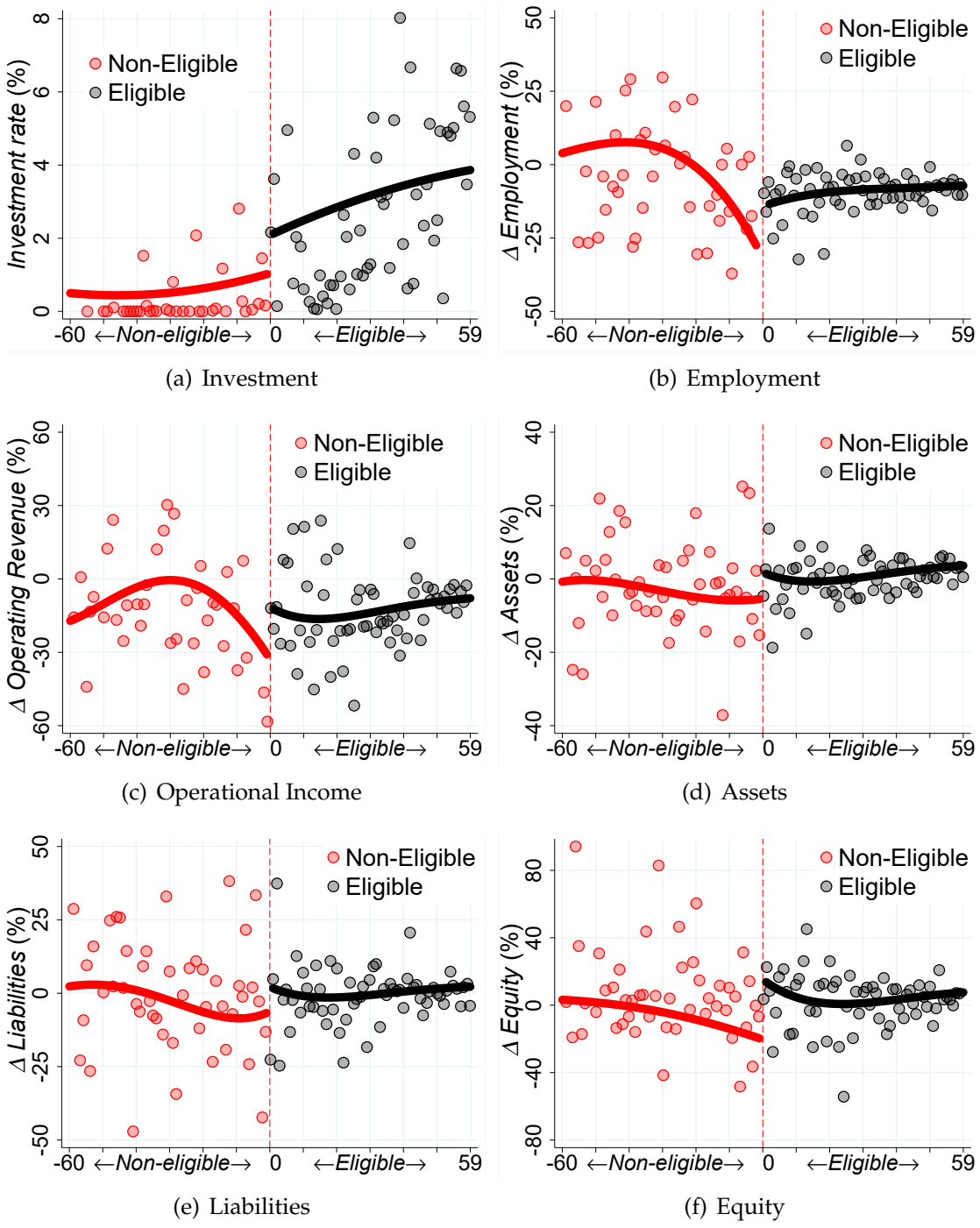
3.3 Robustness checks

For expositional purposes, we present robustness checks focusing on our two main variables of interest: loan amounts and interest rates. Robustness for all other variables, yielding similar results, can be made available upon request. Specifically, we conduct exercises with placebo cutoffs and falsification tests (Section 3.3.1), we test for balanced covariates (Section 3.3.2), and we check the robustness of our results to alternative specifications (Section 3.3.3).

3.3.1 Placebo Cutoffs and Falsification Tests

We begin our robustness checks by evaluating arbitrary cutoff points different from the one triggering treatment. In principle, a significant placebo cutoff could indicate either: (i)

Figure 4: Firm-level outcomes for eligible and non-eligible firms



(a) Investment (b) Employment

(c) Operational Income (d) Assets

(e) Liabilities (f) Equity

The figure shows the impact of the policy on firm-level outcomes along the running variable. Panel (a) shows the investment rate. Panel (b), (c), (d), (e), and (f) show the growth rate of employment, operating revenue, total assets, total liabilities, and equity. We use employment and balance sheet data for firms during 2020-2021. Each dot represents the mean of the outcome variable within a bin of the running variable. The number of bins and specific location are determined using a quantile-spaced mimicking variance approach (see Cattaneo, Idrobo and Titiunik (2019)).

Table 2: RD benchmark results: firm level outcomes

	ΔEmp.	Inv.rate	ΔOp. Rev.	Δ Assets	ΔLiab.	ΔProfit	ΔEquity
Fuzzy-RD	1.83	0.05	3.87	1.70	1.95	2.54	0.85
	(0.7)	(0.0)	(0.8)	(0.8)	(0.7)	(0.8)	(0.5)
	First Stage						
D_{ij}	0.21***	0.22***	0.35***	0.16***	0.19***	0.19***	0.15***
	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.1)	(0.0)
Observations	15,379	11,386	31,786	30,887	30,660	29,762	30,887
BW (in days)	28.9	9.7	7.0	12.8	9.0	9.4	14.8

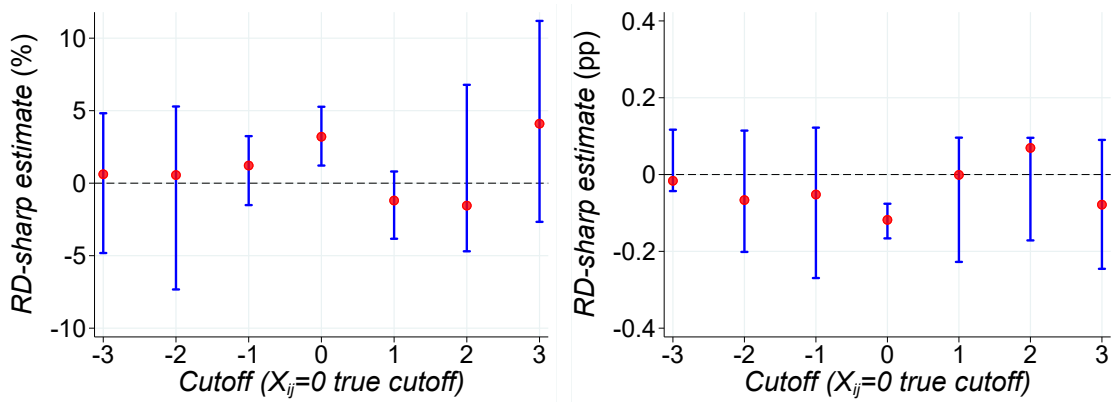
Authors' calculations. Table shows the estimates for the effect of the debt moratorium on firm-level variables for stressed firms. Estimates in the first row correspond to the Fuzzy RD coefficient δ_1 in equation (4). The second row shows the first stage estimates for the probability of treatment (D_{ij}) described in equation (2). Robust Bias-corrected standard errors clustered at the firm's province in parentheses , *, **, ***, indicate significance at the 10%, 5%, and 1% respectively. The last row report the Bandwidth (BW) in days used to compute the local RD estimate. We use employment and balance sheet data for firms during 2020-2021. ΔEmp., ΔOp. Rev., ΔAssets and ΔLiab. denote yearly symmetric growth rates of the number of employees, operating revenues, total assets, and liabilities, respectively. Inv.rate represents the investment rate computed as the ratio of new purchases of buildings, plants, and equipment to total assets lagged one year. ΔProfit, ΔEquity are computed as the yearly change in gross profits and equity relative to the operating revenues and total assets lagged one year, respectively. All columns control for bank and two-digit industry codes' fixed effects.

a concurrent policy, potentially contaminating our results, or (ii) systematic differences among eligible and non-eligible borrowers –even far from the discontinuity point–. In Figure 5, we evaluate placebo cutoffs for days before and after the actual cutoff $X_{ij} = 0$. As expected, none of these different cutoffs are statistically significant for both loan amounts (panel a) and interest rates (panel b). Further, in Table 3, we present a falsification test in which we regress the treatment status (D_{ij}) on banks' and firms' balance sheet information. For the entire sample (column 1), treatment is partially explained by bank variables such as collateral and maturity and firm variables such as profits (in some bandwidths also, assets, liabilities, and equity). However, when restricting the sample to smaller bandwidths (within the vicinity of the triggering threshold), treatment becomes uncoupled from these factors. With a 20-day bandwidth (column 5), the treatment assignment is no further explained by either bank or firm variables. The only explanatory power is driven by the running variable, which, by the characteristics of our design, increases as observations get closer to the cutoff (BW=0). This exogenous variation around the cutoff is precisely what our empirical strategy exploits for the case of stressed firms.

3.3.2 Checking for Balanced Covariates

One crucial element in our RDD identification strategy is that loans in treatment and control groups should be almost identical in everything except receiving treatment. A leading marker, one that rules out precise sorting (i.e., manipulation or self-selection around the cutoff), commonly known as the McCrary Test, was previously presented in

Figure 5: Placebo cutoffs

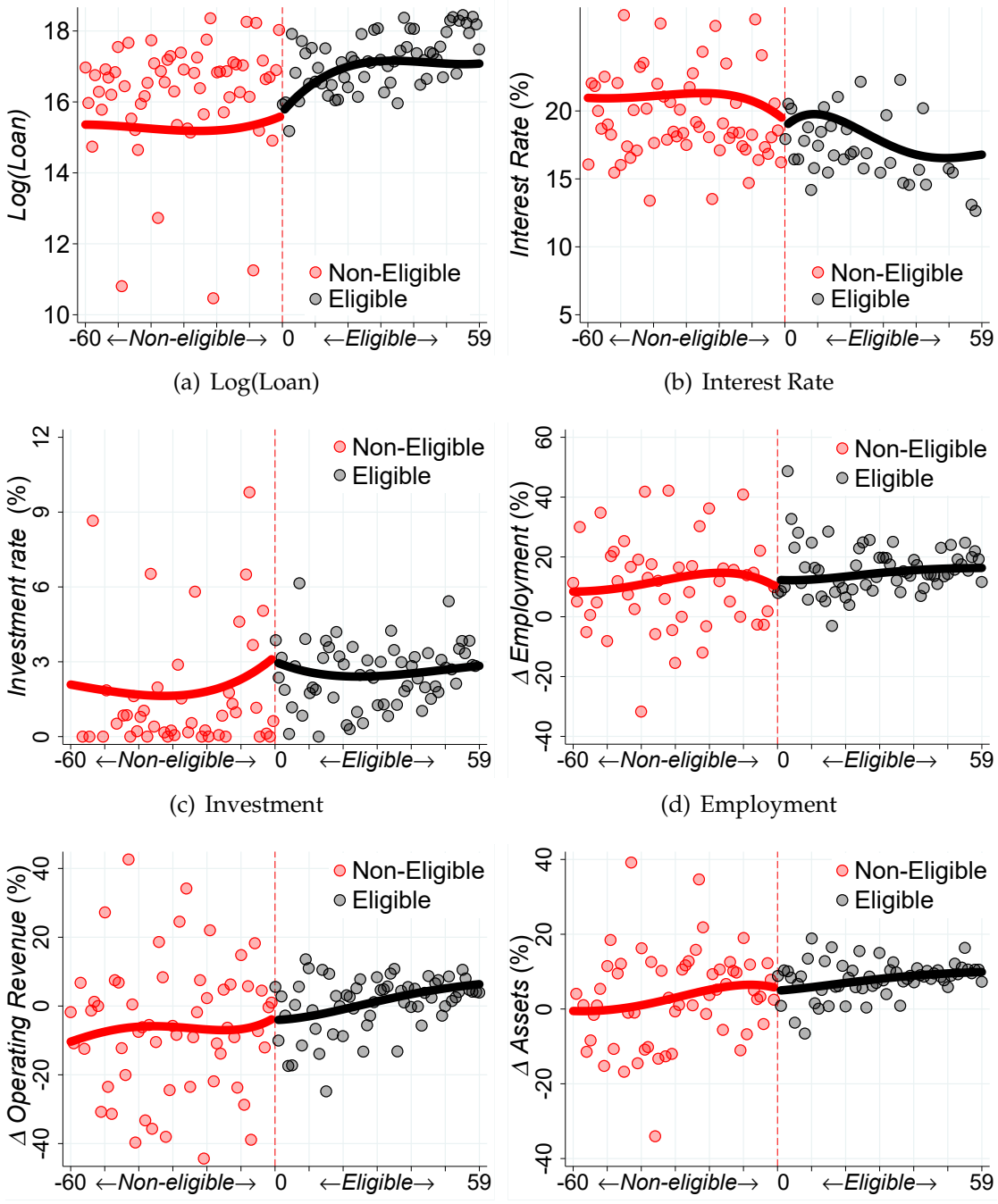


(a) Log(Loan) (b) Interest Rate

The figure shows the sharp RD estimates for (a) the size of new loans and (b) the loan interest rate at the quarter of origination using alternative placebo cutoffs. We employ data on new loans at the quarter of origination during 2020q1-2021q4. Each placebo cutoff denotes the closest possible value (from the true cutoff) for the running variable. The red dots and vertical blue lines capture the point estimates and 95% robust confidence intervals, respectively. To compute RD estimates for positive (negative) placebo cutoffs, we restrict the sample to only eligible (non-eligible) loans to avoid potential "*contamination*" coming from eligibility to the debt moratorium policy (see Cattaneo, Idrobo and Titiunik (2019)).

Figure 1 (panel b). In addition to this test, in Online Appendix C.1, we present a "donut-hole" test, which re-estimates our benchmark results but excludes observations in the immediate neighborhood of the cutoff. Intuitively, the test checks for additional "bunching" of observations around the cutoff that the McCrary test might have potentially missed. As shown, we find similar results when excluding 1, 2, and 3 days before and after the actual cutoff. To complement this analysis, we present a visual inspection of whether loan amount, interest rates, and firm-level variables such as investment, employment, operation income, and total assets carried systematic differences *before* the debt moratorium policy took place (i.e., existing loans, previous to the policy, $t < 2020$). If this were the case, then our results would reflect pre-existing differences rather than a causal relationship due to the policy. As shown in Figure 6, the conditions on existing loans are equally balanced across the running variable for the quarter before the policy (2019Q4).

Figure 6: Testing for pre-existing differences: Stressed Firms



(a) Log(Loan)

(b) Interest Rate

(c) Investment

(d) Employment

(e) Operational Revenue

(f) Assets

The figure examines pre-existing differences along the running variable before the implementation of the policy. We employ loan and balance sheet data for firms at the end of 2019. Panel (a) shows the outstanding loan (in logs of COP), and panel (b) the interest rate. Panel (c) shows the investment rate, while panels (d), (e), and (f) show the growth rate of employment, operating income, and total assets, respectively. Each dot represents the mean of the outcome within a bin of the running variable. The number of bins and specific location are determined using a quantile-spaced mimicking variance approach (see Cattaneo, Idrobo and Titiunik (2019)).

Table 3: Falsification test: (Un)-Predictability of Treatment

	Entire sample	BW=80	BW=60	BW=40	BW=20
Loan variables					
Loan	0.000	0.000	-0.000	0.009	0.030
	(0.001)	(0.001)	(0.001)	(0.006)	(0.022)
Collateral	0.000**	0.002***	0.001**	-0.006	-0.015
	(0.000)	(0.001)	(0.000)	(0.008)	(0.017)
Maturity	0.007***	0.003*	-0.006**	-0.005	0.001
	(0.001)	(0.002)	(0.003)	(0.005)	(0.008)
Running Var X_{ij}	0.001***	0.003***	0.009***	0.012***	0.014***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.002)
Total Assets	0.007	0.012***	0.022***	0.022***	0.004
	(0.007)	(0.003)	(0.002)	(0.003)	(0.017)
Total liabilities	-0.001	-0.001***	-0.002***	-0.002***	-0.000
	(0.001)	(0.000)	(0.000)	(0.000)	(0.002)
Equity	-0.007	-0.012***	-0.022***	-0.022***	-0.005
	(0.007)	(0.003)	(0.002)	(0.004)	(0.017)
Profits	-0.000**	-0.000	-0.000	0.001	0.013
	(0.000)	(0.000)	(0.001)	(0.005)	(0.020)
Constant	0.552***	0.430***	0.335***	0.286***	0.213***
	(0.007)	(0.015)	(0.016)	(0.020)	(0.033)
Observations	15,904	8,458	2,494	968	316
R-squared	8.10	5.26	22.10	21.93	12.98
F-test all	23.29	33.14	128.85	73.17	5.42
pvalue all	0.00	0.00	0.00	0.00	0.00

Each column reports a linear regression with the treatment dummy $D_{ij,t}$ as the dependent variable and with different bandwidth choices (entire sample, 80, 60, 40, and 20 days). Heteroskedasticity-robust standard errors in parentheses , *, **, ***, indicate significance at the 10%, 5%, and 1% respectively. All columns control for bank and year fixed effects.

In Online Appendix C.2, we conduct a formal analysis of all the relevant loan and firm-level variables, which include loan characteristics such as loan outstanding balance, interest rates, collateral requirements, maturity periods, credit ratings, ex-ante default probabilities, ex-post default probabilities, delinquency days, as well as broader firm-level indicators like investment rates, changes in employment, changes in operating revenue, changes in assets, changes in liabilities, and changes in profits. As shown, these results provide evidence of equally balanced distributions across the running variable before the treatment was enacted.

3.3.3 Alternative Specifications

As an additional robustness tests, We also check how our results differ with two changes. First, we restrict our analysis to firms with a single *existing* loan relationship prior the debt moratorium policy to isolate the effect of firms with multiple loans some eligible for treatment (see Online Appendix C.3). Our results not only remain but are, in most

cases, relatively stronger and point to the importance of the moratorium for stressed firms with single bank relationships.

Lastly, we control for firms' credit risk on *existing* loans to absorb any effect of the debt moratorium coming from the "artificial" boost in credit ratings to firms receiving suspension of payments (see Online Appendix C.4). our results show that controlling by this channel strengthens the increase in the size of new loans and the drop in the interest rate on stressed treated firms while, at the same time, absorbs completely the effect on ex-ante firm's default and credit rating, which are now not significant. The latter is consistent with a stronger improvement in end-of-year employment, investment rate, and operating revenues for treated stressed firms when we control for this potentially confounding channel.

4 Quantitative Section

Why a quantitative model? Our empirical analysis establishes that payment moratoria delivered short-run relief to financially stressed firms. However, regression-discontinuity designs, while powerful for causal identification, are fundamentally reduced-form: they provide local causal effects around the threshold but cannot speak to medium-run consequences, dynamic responses of borrowing, investment and labor decisions, or welfare. If moratoria are to remain part of the crisis-policy toolkit, an ex-ante quantitative evaluation is needed.

Moreover, the RDD captures a one-time, unanticipated policy introduction. Since then, moratoria programs have been repeatedly reintroduced and are now partly foreseeable. In such an environment, expectations should be priced in. A fully specified model is therefore required to consistently price moratorium loans alongside standard debt, and to evaluate the long-run implications of embedding these policies into the contract.

To meet this goal, we develop a structural model disciplined by our reduced-form evidence. The model roughly matches the RDD elasticity of investment if labor, and non-guaranteed debt with respect to payment suspension. This "calibrated-to-local-effects" approach uses quasi-experimental moments to discipline dynamic models, allowing us to overcome the limitations of reduced-form estimation and extend the analysis to welfare, policy design, and repeated interventions.

A key modeling choice concerns whether to introduce firm heterogeneity. Rich firm-level heterogeneity would allow us to study distributional impacts, but doing so requires solving for the full cross-sectional distribution of firms and its evolution. This is computationally *infeasible* once we incorporate aggregate shocks, equilibrium default, and

endogenous asset pricing—features that are central to our policy question. Our two-firm setup strikes a balance: it preserves tractability, aligns tightly with the local empirical estimates around the threshold, and crucially, allows for ex-ante evaluation of one time, permanent or recurrent moratorium programs.

Two design choices are central to the framework:

1. **Portfolio choice and asset pricing.** Firms optimally allocate borrowing between (i) conventional long-term loans and (ii) moratorium loans whose payments may be suspended during liquidity shocks. Endogenous pricing is essential: if moratoria are expected to recur—Colombia is already considering a relaunch[13]—firms adjust their portfolios in anticipation. Without endogenous pricing, one misses the counterfactual that firms borrow more in moratorium instruments precisely because these loans embed state-contingent relief. Our contribution is to characterize the equilibrium pricing of moratorium loans under aggregate shocks and to analyze the resulting long-run firm dynamics and welfare.

2. **Dynamic production economy.** The firm faces a neoclassical production technology with decreasing returns, adjustment costs, and stochastic TFP. Two features are central. First, investment and labor decisions interact with borrowing choices, allowing financial shocks to propagate into real activity. Second, firms cannot commit to future repayment. Equilibrium default arises when continuation values fall below the value of entering delinquency, which triggers output losses and temporary exclusion from credit markets. This default structure follows the sovereign-debt tradition (Eaton and Gersovitz, 1981) but is adapted to a corporate environment with long-term debt and state-contingent moratoria. The dynamic production block ensures that both the RDD evidence (which captures short-run marginal responses) and equilibrium pricing (which initially depends on unanticipated firm behavior) jointly discipline the model.

3. **Lender block and market clearing.** XXXX Lenders are competitive, risk-neutral international investors who price loans to break even in expectation. In appendix, we relax this assumption, and introduce risk-averse banks.

The model features two aggregate shocks: (i) *global liquidity shocks* that raise firms' operating overhead costs, and (ii) *TFP shocks*. The shocks are allowed to be correlated, matching

[13] See footnote 4.

the empirical co-movement in Colombian data. During liquidity shocks, payments on moratorium loans are suspended but continue to accrue interest. [14]

Our firm problem follows the Eaton–Gersovitz tradition of unsecured debt and endogenous default, but applied at the corporate level. The structure is closely related to dynamic corporate default models with production (e.g., Gomes and Schmid, 2010; Cui and Kaas, 2021; Crouzet, 2017), who likewise model an optimizing entrepreneur/firm that chooses investment, borrowing, and default, and in which lenders price debt off equilibrium default probabilities.

Empirical discipline. We first introduce debt suspenstion policy as an unanticipated one-time policy to match the model's transition dynamics with the reduced-form evidence we documented in the empirical section, and then use the model for anticipated recurrent policy tool and to investigate alternative counterfactuals. Wherever possible we calibrate parameters to Colombian administrative data.

Policy experiments. We study an unanticipated introduction of moratorium borrowing and trace the effects on loan volumes, spreads, investment, employment, income, and welfare. We also evaluate variants in which (i) interest does *not* accrue during suspension, (ii) part of the principal is forgiven. The model shows that eliminating interest accrual—or adding partial forgiveness—delivers the highest welfare gains: with persistent TFP shocks but short moratoria, pure payment deferral offers only limited relief, whereas combining deferral with forgiveness lowers both default probabilities and spreads in the short while boosting investment, output and thus welfare.

In sum, the quantitative framework links our short-run causal evidence to long-run macro-financial outcomes and guides the design of more effective moratorium policies.

4.1 The model

We consider a dynamic, discrete-time small open economy in which a representative household owns a firm that produces a homogeneous good. The household makes all decisions regarding investment, labor input, borrowing, and default on behalf of the firm. The firm has access to two unsecured long-term debt instruments: a standard non-state-contingent loan and a state-contingent moratorium loan that temporarily suspends payments in bad global conditions. Equity financing is internal to the household–firm sys-

[14] In an earlier version, we embed a Nash-bargaining game between borrower and the bank at default to capture restructuring dynamics. We dropped it in this version both for brevity and to simplify the model as endogenous debt renegotiation did not alter the model implications at all.

tem and is therefore frictionless: the household reallocates resources between consumption and investment at no cost.

A key friction is that the borrower cannot commit to future repayment, borrowing, or investment decisions. As in Eaton and Gersovitz (1981), default arises endogenously, and competitive creditors price long-term loans to break even in expectation given the borrower's future default policy.

Each period proceeds as follows. The household observes the productivity shock and global conditions. Conditional on these realizations, it decides whether to default, how much to invest, and how much to borrow in each loan category. Output is produced using capital k_t and labor L_t according to

$$y_t = A_t \left(k_t^{\alpha^k} L_t^{1-\alpha^k} \right)^{\nu}, \qquad \alpha^k \in (0,1),\ \nu \in (0,1).$$

The productivity shock follows an AR(1) process:

$$\log(A_t) = (1-\rho)\mu + \rho \log(A_{t-1}) + \varepsilon_t, \qquad \varepsilon_t \sim N(0, \sigma_\varepsilon^2),\ |\rho| < 1. \tag{5}$$

4.2 Borrower's problem

We interpret the representative borrower as an owner-managed firm (entrepreneur) that values net payouts. Let c_t denote net payouts (dividends/owner consumption) after investment and debt service. Or, one can assume that the household owns the firm and chooses net payouts. Its preferences are

$$E_0 \sum_{t=0}^{\infty} \beta^t u(c_t, L_t), \qquad 0 < \beta < 1,$$

with period utility given by the Greenwood–Hercowitz–Huffman (GHH) specification

$$u(c_t, L_t) = \frac{\left(c_t - \eta \frac{L_t^{\omega}}{\omega} \right)^{1-\sigma}}{1-\sigma},$$

where $\sigma > 0$ is the coefficient of relative risk aversion and $\omega > 0$ governs the (inverse) Frisch elasticity of labor supply. GHH preferences eliminate wealth effects on labor supply (see Greenwood, Hercowitz and Huffman, 1988).

The first-order condition for labor implies

$$\eta L_t^{\omega-1} = w_t, \tag{6}$$

where w_t denotes the equilibrium real wage. The household receives wage income and residual firm profits, so its static budget constraint is

$$c_t = w_t L_t + \pi_t.$$

Global conditions. Following the formulation in Hatchondo et al. (2025), the global liquidity shock $p_t \in \{p_L, p_H\}$—which increases the firm's operating overhead costs $g(p)$—follows a two-state Markov chain. A stress episode begins with probability $\pi_{LH}(A_t) \in [0,1]$ and ends with probability $\pi_{HL} \in [0,1]$.

To capture the empirical observation that firms are more likely to face adverse global financial conditions when domestic productivity is low (see Calvo, Izquierdo and Talvi, 2006), we assume that the transition probability into a stress episode is decreasing in TFP. Specifically,

$$\pi_{LH}(A_t) = \min\left\{\pi_{LH0}\exp\left(-\pi_{LH1}\,\log(A_t) - \tfrac{1}{2}\pi_{LH1}^2\sigma_\varepsilon^2\right), 1\right\},$$

which generates a "when it rains, it pours" mechanism: low productivity increases the probability of entering global stress.

Borrowing. The firm borrows using long-term, non-state-contingent loans at price q_t. As in the sovereign default literature (Hatchondo and Martinez, 2009; Chatterjee and Eyigungor, 2012), a loan issued at time t promises a stream of geometrically decaying coupons:

$$\kappa, \quad \kappa(1-\delta), \quad \kappa(1-\delta)^2, \ \ldots, \qquad \delta \in (0,1].$$

The coupon κ is set so that, absent default risk, the loan price equals the price of an average one-period loan, $(r+\delta)/(1+r)$. This long-term structure avoids tracking the full maturity distribution. The law of motion for long-term debt is therefore

$$b_{t+1} = (1-\delta)b_t + m_t, \tag{7}$$

where m_t is new issuance. One-period debt is the special case $\delta = 1$.

Moratorium debt $b_{m,t}$ is also long-term, with coupons decaying at rate δ_m, but coupons may be suspended when $p_t = p_H$. During suspension, coupons earn interest at rate r_m, and upon exit the firm pays $e^{r_m}\kappa_m$, where κ_m is set analogously to ensure a risk-free value of $(r+\delta_m)/(1+r)$.

Delinquency. If the household defaults, the firm enters delinquency. It incurs an output cost, cannot borrow, and remains in arrears for a stochastic duration. Upon exit, the firm repays an α fraction of each delinquent loan and regains access to credit markets.

Consumption under repayment.

(i) Payment suspension on moratorium loans, $p_t = p_H$.

$$\begin{aligned} c_t = A_t\big(k_t^{\alpha^k} L_t^{1-\alpha^k}\big)^{\nu} \;-\; \kappa\, b_t \;+\; q_t(b_{m,t+1}, b_{t+1}, s_t)\big[b_{t+1} - b_t(1-\delta)\big] \\ +\; q_{m,t}(b_{m,t+1}, b_{t+1}, s_t)\,\big[b_{m,t+1} - b_{m,t}e^{r_m}\big] \\ -\; \big(k_{t+1} - (1-\delta_k)k_t\big) \;-\; \tfrac{\Theta}{2}(k_{t+1}-k_t)^2 - g(p). \end{aligned}$$

(ii) No suspension on moratorium loans, $p_t = p_L$.

$$\begin{aligned} c_t = A_t\big(k_t^{\alpha^k} L_t^{1-\alpha^k}\big)^{\nu} \;-\; \kappa\, b_t \;+\; q_t(b_{m,t+1}, b_{t+1}, s_t)\big[b_{t+1} - b_t(1-\delta)\big] \\ -\; \kappa_m b_{m,t} \;+\; q_{m,t}(b_{m,t+1}, b_{t+1}, s_t)\,\big[b_{m,t+1} - b_{m,t}(1-\delta_m)\big] \\ -\; \big(k_{t+1} - (1-\delta_k)k_t\big) \;-\; \tfrac{\Theta}{2}(k_{t+1}-k_t)^2 - g(p). \end{aligned}$$

Cost of delinquency. Following standard practice, delinquency entails a direct penalty $\phi(A_t) = \min\{\max(d_0 + d_1 A_t, 0), 1\}$. The dependence on A_t rather than output facilitates a clean labor choice. Consumption during delinquency is

$$c_t = (1-\phi(A_t))\, A_t\big(k_t^{\alpha^k} L_t^{1-\alpha^k}\big)^{\nu} \;-\; \big(k_{t+1} - (1-\delta_k)k_t\big) \;-\; \tfrac{\Theta_d}{2}(k_{t+1}-k_t)^2.$$

4.2.1 Lenders

Lenders are competitive, risk-neutral, and supply funds to both types of long-term loans, taking the firm's borrowing and default policies as given. Their opportunity cost of funds is the world risk-free rate r. The prices of newly issued, non-state-contingent and state-contingent (moratorium) loans are denoted by q_t and $q_{m,t}$, respectively.

If a loan becomes delinquent, lenders can sell it at fair value to a collection agency. We denote the market value of delinquent standard loans by q_t^D and that of delinquent moratorium loans by $q_{m,t}^D$. Competitive pricing implies that both sets of prices satisfy no-arbitrage conditions based on the expected discounted payoff streams associated with repayment and default.

4.3 Recursive representation

We now formulate the household's optimization problem recursively. Let $s \equiv (A, p)$ denote the vector of exogenous states, and let $V(b_m, b, s)$ denote the value of the household that owns the firm and has the option to default. The household chooses to repay whenever the value of repayment exceeds the value of default:

$$V(b_m, b, k, s) = \max\Big\{ V^R(b_m, b, k, s),\ V^D(b_m, b, k, s) \Big\}. \tag{8}$$

Repayment value. The continuation value under repayment is

$$V^R(b_m, b, k, s) = \max_{c, L, k', b'_m, b' \geq 0} \Big\{ u(c, L) + \beta \mathbb{E}_{s'|s}\big[V(b'_m, b', k', s')\big] \Big\} \tag{9}$$

$$\begin{aligned}
\text{s.t.} \qquad c + i = {} & A\left(k^{\alpha^k} L^{1-\alpha^k}\right)^{\nu} - \kappa\, b - \big[1 - \mathcal{I}(p)\big]\,\kappa_m b_m \\
& + q(b'_m, b', k', s)\, f + q_m(b'_m, b', k', s)\, f_m - \frac{\Theta}{2}(k' - k)^2 - g(p), \\
f = {} & b' - b(1 - \delta), \\
f_m = {} & b'_m - \big[1 - \mathcal{I}(p)\big] b_m (1 - \delta_m) - \mathcal{I}(p)\, b_m e^{r_m}, \\
i = {} & k' - (1 - \delta_k)k, \\
q(b'_m, b', k', s) \geq {} & \underline{q} \qquad \text{for all } b' > b(1 - \delta), \\
q_m(b'_m, b', k', s) \geq {} & \underline{q} \qquad \text{for all } b'_m > \big[1 - \mathcal{I}(p)\big] b_m (1 - \delta_m) + \mathcal{I}(p)\, b_m e^{r_m}.
\end{aligned}$$

Here $\mathcal{I}(p)$ is an indicator function equal to 1 when the global shock is in its high-stress state, and 0 otherwise.

Default value. A delinquent firm remains in arrears for a stochastic duration and subsequently resumes debt service by repaying a fraction $\alpha \in (0, 1)$ of both outstanding loan types. During arrears, no new borrowing is allowed and the firm is subject to additional production costs. The continuation value under default is therefore:

$$V^D(b_m, b, k, s) = \max_{c, L, k' \geq 0} \Big\{ u(c, L) + \beta\, \mathbb{E}_{s'|s}\big[V(\alpha b_m,\, \alpha b,\, k', s')\big] \Big\} \tag{10}$$

$$\begin{aligned}
\text{s.t.} \qquad c + i = {} & \big(1 - \phi(A)\big) A\left(k^{\alpha^k} L^{1-\alpha^k}\right)^{\nu} - \frac{\Theta_d}{2}(k' - k)^2, \\
i = {} & k' - (1 - \delta_k)k.
\end{aligned}$$

Standard long–term loan pricing. The no–arbitrage condition for a standard loan is

$$(1+r)\,q(b'_m,b',k',s) = \mathbb{E}_{s'|s}\Bigg[\underbrace{d'\,q^D(b'_m,b',k',s')}_{\substack{\text{Firm defaults next period;}\\ \text{loan sells at delinquent price}}} + \underbrace{(1-d')\left[\kappa+(1-\delta)\,q\big(b''_m,b'',k'',s'\big)\right]}_{\substack{\text{Firm repays;}\\ \text{lender receives coupon } \kappa\\ \text{and resale value } (1-\delta)q}}\Bigg], \tag{11}$$

where $d' = \hat{d}(b'_m,b',k',s')$ is the equilibrium default decision next period, and $b'' = \hat{b}(b'_m,b',k',s')$, $b''_m = \hat{b}_m(b'_m,b',k',s')$ are next–period equilibrium borrowing choices following repayment.

Equation (11) states that selling the loan today and investing at the risk–free rate yields the same return as holding the loan. If the firm repays, lenders receive one coupon κ and the remaining amortization value $(1-\delta)$ of the loan at price $q(b''_m,b'',k'',s')$. If the firm defaults, lenders sell the loan at the delinquent price q^D.

Delinquent standard loan pricing. A delinquent loan is either carried forward or repaid after the firm exits arrears. Its price satisfies

$$(1+r)\,q^D(b'_m,b',k',s) = \mathbb{E}_{s'|s}\Big[\underbrace{(1-\xi)\,q^D(b'_m,b',k',s')}_{\substack{\text{Firm remains in}\\ \text{arrears}}} + \underbrace{\xi\,\alpha\,q\Big(\hat{b}_m(\alpha b'_m,\alpha b',k',s'),\ \hat{b}(\alpha b'_m,\alpha b',k',s'),k''\ s'\Big)}_{\substack{\text{Firm exits delinquency;}\\ \text{repays fraction } \alpha \text{ of debt}}}\Big]. \tag{12}$$

Moratorium loan pricing. A moratorium loan pays its coupon only when the global state does not trigger a payment suspension. Its no–arbitrage price is

$$\begin{aligned}(1+r)\,q_m(b'_m,b',k',s) = \mathbb{E}_{s'|s}\Big[& \underbrace{d'\,q^D_m(b'_m,b',k',s')}_{\substack{\text{Firm defaults;}\\ \text{loan sells at delinquent price}}} \\ & + \underbrace{(1-d')\,\big(1-\mathcal{I}(p')\big)\left[\kappa+(1-\delta_m)\,q_m(b''_m,b'',k'',s')\right]}_{\text{Repayment in normal times; coupon } \kappa \text{ is paid}} \\ & + \underbrace{(1-d')\,\mathcal{I}(p')\,e^{r_m}\,q_m(b''_m,b'',k'',s')}_{\substack{\text{Repayment during suspension;}\\ \text{coupon skipped, principal grows at rate } e^{r_m}}}\Big].\end{aligned} \tag{13}$$

Delinquent moratorium loan pricing. When a moratorium loan is in arrears, its price satisfies

$$(1+r)\, q_m^D(b'_m, b', k', s) = \mathbb{E}_{s'|s}\Big[(1-\xi)\, q_m^D(b'_m, b', k', s') + \xi\, \alpha\, q_m\Big(\hat{b}_m(\alpha b'_m, \alpha b', k', s'),\ \hat{b}(\alpha b'_m, \alpha b', k', s'), k''\ s'\Big)\Big]. \tag{14}$$

4.4 Definition of equilibrium

This paper focuses on a Markov perfect equilibrium. The representative household cannot commit to future repayment and borrowing decisions, so its strategies depend only on payoff-relevant state variables.

Definition 1 (Markov perfect equilibrium). *A Markov perfect equilibrium consists of value functions $V(b_m, b, k, s)$, $V^R(b_m, b, k, s)$, $V^D(b_m, b, k, s)$, bond pricing functions $q(b'_m, b', k', s)$ and $q_m(b'_m, b', k', s)$ (and their delinquent counterparts $q^D(b'_m, b', k', s)$ and $q_m^D(b'_m, b', k', s)$), a default rule $\hat{d}(b_m, b, k, s)$, and borrowing rules $\hat{b}(b_m, b, k, s)$ and $\hat{b}_m(b_m, b, k, s)$ such that:*

1. *Given the bond pricing functions q, q_m, q^D, and q_m^D, the policy rules $\{\hat{d}, \hat{b}, \hat{b}_m\hat{k}\}$ solve the firm's dynamic optimization problem, and the associated value functions satisfy the Bellman equations (8), (9), and (10).*

2. *Given the policy rules $\{\hat{d}, \hat{b}, \hat{b}_m\hat{k}\}$, the pricing functions q, q_m, q^D, and q_m^D satisfy the lenders' zero–profit (no–arbitrage) conditions (11)–(14).*

We relegate the details of the calibration to Section Appendix E.1 and the numerical algorithm to Section Appendix E.2. Most parameters are disciplined using moments computed from our administrative firm-level data or aggregate Colombian statistics. Before turning to the quantitative results, we briefly summarize how the model is disciplined and how it connects to the empirical evidence. Table 5 reports the empirical elasticities from the regression discontinuity design alongside their model-implied counterparts under a one-time, unanticipated payment suspension. The investment elasticity is a targeted moment and pins down the investment adjustment cost parameter, ensuring that the model reproduces the marginal real response identified in the data. The remaining elasticities—employment, non-contingent borrowing, and credit prices—are not targeted and therefore provide out-of-sample validation of the model's transmission mechanisms. Table 4 reports the long-run moments used to discipline the steady state, including leverage, spreads, default frequencies, and business-cycle statistics, while Table E5 summarizes the parameter values and their associated targets. Together, these tables establish a transparent

mapping between the quasi-experimental evidence and the structural model, providing a disciplined foundation for the counterfactual and welfare analyses that follow.

5 Quantitative Results

5.1 One-time moratoria and RDD meets model

Figure 7 provides a first characterization of the mechanism through which moratoria affect the firm's repayment/default incentives in the model. The figure plots the default cutoff—the debt threshold $\bar{b}(\cdot)$ at which the firm is indifferent between repayment and default—under a liquidity shock, comparing an economy without moratoria (solid black) to one in which a one-time, unanticipated moratorium option is available (dashed red). For any given state, the firm *defaults* (respectively, *repays*) for debt levels below (respectively, above) the relevant cutoff curve.[15]

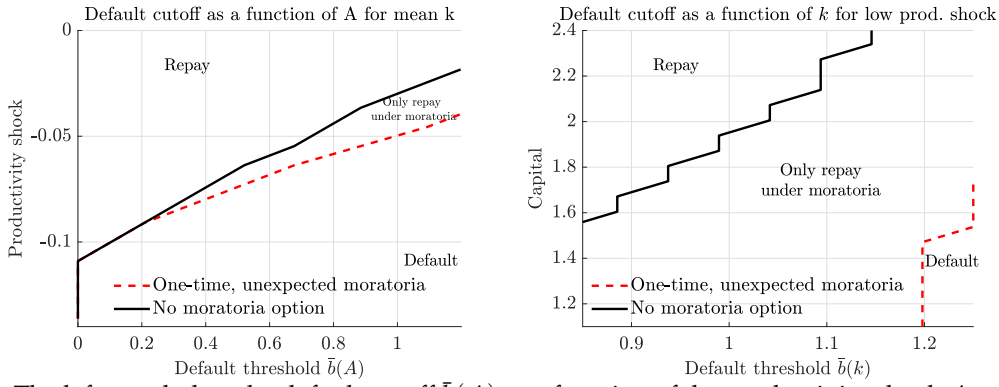
The left panel varies productivity A while holding capital at its mean. Allowing for moratoria shifts the cutoff downward across productivity states, implying that repayment is optimal in a larger set of states once temporary payment suspension is available. The region between the dashed red and solid black cutoffs identifies states in which the firm would default absent moratoria but instead remains in repayment when the option is available. The right panel presents the analogous comparison along the capital dimension, plotting $\bar{b}(k)$ at a low-productivity realization, $A = \mathbb{E}(A) - 2\sigma_\varepsilon$. Consistent with the left panel, moratoria reduce the set of (b, k) states in which default is optimal.

Taken together, Figure 7 shows that moratoria operate primarily by relaxing near-term repayment pressure in stress states, thereby preventing default at the margin. The remainder of this section quantifies how these shifts in the default region translate into changes in borrowing, investment, employment, and aggregate outcomes.

Bond prices and borrowing under a one-time, unanticipated moratorium. Figure 8 plots the equilibrium bond price schedule and the associated borrowing policy as functions of current productivity under a liquidity shock (evaluated at mean capital). The moratorium option slightly increases bond prices—the dashed red curve lies marginally above the solid black curve—indicating a modest decline in spreads in the most stressed repayment states. The borrowing policy is likewise only modestly affected: firms borrow slightly more when the moratorium option is available, with the difference concentrated in low-to-

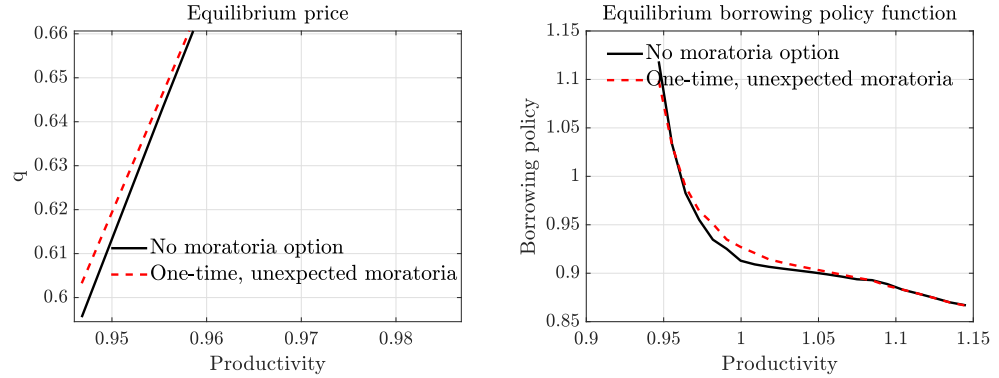
[15] To implement an unanticipated policy within a stationary solution, we include a moratorium regime that arrives with probability $\varepsilon_m = 10^{-6}$ whenever $p_t = p_H$, high-stress state. This makes the event effectively unexpected ex ante while allowing us to compute decision rules conditional on its realization.

Figure 7: Default policy functions: introducing a one-off moratorium (payment suspension)



Notes: The left panel plots the default cutoff $\bar{b}(A)$ as a function of the productivity shock A, evaluated at mean capital and under a liquidity shock, for a one-time, unanticipated moratorium. In each economy, firms *default* (respectively, *repay*) for states *below* (respectively, *above*) the corresponding cutoff curve. The dashed red curve (moratorium available) lies below the solid black curve (no moratorium), implying a larger repayment region: states between the two curves are those in which firms would default absent moratoria but repay when the moratorium option is available. The right panel analogously plots the default cutoff $\bar{b}(k)$ as a function of capital k, evaluated at a low-productivity state $A = \mathbb{E}(A) - 2\sigma_\varepsilon$ and under a liquidity shock, for a one-time, unanticipated moratorium.

Figure 8: Equilibrium borrowing and price functions: introducing a one-off moratorium (payment suspension)



Notes: The left panel plots the equilibrium bond price schedule, $q(A)$, as a function of current productivity A in the benchmark economy without moratoria (solid black) and in an otherwise identical economy in which a payment suspension (moratorium) can be introduced once and is unanticipated (dashed red). The right panel plots the corresponding equilibrium borrowing policy (next-period debt choice) as a function of A. Both objects are evaluated at mean capital and conditional on a liquidity shock.

intermediate productivity states. Very close to the default boundary, however, the firm borrows slightly less, consistent with a more precautionary posture in states where default incentives remain high.

Why are price effects small despite a visible shrinkage of the default region? The small movement in q is natural in a one-time, unanticipated experiment for three reasons.

First, equilibrium prices for *newly issued* debt are forward-looking and depend primarily on expected discounted payoffs *after issuance*, i.e., on future default probabilities and recoveries. A one-off moratorium that arrives as a surprise and does not persist has limited effects on these forward-looking objects, even if it materially affects the *current-period* default decision. Second, the reduction in default risk induced by moratoria is concentrated near the default boundary and therefore affects expected payoffs only for a narrow set of states, limiting the impact on prices averaged over future realizations. Third, equilibrium feedback in quantities partially offsets the direct risk-reduction effect: because repayment becomes more attractive in crisis states, firms can sustain (and optimally choose) slightly higher leverage, which raises future default incentives and dampens the increase in bond prices.

In the one-time, unanticipated experiment, moratoria primarily operate through the *extensive margin* (preventing default for marginal firms) and through real allocations (higher continuation value and capital accumulation), rather than through large, persistent changes in equilibrium borrowing costs. Next, we describe the model's capital policy dynamics.

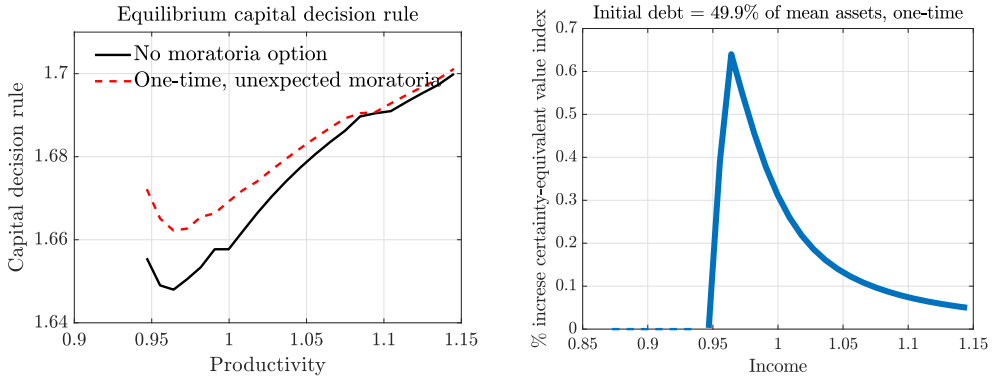
Capital policy functions. Left chart Figure 9 shows the optimal capital choice as a function of productivity under a one-time, unanticipated moratorium. When the moratorium option is available, firms invest more (choose higher next-period capital) over the range of low-to-intermediate productivity states in which liquidity is tight and default risk is elevated. The gap in capital policies narrows at high productivity, where firms are unconstrained and repayment is optimal even absent moratoria. This pattern is consistent with the moratorium operating primarily by relaxing short-run liquidity constraints and lowering effective rollover risk, thereby increasing the expected return to maintaining the firm as a going concern.

Welfare metric (GHH preferences). We compute *state-dependent welfare gains* as the proportional change in lifetime value that would make the agent indifferent between the baseline economy and an otherwise identical economy in which moratorium loans are available. With Greenwood–Hercowitz–Huffman (GHH) preferences, welfare cannot be mapped into a simple consumption-equivalent variation because utility depends on a composite of consumption and labor. Specifically, period utility is

$$u(c, L) \;=\; \frac{\left(\tilde{c}\right)^{1-\sigma}}{1-\sigma}, \qquad \tilde{c} \;\equiv\; c - \eta \frac{L^{\omega}}{\omega},$$

so welfare comparisons necessarily reflect changes in both consumption and labor effort through the composite $\tilde{c}$.

Figure 9: Capital decision rules and welfare: introducing a one-off moratorium (payment suspension)



Notes: The left panel plots the firm's capital decision rule, $k'(A)$, as a function of current productivity A in the benchmark economy without moratoria (solid black) and in an otherwise identical economy in which a payment suspension (moratorium) can be introduced once and is unanticipated (dashed red). The policy functions are evaluated at mean capital, mean debt and conditional on a liquidity shock. The welfare panel reports state-dependent welfare changes under GHH preferences as percent changes in the certainty-equivalent value index, computed as $100 \times \left(V^{\text{one-time}}/V^{\text{baseline}} - 1\right)$ for the initial debt position indicated in the panel, where $V^{\text{one-time}}$ and $V^{baseline}$ denote continuation values with and without the moratorium option, respectively. The flat segments at the zero line correspond to productivity states in which the firm defaults in both economies, so the moratorium option does not affect continuation values and welfare gains are zero.

In the quantitative analysis we work with the certainty-equivalent value index implied by the Bellman recursion,

$$V^j(b_{m,t}, b_t, s_t) \;=\; \left(\tilde{c}_t^{\,j\,1-\sigma} \;+\; \beta\, \mathbb{E}_t\left[V^j(b_{m,t+1}, b_{t+1}, s_{t+1})^{1-\sigma}\right]\right)^{\frac{1}{1-\sigma}},$$

which is in one-to-one correspondence with the standard expected-discounted-utility representation under CRRA over $\tilde{c}$. We then report welfare gains (in percent) as

$$\Delta V(b_{m,t}, b_t, s_t) \;=\; 100 \times \left(\frac{V^{\text{moratoria}}(b_{m,t}, b_t, s_t)}{V^{\text{baseline}}(b_t, s_t)} - 1\right),$$

where $s_t = (A_t, p_t)$ collects exogenous productivity A_t and the liquidity shock p_t. Positive values indicate that the economy with moratorium loans delivers higher lifetime utility (through the composite $\tilde{c}$), starting from the same initial state.

Interpreting the welfare profile. Figure 9 plots ΔV as a function of current productivity. Welfare gains are highly state dependent. Gains are essentially zero at very low productivity levels because the firm defaults in both environments and the moratorium option does not alter equilibrium allocations or continuation values. Welfare gains rise sharply around the default boundary and peak for *marginal* states—those for which access to a moratorium shifts the repayment/default decision. In these states, the moratorium prevents default,

producing a discrete improvement in continuation value through avoided default costs and preserved access to future credit. At higher productivity levels, where repayment is optimal regardless of the policy, welfare gains decline and become small: the moratorium primarily provides transitory liquidity relief, which has limited value when constraints are slack and default risk is remote.

Takeaways. Taken together, these decision rules highlight three implications. First, the welfare benefits of a one-off moratorium are concentrated at the extensive margin: they are largest precisely in states where the policy shifts the default decision. Second, away from the default region, moratoria have modest welfare effects because they do not materially alter long-run allocations when firms are already safely repaying. Third, the main real-side adjustment is stronger capital accumulation in crisis states, reflecting improved short-run financing conditions and a higher continuation value of repayment. These results underscore that the effectiveness of moratoria hinges on targeting stressed firms near the default boundary rather than on broad-based use in normal times.

Our decision rules imply that the one-period, unanticipated moratorium generates responses that are qualitatively consistent with the RDD evidence in Section 3. In particular, the moratorium raises investment, reduces default risk, lowers borrowing costs on new credit, and modestly increases borrowing volumes depending on the severity of the productivity shock. In the next step, we assess the model's quantitative fit by comparing these implications to their empirical counterparts through elasticity moments for the corresponding outcomes.

5.1.1 Data meets the Model: Empirical vs. Model-Implied Elasticities

A central goal of the quantitative analysis is to ensure that the model reproduces the *marginal* firm-level responses to debt-service relief identified in the regression discontinuity design (RDD) in Section 3. We make the link between the data and the model explicit by disciplining a key real rigidity—the investment adjustment-cost parameter Θ—to match the empirical elasticity of investment with respect to realized payments, $(\partial I/\partial P)$. All remaining elasticities are *not* targeted and therefore provide out-of-sample validation of the model's transmission mechanisms. This discipline-and-validate strategy is designed to avoid mechanical overfitting, while ensuring that the model matches the most direct "real" margin estimated in the quasi-experiment.[16]

[16] Assessing whether a quantitative model aligns with micro estimates is inherently non-trivial. Bridging local micro-responses to a quantitative macro model involves conceptual and measurement gaps (timing, aggregation, and general-equilibrium feedback), and the comparison should be interpreted as an external validation exercise rather than an exact mapping (see Önder et al., 2024 for related discussion).

Table 4: Long-run effects of introducing moratorium loans.

	Data	Benchmark	Moratoria
Mean standard loan/assets (%)	50.8	49.1	31.4
Mean moratorium loan/assets (%)	*n.a.*	*n.a.*	20.0
Mean r_s (%)	2.6	2.4	2.5
Mean Investment rate (%)	11.1	12	12
Mean moratorium r_s (%)	*n.a.*	*n.a.*	3.6
Share of NPL	5	7.0	7.1
Recovery rate (%)	67	67	67
Duration	3.8	3.9	3.9
Duration moratorium	*n.a.*	*n.a.*	4.2
σ_{r_s}	2.2	1.0	2.8
σ_{r_s} moratorium	*n.a.*	*n.a.*	2.9
Std investment rate (%)	XX	1	1
Productivity decline during defaults (%)	18.1	14.4	14.3
Labor decline during high-risk-premium (%)	3.6	2.8	3.2
Probability high-risk-premium starts (%)	15.0	15.0	15.0
Lower income during high-risk-premium (%)	4.0	4	4.5
Δ r_s with high-risk-premium shock	1.5	1.7	1.7
$\sigma(c)/\sigma(y)$	0.87	0.95	0.93
$\rho(c, y)$	0.92	0.99	0.99

The standard deviation of x is denoted by $\sigma(x)$. Moments are computed using detrended series. Trends are computed using the Hodrick-Prescott filter with a smoothing parameter of 100. Moments for the simulations correspond to the mean value of each moment in 500 simulation samples, with each sample including 5 years without a default episode. Simulation samples start at least five years after a default. Default episodes are excluded to improve comparability with the data. Consumption and income are expressed in logs. Default frequencies and the probability that a high-risk-premium episode starts are computed using all simulation periods. For moratorium debt, the yield (and spread), debt duration, and debt stock are computed using expected payments, thus incorporating uncertainty about the timing of payments.

The RDD identifies the local causal effect of *access* to the moratorium for firms near the eligibility cutoff, where observables are balanced by construction. In the model, we replicate this margin by holding fixed the same pre-policy state and the same aggregate shock history, and comparing outcomes under two policy regimes: an economy in which the moratorium rule suspends scheduled payments during the crisis episode, and an otherwise identical economy without payment suspension. We then summarize both the empirical and model responses using elasticities to realized annual payments, so that the comparison is scale-free and directly interpretable.

Formally, let $\varepsilon_I^{\text{emp}}$ denote the empirical elasticity of investment to payment relief computed at the cutoff (Section 5.1.2). In the model, for any candidate Θ, we compute the corresponding elasticity under the same one-time, unanticipated suspension experiment, $\varepsilon_I^{\text{model}}(\Theta)$. We discipline Θ by minimizing the distance between the model-implied and empirical investment elasticities,

$$\Theta \in \arg\min_{\Theta \in \mathcal{T}} \left| \varepsilon_I^{\text{model}}(\Theta) - \varepsilon_I^{\text{emp}} \right|, \tag{15}$$

while imposing that the model-generated standard deviation of the investment rate lies within an empirically plausible range. Having pinned down Θ using the investment elasticity, we report the implied elasticities for employment, non-contingent borrowing, and credit prices without further targeting; their alignment with the data constitutes a disciplined, out-of-sample check of the model.

Figure **??** reports impulse responses for the crisis experiment in which a moratorium is introduced as a *one-off* policy that agents do not anticipate. At time 0, the economy is hit by a two-standard-deviation productivity shock and a liquidity (high-risk-premium) shock; thereafter, productivity evolves according to (5) and the liquidity shock follows its Markov transition. Each panel plots the percent deviation of a variable in the moratorium economy relative to the otherwise identical economy without payment suspension.

The model reproduces the qualitative patterns emphasized in the data. When scheduled payments are suspended, firms experience immediate cash-flow relief, which relaxes rollover pressure and reduces default risk in the crisis state. This improves the pricing of new credit and allows firms to re-optimize investment and labor choices. At the same time, the response of *non-moratorium* borrowing reflects the interaction of (i) lower near-term debt service and (ii) forward-looking leverage incentives under endogenous default risk. These mechanisms are central for the model's long-run and welfare implications studied below.

5.1.2 Computation of Elasticity Measures

We summarize the RDD and the model using the same scale-free object: the elasticity of an outcome to *realized annual debt-service payments*. Let P denote annual payments actually made (debt service), and let $X \in \{I, L, b, q\}$ denote an outcome of interest (annual investment, employment, new standard borrowing, and the price of new credit).[17] For a one-time, unanticipated payment suspension, we compute the elasticity to a *decrease* in payments (payment relief) as

$$\varepsilon_X \equiv \frac{\frac{\Delta X}{\bar{X}}}{-\frac{\Delta P}{\bar{P}}}, \tag{16}$$

where $\Delta X \equiv X^{\text{mor}} - X^{\text{no mor}}$, $\bar{X}$ is the corresponding baseline average, and $\Delta P \equiv P^{\text{mor}} - P^{\text{no mor}} < 0$. This object answers: *by how many percent does X change when annual payments fall by 1 percent?*

[17] These are intensive-margin responses to *realized* payments. They are distinct from take-up (extensive margin) and from elasticities to an economy-wide change in interest rates.

Table 5: Empirical and model-implied elasticities to payment suspensions

Outcome	Empirical	Model	Status
Investment $(\partial I/\partial P)$	$\varepsilon_I^{\text{emp}}$	$\varepsilon_I^{\text{model}}$	*Targeted*
Employment $(\partial L/\partial P)$	$\varepsilon_L^{\text{emp}}$	$\varepsilon_L^{\text{model}}$	Validation
New standard debt $(\partial b/\partial P)$	$\varepsilon_b^{\text{emp}}$	$\varepsilon_b^{\text{model}}$	Validation
Price of new credit $(\partial q/\partial P)$	$\varepsilon_q^{\text{emp}}$	$\varepsilon_q^{\text{model}}$	Validation

When payment relief is large and discrete (e.g., near-complete suspension), we also report the corresponding semi-elasticity with respect to payments in levels:

$$\tilde{\varepsilon}_X \equiv \frac{\Delta X/\bar{X}}{-\Delta P}, \tag{17}$$

where ΔP is expressed in levels (goods). This is useful when $\bar{P}$ varies sharply across states or when $-\Delta P/\bar{P}$ is close to one by construction.

Empirical computation (RDD). In the data, we use realized debt-service flows to measure the moratorium-induced change in annual payments, ΔP, and compute $\Delta X/\bar{X}$ for each outcome X around the cutoff. If annual payments fall by p percent and annual investment rises by i percent, then $\varepsilon_I^{\text{emp}} = i/p$. We compute analogous objects for employment, new standard borrowing, and credit prices/spreads.

Model computation. In the model, we evaluate the same one-time, unanticipated suspension experiment by comparing two otherwise identical economies (with and without payment suspension) under the same pre-policy state and aggregate shock history. We construct annual payments and annual outcomes by aggregating model-period flows within a year, and then form $\varepsilon_X^{\text{model}}$ using (16). When the policy suspends all scheduled payments over the measurement window so that $P^{\text{mor}} = 0$, the denominator simplifies and (16) reduces to $\varepsilon_X = \Delta X/\bar{X}$ (up to the choice of $\bar{P}$).

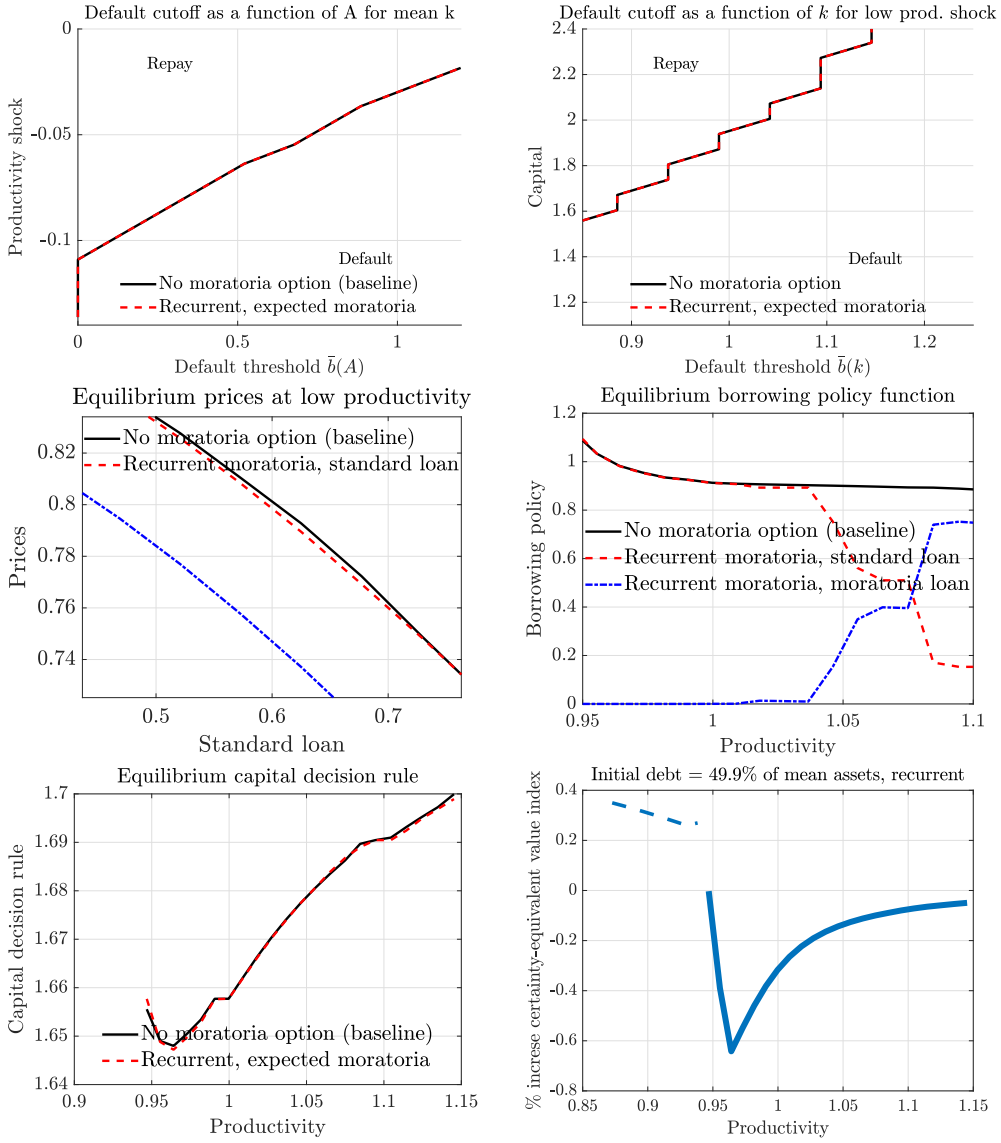
Table 6: RDD responses to payment suspensions: data versus model

	RDD (data)		Model	
Outcome	**Estimate**	**SE**	**Implied**	**Status**
Investment rate	$\widehat{\Delta I/I}$	$(\cdot)$	$\Delta I/I$	*Targeted*
Employment	$\widehat{\Delta L/L}$	$(\cdot)$	$\Delta L/L$	Validation
New standard debt	$\widehat{\Delta b/b}$	$(\cdot)$	$\Delta b/b$	Validation
Loan spread / price	$\widehat{\Delta r_s}$ (or $\widehat{\Delta q/q}$)	$(\cdot)$	Δr_s (or $\Delta q/q$)	Validation

Notes: Each entry reports the percent response of the outcome to a one-time, unanticipated payment suspension at the RDD cutoff. In the model, we replicate the same experiment holding fixed the pre-policy state and aggregate shock history. The investment response is targeted by choosing the investment adjustment-cost parameter Θ; the remaining responses are untargeted and provide out-of-sample validation.

5.2 Recurrent introduction

Figure 10: Decision rules: introducing a recurrent moratorium



Notes: The figure compares decision rules in the baseline economy without moratoria (solid black) and an economy with recurrent, anticipated moratoria (dashed/dash-dotted lines). The default-cutoff panels plot the boundary between repayment and default as a function of productivity A (evaluated at mean capital) and as a function of capital k (evaluated at a low-productivity state), conditional on a liquidity shock. The price panel reports equilibrium bond prices as functions of standard loan b: the baseline standard-loan price schedule (black), the standard-loan price schedule in the recurrent economy (red dashed), and the moratorium-eligible loan price schedule in the recurrent economy (blue dash-dotted). The borrowing-policy panel plots next-period borrowing by instrument in the recurrent economy and highlights substitution from standard loans toward moratorium-eligible loans. The capital panel plots the corresponding capital decision rule $k'(A)$. The welfare panel reports state-dependent welfare changes under GHH preferences as percent changes in the certainty-equivalent value index, computed as $100 \times \left(V^{\text{recurrent}}/V^{\text{baseline}} - 1\right)$ for the initial debt position of 49.9% of mean assets.

Figure 10 repeats the decision-rule analysis when moratoria are *recurrent* and therefore *anticipated*. This environment differs sharply from the one-off experiment: once agents expect moratoria to be available in the future, the option is priced into contracts and internalized in firms' ex ante balance-sheet choices. The resulting equilibrium changes are therefore best understood as a shift in *contracting and incentives*, rather than a mechanical relaxation of borrowing costs.

Default incentives. The first two panels plot default cutoffs as functions of productivity (evaluated at mean capital) and as functions of capital (evaluated at a low-productivity state), respectively. Relative to the one-off experiment, recurrent moratoria does not induce a shift in the default boundary: the repayment region does not change at all. The intuition is that, once moratoria are anticipated, firms and lenders adjust ex ante; the policy is no longer a surprise liquidity injection, and equilibrium borrowing choices partially undo the contemporaneous shift in default incentives.

Equilibrium prices: pricing the insurance *and* the dilution wedge. The price panel highlights two features of equilibrium pricing under recurrent, anticipated moratoria. First, the recurrent economy features a second instrument—a moratorium-eligible loan—whose price schedule (blue) lies strictly below the standard-loan schedule, especially in low-productivity states. This wedge is the *insurance premium* for payment-suspension contingencies: because moratoria reduce lenders' expected near-term repayments in some states, lenders require compensation in the form of a lower bond price (higher spread) on moratorium-eligible debt.

Second, the panel also shows that recurrent moratoria can also depress the price of *standard* loans in sufficiently bad states, i.e., $q^{\text{recurrent}}(A) < q^{\text{baseline}}(A)$ for low A, even though moratorium-eligible debt is pari passu in default. This pattern is consistent with a commitment (debt-dilution) mechanism under long-term debt: the market value of a standard claim issued today depends on future issuance and repayment policies, and anticipated future take-up of moratorium-eligible borrowing shifts the distribution of next-period balance sheets and rollover conditions, lowering expected payoffs on outstanding standard debt precisely where default risk is most sensitive. Taken together, the figure shows that recurrent moratoria are *priced* not only through an explicit premium on moratorium-eligible borrowing, but also through a deterioration in standard credit terms in the most distressed states.

Borrowing: substitution across instruments. Consistent with the price wedge, the borrowing-policy panel shows that recurrent moratoria primarily affect the *composition* of borrowing. Firms substitute toward moratorium-eligible borrowing in states where liquidity risk is salient, while reducing standard borrowing correspondingly, so that overall

borrowing remains close to the baseline over much of the state space. Very close to the default region, however, borrowing remains disciplined by high marginal default risk, limiting the scope for additional leverage.

Investment and capital accumulation. Capital decision rules remain very similar across regimes. With standard-loan prices essentially unchanged and moratorium-eligible borrowing carrying an explicit premium, recurrent moratoria do not generate a large relaxation of financing conditions. Consequently, the investment response that was prominent under a one-off, unanticipated policy becomes muted once the policy is priced and internalized.

Welfare. Finally, the welfare panel exhibits a pronounced nonlinearity that coincides with the repayment/default regions. The sharp jump occurs at the state where the optimal policy switches between repayment and default. Because default entails a discrete change in continuation payoffs (e.g., debt relief, default costs, and post-default continuation value), the value function is kinked at the default boundary. Within the repayment region, welfare reflects an insurance–discipline trade-off. Welfare is lower across repayment states because the insurance is not free: firms pay an explicit premium on moratorium-eligible borrowing and, in equilibrium, adjust their balance sheets in ways that can increase exposure to financial distress risk over time.

Key takeaway. When moratoria are recurrent and anticipated, they are *priced*: standard-loan prices and real decision rules change little, while the main equilibrium response is substitution into moratorium-eligible debt that carries an insurance premium. As a result, the recurrent regime delivers only modest shifts in default cutoffs and investment, and welfare is shaped by an insurance–incentives trade-off rather than a broad-based easing of borrowing conditions.

Recurrent moratoria and debt dilution under pari passu claims. In our recurrent economy, moratorium-eligible debt is *pari passu* with standard debt in default: both claims share recoveries pro rata. Nevertheless, recurrent moratoria can generate a commitment (debt-dilution) problem because debt is long term. The price of a claim issued today depends on expected discounted payoffs, which in turn depend on *future* issuance and repayment policies. Anticipated future issuance of moratorium-eligible debt affects the distribution of next-period balance sheets and hence default risk and continuation values, altering the payoff distribution of outstanding claims even without any change in priority. This is the standard dilution channel: under discretion, the borrower does not internalize how marginal issuance in the future changes the market value of previously issued long-term claims.

Why welfare can fall even starting from $b_m = 0$. Because prices and continuation values are determined in equilibrium, the recurrent-moratorium economy is a fixed point in

which lenders price standard debt given expectations of future portfolio choices, including the use of moratorium-eligible borrowing in some states. Thus, even at $b_m = 0$ today, lifetime welfare can be lower if the anticipation of future take-up worsens equilibrium intertemporal trade-offs or increases exposure to financial distress. In a GHH environment, these effects operate through the consumption–labor composite $\tilde{c} = c - \eta \frac{L^\omega}{\omega}$: higher expected debt service and a higher likelihood of operating near financing constraints reduce $\tilde{c}$ and therefore lifetime utility.

Why firms nevertheless use the moratorium-eligible instrument. Firms choose moratorium-eligible borrowing because it provides state-contingent liquidity insurance: it shifts resources toward states in which liquidity shocks bind and the marginal value of relaxing near-term payments is high. The equilibrium wedge in prices—moratorium-eligible debt trading at a lower price (higher spread) than standard debt—is the insurance premium. Portfolio choice therefore reflects a trade-off between paying this premium in normal times and mitigating sharp declines in $\tilde{c}$ in adverse states. The welfare losses under recurrent use reflect that this insurance is obtained under discretion rather than commitment, so equilibrium portfolio choices can amplify dilution-type externalities even when claims are pari passu.

5.3 Impulse responses of one-time vs. recurrent moratoria

To assess the dynamic and long-run implications of moratoria, we complement the steady-state comparisons with impulse response functions (IRFs). We consider three environments: (i) a benchmark economy without moratorium-eligible debt; (ii) a *one-time* policy experiment in which an unanticipated payment suspension is introduced for existing standard loans; and (iii) a *recurrent* regime in which firms can borrow using both standard loans and moratorium-eligible loans. Throughout, suspended payments accrue the risk-free rate ($r_m = r$), so triggering the contingency clause entails no nominal haircut. Moratorium-loan payments decay at the same rate as standard loan payments ($\delta_m = \delta$).[18]

[18] Assuming $\delta_m = \delta$ implies that moratorium-eligible loans have a longer effective duration than standard non-contingent loans because payments are postponed when the clause is triggered (Figure F7). Longer duration can amplify inefficiencies associated with limited commitment and debt dilution (see, e.g., Hatchondo and Martinez, 2009). We therefore verify that our results are robust to varying δ_m: aligning moratorium-loan duration with that of standard loans does not materially affect the conclusions. This confirms that the higher default risk associated with moratorium borrowing (Table 4) is not mechanically driven by longer duration.

Table 4 reports long-run moments for the benchmark economy (column 2) and for the economy with moratorium-eligible borrowing (column 3). Figure 11 provides the IRFs.[19]

Impulse responses under one-time vs. recurrent moratoria. Figure 11 reports IRFs to a severe adverse initial condition. We initialize the economy at $A_0 = \mathbb{E}(A) - 2\sigma_\varepsilon$ and $p_0 = 1$ (a liquidity shock), and then let (A_t, p_t) evolve according to their estimated transition processes. Each point is computed as the mean over 20,000 simulated paths. All panels report percentage deviations from the *benchmark* steady state ("Rel. Δ in %").

One-time, unanticipated moratorium: crisis-time insurance with short-run real effects. The one-time moratorium (yellow dashed) delivers an immediate stabilization in the crisis period. The initial contractions in *investment*, *payout*, *labor*, and *output* are noticeably smaller than in the benchmark (red dash-dotted), consistent with the decision rules: an unanticipated payment suspension relaxes the liquidity constraint precisely when the firm is closest to the default boundary. The spike in default is substantially attenuated, and the spread on standard credit rises by less on impact. These effects fade quickly as shocks mean revert and the moratorium is not expected to recur, so the one-time experiment primarily reshapes outcomes in the first few years.

Recurrent moratoria: pricing and portfolio substitution dominate. Under recurrent, anticipated moratoria (blue solid), macro aggregates (*investment, payout, labor, output*) and even *defaults* and *spreads* track the benchmark closely after the initial shock. This muted aggregate response mirrors the recurrent decision rules: once moratoria are anticipated, the policy is priced into contracting and does not generate a large surprise easing of financing conditions. The dominant adjustment instead occurs through *portfolio composition*. The share of *standard loans/assets* declines persistently, while *moratorium-eligible loans/assets* rises and remains elevated for many years. This substitution is the dynamic counterpart of the recurrent policy functions: firms endogenously tilt borrowing toward moratorium-eligible debt (which carries an explicit insurance premium) and away from standard borrowing.

Welfare: insurance gains under one-time use versus insurance–dilution costs under recurrent use. The welfare panel summarizes the intertemporal trade-off. In the one-time experiment, welfare improves on impact and then converges back toward zero as the economy exits the crisis and the intervention is not expected to recur. In contrast, recurrent

[19] We simulate economies with a large cross-section of firms. Simulations begin from a pool of 100,000 firms with zero debt and draws from the ergodic income distribution. We simulate the benchmark, one-time, and recurrent economies separately. For the benchmark and one-time economies, firms follow the benchmark decision rules; the one-time experiment is implemented as a rare-event regime that arrives with probability $\varepsilon_m = 10^{-6}$ in the high-stress state ($p_t = p_H$), ensuring the intervention is unanticipated within a stationary solution. For the recurrent economy, firms follow the decision rules of the economy with moratorium-eligible borrowing. We simulate each economy until aggregates converge to the corresponding steady state. See Önder, 2023 for details.

moratoria generate sustained welfare losses. The reason is that the insurance is not free once anticipated: firms pay premia on moratorium-eligible borrowing and, in sufficiently bad states, the equilibrium cost of standard borrowing can also deteriorate through a long-term debt (dilution/commitment) channel. Under GHH preferences, these forces operate through the consumption–labor composite $\tilde{c} = c - \eta \frac{L^\omega}{\omega}$: higher expected debt service and tighter rollover conditions require lower consumption and/or higher labor effort in repayment states, lowering lifetime utility even when average aggregates move little.

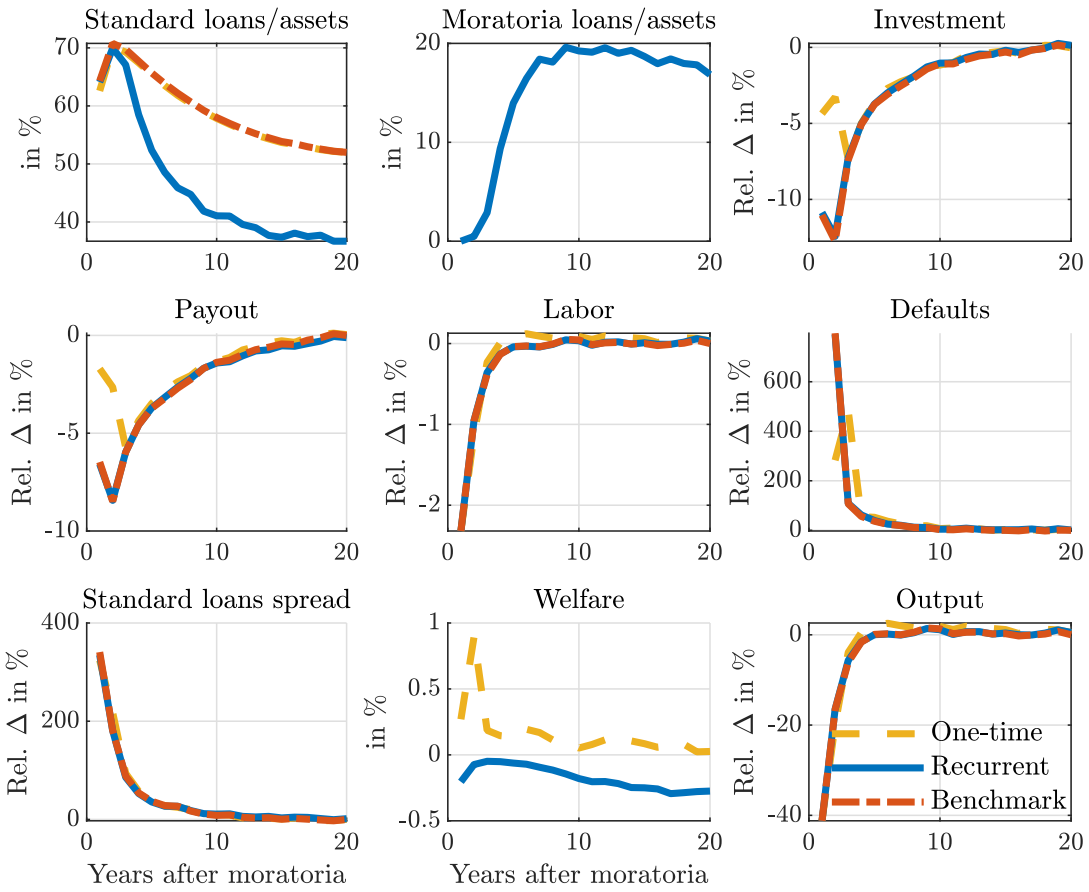
Key takeaway. The IRFs reinforce the message from the decision rules. A one-time, unanticipated moratorium acts as *emergency liquidity insurance*: it reduces default and cushions investment and output at the peak of the crisis, with effects that dissipate as shocks revert. When moratoria are recurrent and anticipated, the policy becomes *priced and internalized*: equilibrium borrowing costs and real allocations change little, the main response is persistent substitution toward moratorium-eligible borrowing, and welfare reflects an insurance–dilution trade-off under discretion.

Discussion A natural concern is that any moratorium rule in the policy toolkit should be anticipated and therefore priced. This is correct, but it does not imply that moratoria are irrelevant. Pricing simply means the policy operates as an insurance contract: borrowers receive state-contingent relief in stress states and pay for it in normal times. Whether such priced insurance raises welfare depends on its expected frequency and on equilibrium incentive effects. Our one-time experiment can be interpreted as the limiting case of a rare, emergency-only intervention (trigger probability $\varepsilon \to 0$), which delivers large benefits by preventing inefficient default at the peak of the crisis. The recurrent regime corresponds to more frequent, anticipated use; in that case, equilibrium portfolio substitution, premia on moratorium-eligible borrowing, and long-term debt dilution can dominate the insurance value and reduce welfare. Hence the policy implication is not that moratoria should never be used, but that their welfare effects hinge on credible limits on frequency/eligibility and on contract design.

6 Alternative design: interest forgiveness (a small haircut)

Our baseline results show that an unanticipated, one-time moratorium generates the largest short-run welfare gains by providing crisis-time liquidity insurance. In this section, we therefore take the one-time intervention as the benchmark and study how *design features*—in particular the treatment of interest—shape welfare.

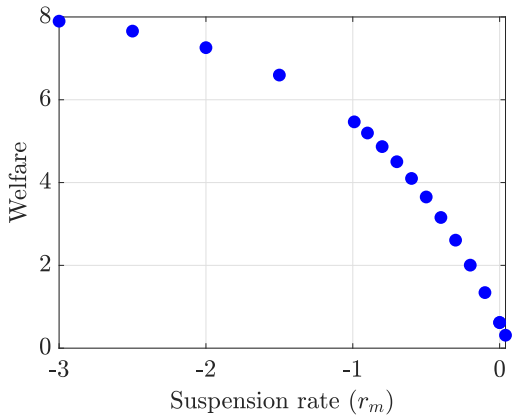
Figure 11: Impulse response functions to a liquidity shock: one-time versus recurrent moratoria



Notes: The figure plots impulse responses to an initial crisis state with productivity $A_0 = \mathbb{E}(A) - 2\sigma_\varepsilon$ and a liquidity shock $p_0 = 1$. Thereafter, (A_t, p_t) follow their Markov transition processes. Each series is computed as the mean across 20,000 simulated paths. "Rel. Δ in %" denotes percentage deviations from the benchmark steady state. Yellow dashed lines show the economy with a one-time, unanticipated moratorium introduced on impact; blue solid lines show the economy with recurrent, anticipated moratoria; red dash-dotted lines show the benchmark economy without moratoria.

Baseline design and cross-country variation. In the baseline moratorium, payments are suspended but interest continues to accrue at the risk-free rate, $r_m = r$. This corresponds closely to the Colombian program we study, where missed payments were deferred rather than forgiven. Moratoria implemented elsewhere have differed in an important dimension: for example, Belgium suspended payments without interest accrual, which implies partial debt relief rather than pure deferral. Motivated by this cross-country variation, we ask which design delivers higher welfare in our model.

Figure 12: Optimal moratorium debt relief.



The panel shows the average welfare gains for a given suspension rate r_m.

From liquidity smoothing to debt relief. A key distinction is whether the moratorium is *NPV-neutral* for lenders. When $r_m = r$, the policy mainly reshapes the timing of cash flows and operates as liquidity smoothing. When interest does not accrue ($r_m = 0$), the moratorium introduces a (small) present-value haircut on the suspended payments, turning the policy into partial debt relief. More generally, suspending only a fraction of payments provides weaker relief and therefore weaker insurance.

Main result: more relief can dominate. We show that firms do not prefer less debt relief. Figure 12 demonstrates that welfare gains are smaller when the policy suspends only a fraction of debt-service payments. Intuitively, partial suspension delivers limited breathing room precisely in the states where constraints bind, so it does less to prevent costly default and distress dynamics.

Interest forgiveness. Figure 13 considers the polar case of interest forgiveness, in which interest does not accrue during the suspension window ($r_m = 0$). Relative to the baseline one-time experiment in Figure **??** (pure payment deferral with interest accruing), this design introduces a small present-value haircut on the affected liabilities and therefore provides direct debt relief rather than only liquidity smoothing.

Balance-sheet response. A salient difference is the behavior of *standard loans*. Under interest forgiveness, standard loans fall sharply on impact and remain below baseline for several years. This contrasts with the deferral-only experiment, where the firm relies more heavily on standard loans in the crisis. The intuition is straightforward: when suspended interest is forgiven, the moratorium delivers a larger improvement in contemporaneous cash flow and effective net worth, reducing the need to finance operations through additional standard credit. Put differently, interest forgiveness shifts the adjustment margin from *borrowing more* to *borrowing less*. To thin on the intuition, under pure deferral ($r_m = r$),

the moratorium primarily smooths liquidity: it postpones debt service but leaves the present value of liabilities largely unchanged. In the crisis state, firms therefore use the suspension as a bridge and rely on additional standard borrowing to cover residual financing needs and to avoid costly default while maintaining investment. Moreover, because deferred obligations are not forgiven, repayment states feature higher future debt service, keeping leverage elevated into the recovery.

When interest does not accrue ($r_m = 0$), the moratorium becomes partial debt relief rather than liquidity smoothing. Forgiveness improves effective net worth and lowers the expected future debt-service burden precisely in high-stress states, reducing the need for external finance on impact. As the economy recovers, the absence of an accumulated repayment burden allows firms to rebuild balance sheets faster; they use improved cash flow to pay down debt rather than roll it over. This generates a sharp drop in standard borrowing on impact and a persistent period of below-baseline leverage, even though the intervention itself is one-time.

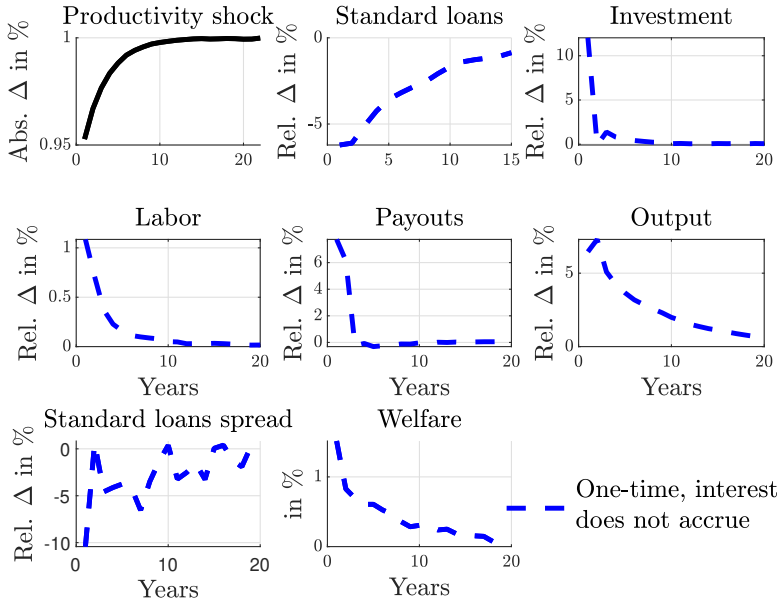
Prices and spreads. Because forgiveness reduces required debt service in the most stressed states, it lowers default incentives and improves the expected payoff to lenders on outstanding standard loans. Consistent with this mechanism, the standard-loan spread declines on impact in Figure 13. This spread compression is muted (or absent) under pure deferral, where the present value of promised payments is largely unchanged and the policy mainly affects the timing of cash flows.

Real activity and payouts. The more generous relief also strengthens the real response on impact. Investment and output jump in the crisis year and then gradually converge back as productivity mean reverts. Relative to the deferral-only design, interest forgiveness allows the firm to sustain higher investment while simultaneously easing balance-sheet pressure, which is also reflected in higher payouts in the early years: part of the relief is absorbed through real expansion and part is distributed when constraints relax quickly.

Welfare. Finally, welfare gains are larger under interest forgiveness. In the model, forgiving accrued interest raises welfare for two reinforcing reasons: it delivers resources precisely in high-marginal-utility states (under GHH, by improving the composite $\tilde{c} = c - \eta \frac{L^{\omega}}{\omega}$), and it reduces expected distress costs by lowering debt service and spreads in bad states. This result sharpens the paper's design message: moratoria that merely postpone payments mainly provide short-run liquidity insurance, whereas moratoria that also forgive interest operate as partial debt relief and generate materially larger welfare gains.

Key takeaway. Contract design is first order. When a moratorium is implemented as pure deferral, firms respond primarily by adjusting borrowing and investment in the

Figure 13: Impulse response functions of one-time introduction of moratorium loans with interest rate not accruing.



Notes: The figure plots impulse responses to an initial crisis state with productivity $A_0 = \mathbb{E}(A) - 2\sigma_\varepsilon$ and a liquidity shock, after which (A_t, p_t) follow their Markov transition processes. Each series is computed as the mean across simulated paths and is reported as a percentage deviation from the baseline where moratoria is not introduced ("Rel. Δ in %"). The policy corresponds to a one-time, unanticipated moratorium in which interest *does not accrue* during the suspension period, implying a small present-value haircut on the affected payments. Panels report the responses of standard borrowing, investment, labor, payouts, output, the standard-loan spread, and welfare.

crisis. When interest is forgiven, the policy becomes debt relief: it reduces leverage needs, compresses spreads in distress states, and amplifies welfare gains.

7 Conclusion

Our study presents a thorough examination of the effects of implementing a debt moratorium policy, which is historically one of the oldest policy proposals to address repayment challenges during periods of economic distress. By combining theoretical predictions with empirical and quantitative analysis, we aim to shed light on the effects of this policy across several dimensions.

Theoretical predictions, based on the concepts of demand and supply elasticities, suggest that firms not experiencing financial stress will face higher loan interest rates, while stressed firms will observe an increase in their loan amounts. To empirically test these predictions, we use administrative data from Colombia and, for the case of stressed

firms, employ a regression discontinuity design. We argue that by comparing loans that barely qualified for the policy with those that barely missed it, we can accurately assess the causal effects of the policy.

We find that stressed firms accessing moratorium experience more favorable loan conditions on subsequent borrowing, characterized by higher loan amounts, a higher probability of obtaining an new loan, and lower interest rates. In addition to examining the impact on loan rates and amounts, our analysis also examines how real variables such as investment and labor are affected by the debt moratorium policy. Our findings indicate that stressed firms benefiting from the debt moratorium, experience positive changes in various key indicators such as employment, investment, operating revenues, and assets.

Lastly, we construct a quantitative default model to gain insights into the long-run gains and losses associated with debt moratorium policies in a general equilibrium framework. In particular, our results indicate that the moratorium policy is welfare improving, and gains become more substantial when the policy includes forgiveness of interest accumulation during suspension episodes.

Through our comprehensive approach, which combines theoretical, empirical, and quantitative analysis, we aim to provide a comprehensive assessment of the effects of debt moratorium policies and provide valuable insights for policymakers involved in designing and implementing such policies.

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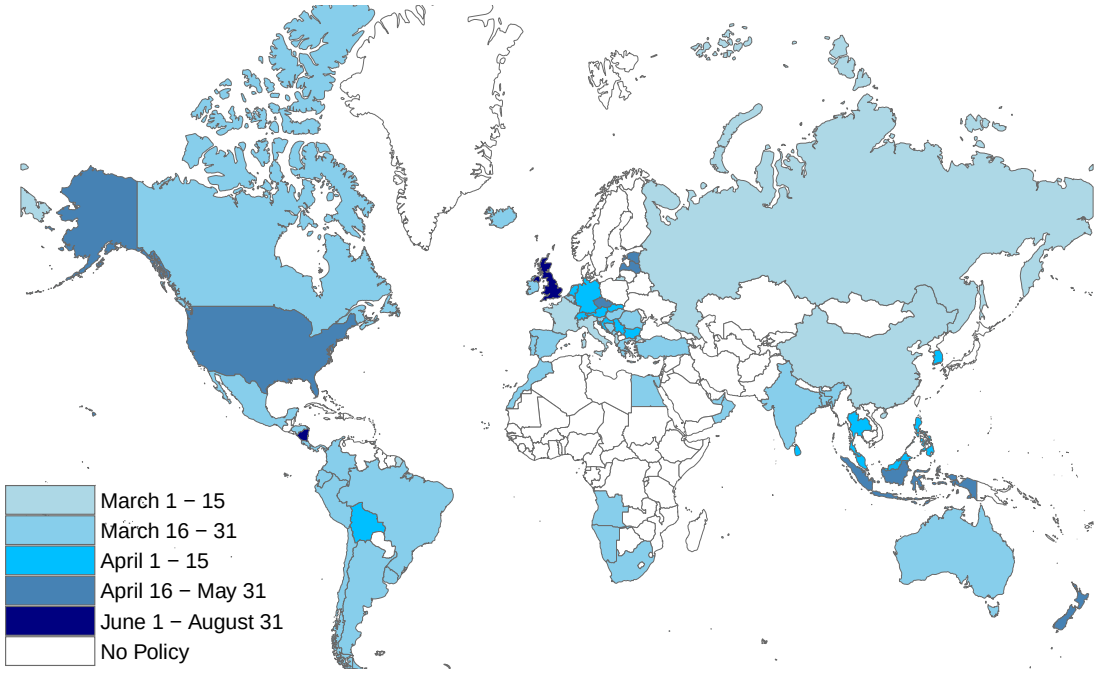
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Appendix A Moratoria in other countries

Figure A1: Moratorium Policies (COVID-19)



The figure displays the nations that have implemented a form of moratorium policy after the start of the COVID-19 pandemic. For details on the implementation for each colored country, please refer to the working paper version of the manuscript.

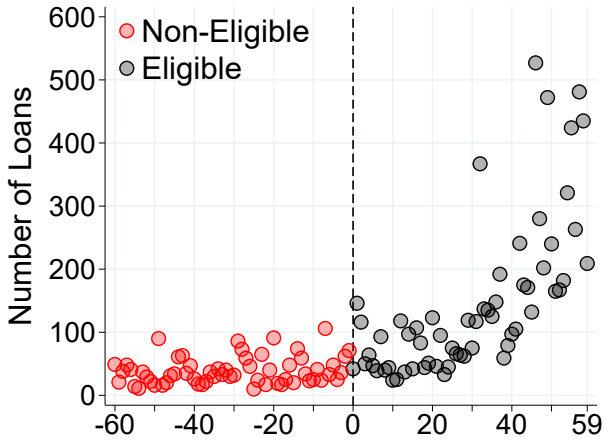
Appendix B Pre-treatment Distribution of Loans along the running variable

In Figure 1, we observe an increase in the number of loans towards the right end of the figure, indicating a greater number of loans with fewer delinquency days. This is a common pattern because delinquency records drop out as loans are paid off, leading to a higher number of loan accounts with fewer delinquency days. The notation "+59" refers to loans with only 1 day of delinquency.

To support this explanation, Figure B2 presents data from a pre-treatment period, as if the policy had been enacted in 2019Q2. Notably, this chart displays a remarkably similar pattern to that of Figure 1. The consistency of this pattern holds if we use data from 2019Q3 or 2019Q4 as well.

These observations reinforce the notion that the increase in loans with fewer delinquency days is a natural outcome of loan payment dynamics.

Figure B2: Pre-treatment distribution of loans along the running variable



The figure displays the number of corporate loans along a placebo running variable computed with pre-treatment information on delinquency days. Red dots are loans with more than 60 days of delinquency by the end of 2019Q2. Black dots represent loans with less than 60 days of delinquency by the end of 2019Q2.

Appendix C Results for Non-Stressed Firms

We extend our analysis to non-stressed firms—those without arrears at the time of the policy cutoff. Since all non-stressed firms were eligible, we use a difference-in-differences (DID) approach that compares firms that received the moratorium with those that did not. The identification relies on time and firm-bank pair fixed effects to control for both demand-side unobservables and time-varying shocks common across firms.[20] While less clean than the RDD used for stressed firms, this approach allows us to explore broader policy effects across the loan book.

Formally, we estimate:

$$Loan_{ij,t+1} = \alpha_{j,it} + \gamma D_{ij} + \underbrace{\beta D_{ij} \times T_t}_{\substack{\text{new loans originated} \\ \text{on or after 2020Q1}}} + \underbrace{\sum_{\tau=1}^{q} \phi_{-\tau} D_{ij} \times T_{t+\tau}}_{\substack{\text{new loans originated} \\ \text{on or before 2019Q4}}} + \epsilon_{ij,t} \tag{C1}$$

where the $Loan_{ij,t}$ variable again denotes the various outcomes capturing new loan conditions in quarter "t", and D_{ij} is a treatment indicator for *existent* loans that received a moratorium. The term $\alpha_{i,jt}$ includes bank and firm-time fixed effects, with the latter specifically controlling for unobserved demand-driven factors. Finally, T_t is a time dummy switched on for $2020Q1 \leq t \leq 2021Q4$, while $T_{t+\tau}$ denotes quarterly time dummies before

[20] In Appendix Online Appendix D, we provide evidence supporting the parallel trends assumption for both loan- and firm-level outcomes.

the policy took place (i.e., $t \leq 2019Q4$). Our coefficient of interest is "β", which captures the effect of debt moratorium on new loans (those that originated after the policy between 2020-2021).[21]

Table C1 shows the DID estimates for new loan conditions. While magnitudes are small, the results suggest mildly tighter lending conditions for treated firms: a statistically significant reduction in the probability of receiving a new loan (–0.078 pp), a modest increase in interest rates (0.005 pp), and a small rise in ex-post default risk (0.002 pp). The effects on loan size and other characteristics are either insignificant or economically negligible.

Table C1: DID Benchmark results: new loans

	Intensive	Extensive	Interest	Maturity	Collateral	Rating	Default Prob.	
	Log(Loan)	$\mathbb{1}\{\text{loan}\}$					Ex-ante	Ex-post
DID	-0.149	-0.078***	0.005*	-0.109	-0.046	-0.010	0.001	0.002***
	(0.092)	(0.008)	(0.003)	(0.089)	(0.032)	(0.006)	(0.001)	(0.000)
Observations	263,304	379,577	267,415	272,872	263,304	272,872	272,868	809,435
$\bar{R}^2$	0.426	0.183	0.376	0.173	0.029	0.573	0.679	0.145

Authors' calculations. Table shows the estimates for the effect of the debt moratorium on new loan conditions for non-stressed firms. Estimates correspond to DID coefficient β in equation (C1). Standard errors in parentheses, *, **, ***, indicate significance at the 10%, 5%, and 1% respectively. We employ data on new loan conditions during 2018Q4-2021Q4. To capture the intensive margin for new loans, we use the amount (in logs of COP) at the quarter of origination. The extensive margin of new loans is captured by a dummy taking the value of one in the quarter of origination. Maturity is denoted in number of years, collateral is expressed as percentages of the loan amount, credit rating is a categorical variable from 1-5 where 5 is the highest rating, ex-ante default represents the expected default probability assigned to the loan by the bank, and ex-post default is a dummy variable that takes the value of one if the loan has more than thirty days of delinquency at the end of each quarter. The interest rate, maturity, collateral, rating of new loans, and ex-ante default are measured only at the quarter of origination of the loan. All columns control for bank and firm-quarter fixed effects.

Table C2 reports the corresponding estimates for firm-level outcomes. Again, the effects are limited: we observe small declines in employment (–0.026 pp), total assets (–0.016 pp), and liabilities (–0.027 pp), with no significant changes in revenues, investment, profits, or equity. These muted effects align with our interpretation that non-stressed firms are less financially constrained and thus less responsive to credit relief.

Figure C3 presents pre-trend diagnostics for loan amounts and interest rates, supporting the validity of the DID design. Additional checks for other loan- and firm-level outcomes are reported in Appendix Online Appendix D.

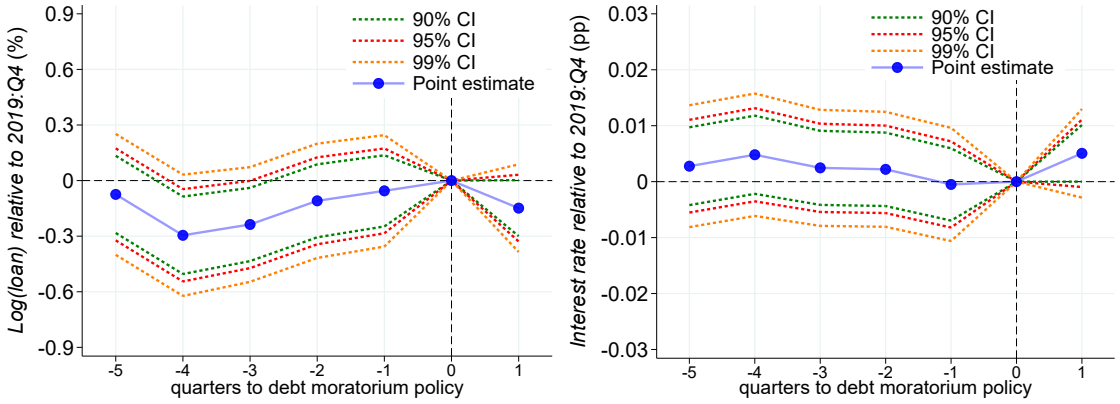
[21] By definition, non-stressed firms have a zero number of delinquency days on their *existing* loans, and hence were eligible to receive debt moratorium at the time of the policy cutoff date.

Table C2: DID benchmark results: firm level outcomes

	ΔEmp.	Inv. rate	ΔOp. Rev.	Δ Assets	ΔLiab.	ΔProfit	ΔEquity
DID	-0.026*	0.022	0.013	-0.016***	-0.027**	-0.001	0.647
	(0.015)	(0.047)	(0.016)	(0.003)	(0.010)	(0.005)	(0.450)
Observations	131,431	76,044	204,954	206,437	208,564	196,029	202,815
$\bar{R}^2$	6.7	0.2	1.5	2.7	1.0	3.3	0.0

Authors' calculations. Table shows the estimates for the effect of the debt moratorium on firm-level variables for non-stressed firms. Estimates correspond to the DID coefficient β in equation (C1). Standard errors clustered at the firm's province in parentheses , *, **, ***, indicate significance at the 10%, 5%, and 1% respectively. We use employment and balance sheet data for firms during 2015-2021. ΔEmp., ΔOp. Rev., ΔAssets and ΔLiab. denote yearly symmetric growth rates of the number of employees, operating revenues, total assets, and liabilities, respectively. Inv.rate represents the investment rate computed as the ratio of new purchases of buildings, plants, and equipment to total assets lagged one year. ΔProfits, ΔEquity are computed as the yearly change in gross profits and equity relative to the operating revenues and total assets lagged one year, respectively. All columns control for bank-year and two-digit industry code fixed effects.

Figure C3: Parallel Trends: Non-Stressed Firms



(a) Log(Loan) (b) Interest Rate

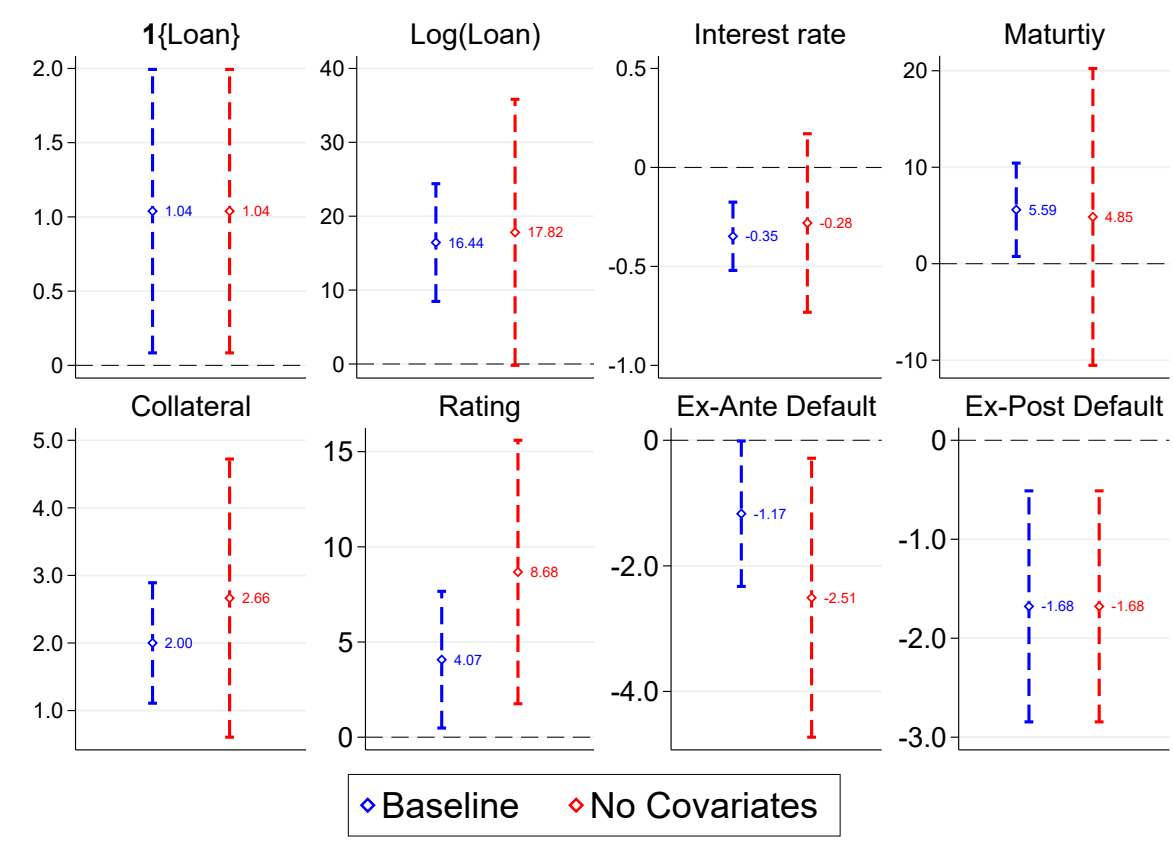
Figure plots lead and post-treatment interaction coefficients from equation (C1) for new loan outcomes (loan size in panel a, interest rate in panel b). Confidence intervals indicate no pre-trends.

Overall, these findings reinforce that the moratorium policy had limited effects on non-stressed firms—consistent with our model's prediction that targeting relief to vulnerable firms maximizes welfare.

Appendix D Fuzzy RD Estimates With and Without Covariates

To assess the robustness of our RDD estimates, we compare results from the baseline specification—with controls for bank, origination quarter, firm industry, and pre-policy loan characteristics—to a version that omits all covariates. As shown in Figure D4, dropping these controls increases the variance of the estimates but does not materially alter their magnitude or direction. This comparison confirms the robustness of our findings: including controls improves precision, particularly for interest rates and ex-ante default risk, but the overall conclusions remain unchanged. The moratorium had significant effects on the composition and pricing of new credit for stressed firms.

Figure D4: Fuzzy RD Estimates: Baseline vs. No Controls



Authors' calculations. Each panel reports the Fuzzy RD estimate of the effect of the debt moratorium on different new loan outcomes for stressed firms. The "Baseline" (blue) estimates include controls for bank, quarter of origination, and firm's two-digit industry code. For loan amount and interest rate, we additionally control for the outstanding balance and interest rate of the existing loan at the end of 2020Q1, respectively. The "No Covariates" (red) estimates omit all controls. Confidence intervals at the 90% level. See Table 1 for full regression results and standard errors.

Appendix E Summary Statistics

Table E3: Loan and firm level outcomes: Stressed

	Non-Eligible						Eligible Treated						Eligible Non-Treated					
	Mean	S.D	p^{25}	p^{50}	p^{75}	N_{obs}	Mean	S.D	p^{25}	p^{50}	p^{75}	N_{obs}	Mean	S.D	p^{25}	p^{50}	p^{75}	N_{obs}
Loan	88	661	0.01	0.04	0.24	710	615	1395	42	175	501	14,140	412	1383	0.16	20	182	20,222
$\mathbb{1}\{\text{Loan}\}$	0.19	0.40	0	0	0	911	0.22	0.41	0	0	0	34,462	0.28	0.45	0	0	1	35,391
Interest	0.23	0.08	0.26	0.26	0.26	705	0.12	0.07	0.07	0.10	0.16	14,084	0.18	0.09	0.09	0.23	0.26	20,129
Maturity	0.70	1.98	0.08	0.08	0.08	710	2.56	2.25	0.66	2.41	3.46	14,140	1.18	1.78	0.08	0.10	2.00	20,222
Collateral	0.26	1.22	0.00	0.00	0.00	710	0.39	0.82	0.00	0.22	0.47	14,031	0.27	0.86	0.00	0.00	0.25	20,001
Rating	3.50	1.57	2.00	4.00	5.00	710	4.74	0.64	5.00	5.00	5.00	14,140	4.75	0.60	5.00	5.00	5.00	20,222
Ex-ante default	0.38	0.44	0.04	0.05	1.00	710	0.07	0.15	0.02	0.04	0.04	14,140	0.07	0.13	0.04	0.04	0.04	20,222
Ex-post default	0.34	0.47	0.00	0.00	1.00	966	0.03	0.18	0.00	0.00	0.00	33,331	0.07	0.25	0.00	0.00	0.00	34,604
Past due days	51.49	135.50	0.00	17.00	50.00	966	5.67	27.06	0.00	0.00	1.00	33,331	8.23	25.85	0.00	0.00	7.00	34,604
ΔEmp.	-0.22	0.52	-0.33	-0.09	-0.01	552	-0.04	0.43	-0.12	-0.04	0.00	8,057	-0.12	0.41	-0.17	-0.05	0.00	6,353
Inv.rate	0.01	0.03	0.00	0.00	0.00	942	0.03	0.07	0.00	0.00	0.02	6,723	0.02	0.06	0.00	0.00	0.02	3,374
ΔOp.Rev	-0.17	0.98	-0.71	-0.09	0.35	1,784	-0.01	0.67	-0.30	0.03	0.31	19,261	-0.02	0.80	-0.32	0.04	0.32	10,795
ΔLiab.	-0.05	0.37	-0.10	-0.00	0.05	1,863	0.05	0.30	-0.05	0.03	0.16	19,464	0.05	0.34	-0.05	0.03	0.18	11,014
ΔAssets	-0.04	0.60	-0.14	0.00	0.10	1,843	0.03	0.50	-0.13	0.03	0.21	19,319	0.02	0.59	-0.18	0.02	0.26	10,936
ΔProfits	0.02	0.41	-0.15	0.00	0.12	1,672	0.03	0.29	-0.08	0.00	0.10	18,183	0.04	0.33	-0.07	0.00	0.11	9,926
ΔEquity	-0.01	0.24	-0.06	0.00	0.04	1,863	0.04	0.19	-0.01	0.02	0.08	19,464	0.05	0.23	-0.02	0.03	0.10	11,014

Authors' calculations. The Table presents the summary statistics for stressed firms. For loan level variables, we consider only information on new loans originated during 2020Q1-2021Q4. Loan amount (in millions of COP) represents the value of the new loan at the quarter of origination, $\mathbb{1}\{\text{Loan}\}$ (extensive margin) represents a dummy taking the value of one in the quarter of origination of the loan. Maturity is denoted in number of years, collateral is expressed as a percentage of the loan amount, credit rating is a categorical variable from 1-5 where 5 is the highest rating, ex-ante default represents the expected default probability assigned to the loan by the bank, and ex-post default is a dummy variable that takes the value of one if the loan has more than thirty days of delinquency at the end of the quarter. The interest rate, maturity, collateral, rating of new loans, and ex-ante default are measured at the quarter of origination. For firm-level variables, we use employment and balance sheet data from 2020 to 2021. ΔEmp., ΔOp. Rev., ΔAssets and ΔLiab. denote yearly symmetric growth rates of the number of employees, operating revenues, total assets, and liabilities, respectively. Inv.rate represents the investment rate computed as the ratio of new purchases of buildings, plants, and equipment to total assets lagged one year. ΔProfit, ΔEquity are computed as the yearly change in gross profits and equity relative to the operating revenues and total assets lagged one year, respectively.

Table E4: Loan and firm level outcomes: Non Stressed

	Eligible Treated						Eligible Non-Treated					
	Mean	S.D	P^{25}	P^{50}	P^{75}	N_{obs}	Mean	S.D	P^{25}	P^{50}	P^{75}	N_{obs}
Loan	735	1823	50	190	561	41,631	905	2441	13	118	510	70,074
$\mathbb{1}\{\text{Loan}\}$	0.21	0.41	0	0	0	203,907	0.26	0.44	0	0	1	282,803
Interest	0.11	0.07	0.07	0.09	0.14	42,069	0.12	0.08	0.06	0.09	0.18	72,541
Maturity	2.24	2.06	1.00	2.00	3.00	42,268	1.71	1.89	0.25	1.00	3.00	72,996
Collateral	0.37	0.72	0.00	0.17	0.50	41,631	0.34	0.78	0.00	0.00	0.50	70,074
Rating	4.91	0.36	5.00	5.00	5.00	42,268	4.95	0.30	5.00	5.00	5.00	72,996
Ex-ante default	0.04	0.07	0.02	0.04	0.04	42,268	0.04	0.06	0.02	0.04	0.04	72,994
Ex-post default	0.00	0.07	0.00	0.00	0.00	202,161	0.00	0.05	0.00	0.00	0.00	280,912
Delinq days	1.64	9.78	0.00	0.00	0.00	42,268	1.01	7.01	0.00	0.00	0.00	72,996
ΔEmp	-0.06	0.28	-0.11	-0.03	0.00	12,189	0.07	0.33	-0.12	-0.04	0.00	21,656
Inv.rate	0.06	1.92	0.00	0.00	0.02	10,695	0.03	0.20	0.00	0.00	0.02	15,143
ΔOp.Rev.	0.03	0.63	-0.23	0.06	0.32	32,743	0.02	1.69	-0.22	0.06	0.31	46,847
ΔLiab.	0.07	0.29	-0.04	0.05	0.19	33,079	0.08	0.32	-0.04	0.05	0.20	47,502
ΔAssets	0.05	0.50	-0.14	0.04	0.26	32,845	0.05	0.58	-0.18	0.04	0.31	47,259
ΔProfits	0.06	0.34	-0.06	0.00	0.11	30,799	0.06	0.38	-0.06	0.00	0.11	43,891
ΔEquity	0.06	0.19	-0.00	0.03	0.10	33,079	0.07	0.22	-0.00	0.04	0.12	47,502

Authors' calculations. The Table presents the summary statistics for non-stressed firms. For loan level variables, we consider only information on new loans originated during 2020Q1-2021Q4. Loan amount (in millions of COP) represents the value of the new loan at the quarter of origination, $\mathbb{1}\{\text{Loan}\}$ (extensive margin) represents a dummy taking the value of one in the quarter of origination. Maturity is denoted in number of years, collateral is expressed as a percentage of the loan amount, credit rating is a categorical variable from 1-5 where 5 is the highest rating, ex-ante default represents the expected default probability assigned to the loan by the bank, and ex-post default is a dummy variable that takes the value of one if the loan has more than thirty days of delinquency at the end of the quarter. The interest rate, maturity, collateral, rating of new loans, and ex-ante default are measured at the quarter of origination. For firm-level variables, we use employment and balance sheet data from 2020 to 2021. ΔEmp., ΔOp. Rev., ΔAssets and ΔLiab. denote yearly symmetric growth rates of the number of employees, operating revenues, total assets, and liabilities, respectively. Inv.rate represents the investment rate computed as the ratio of new purchases of buildings, plants, and equipment to total assets lagged one year. ΔProfit, ΔEquity are computed as the yearly change in gross profits and equity relative to the operating revenues and total assets lagged one year, respectively.

Appendix E.1 Calibration

We calibrate the model economy at an annual frequency as our firm level variables are observed at annual frequency. For most parameters, we resort to the administrative Colombian data and estimate it ourselves. For the remaining parameters, we use conventional estimates reported in the literature. Table E5 presents the calibrated parameter values.

The risk aversion parameter is set to 2 and the annual risk free interest rate r^f is set to 4%, the conventional values used in the literature. We set the labor supply curvature parameter to $\omega = 3.64$, which implies a Frisch elasticity of $1/(\omega - 1) \approx 0.40$. This value is in line with micro-level estimates of labor supply elasticities and is commonly used in quantitative models with limited labor adjustment at the firm level (e.g., $\varepsilon^F \in [0.27, 0.53]$ with a central estimate around 0.40; Whalen and Reichling, 2017; Reichling and Whalen, 2012).

Table E5: Parameter values

	Parameter	Value	Target
Risk aversion	σ	2	Standard RBC value
Risk-free rate	r^f	4%	Standard RBC value
Discount factor	β	0.92	Standard value
Recovery rate	α	0.67	33% haircut
Standard loan decay rate	δ	0.21	Average duration of 3.8 years
Capital depreciation rate	δ_k	0.12	Data
Return to scale	ν	0.85	Standard parameter
Probability of reentry after default	ξ	1/3	Data
Lower bound for bond prices	$\underline{q}$	0.4	-
Labor supply curvature parameter	ω	3.64	Frisch wage elasticity = $\frac{1}{\omega-1} = 0.38$
Share of capital	α^k	0.33	Standard capital share
Share of labor	$1-\alpha^k$	0.67	Standard labor share
		Calibrated	
Income autocorrelation coefficient	ρ_ϵ	0.702	Operating income (0.752)
Standard deviation of innovations	σ_ϵ	2.42%	Opr. income std. deviation (0.015)
Income cost of defaulting	d_0	-2.56	Spread and loan-to-assets ratio
Income cost of defaulting	d_1	2.725	Spread and loan-to-assets ratio
Probability of entering high risk premium	π_{LH0}	0.22	3 high-risk-premium episodes every twenty years
Probability of entering high risk premium	π_{LH1}	30	4.5% lower output than trend
Probability of exiting high risk premium	π_{HL}	0.8	Persistency of liquidity shock
Adjustment cost of investment	Θ	4.1	Investment elasticity under one-time introduction
Adjustment cost of investment	Θ_d	30	Std. deviation of investment during default
Liquidity operating income shock	$g(p=L)$	0	Standardized to be 0 during normal times
Liquidity operating income shock	$g(p=H)$	0.1	10% annual operating income loss

The median loan-to-assets ratio equals to 50.8% in our administrative data. The productivity shocks in the model follow an AR(1) process as in equation (5). The longest time frame during which the data are available prior to the inception of moratorium laws in our administrative data is for the period 2004 to 2019. As this was not limited to estimate the productivity shock, we resorted to Real GDP constant national prices for Colombia, available at FRED website, for the period between 1950-2019. The standard deviation coefficient and the autocorrelation coefficient of the cyclical component of the shock is is 2.42% and 0.702, respectively.

Further, a penalty scheme is necessary in this class of models because otherwise the household would always default, and lenders would price it accordingly. So in equilibrium, only a limited amount of debt issuance at very high spreads can be generated. In our calibration, we target the standard loan-to-operating income ratio of 50.8 percent which corresponds to the median loan-to-operating income ratio in Colombia. We calibrate the value of the parameters (d_0 and d_1) targeting the mean levels of debt and interest rate.

We do not observe bankruptcy in our data. Thus, we instead use non-performing loans (NPL) as non-targeted default rate.

We set δ at 0.21. With that value, the maturity of loans 3.8 years, which is the average loan maturity in our administrative data. The definition of duration in Macaulay (1938) is standard in calculating the long-term loan duration. Duration D is the weighted average maturity of future cash flows. A loan issued at time t makes periodic payments κ for the subsequent periods with a geometrically decay rate δ.[22] Observe that equation (E3) is 1 for

[22] Duration D satisfies,

$$D(\kappa) = \frac{1}{q}\left(\sum_{j=1}^{J} j\frac{\kappa(1-\delta)^{j-1}}{(1+i)^j}\right)$$

$\delta = 1$. The spread r_s is defined as the difference between yield i and the risk-free rate r. The annualized spread reported in the tables is computed as

$$1 + r_s = \left(\frac{1+i}{1+r}\right).$$

The debt levels obtained from the simulations are equivalent to the present value of future debt obligations, which are discounted at the risk-free rate and computed as $\frac{b(1+r)}{\delta+r}$.

Appendix E.2 Numerical Solution

This section briefly sketches the main numerical algorithm, relegating the details of the implementation to Online Appendix E. In particular, solving the model relies on iterating the value functions V^R and V^D, price functions q, q_m. To avoid the potential multiplicity problem outlined in Krusell and Smith (2003), we first solve the equilibrium of the finite-horizon economy. We start with an initial guess for the terminal value and iterate backward until the differences in value and price functions for two subsequent periods are less than 10^{-5}. We then use the obtained values as the equilibrium of the infinite horizon economy.

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where i is the periodic yield an investor would earn if the bond is held to maturity without any defaults and it satisfies

$$q = \sum_{j=1}^{\infty} \frac{\kappa(1-\delta)^{j-1}}{(1+i)^j},$$

and the periodic yield i reads as

$$i = \frac{\kappa}{q} - \delta$$

with which D becomes

$$D = \frac{1}{q(1-\delta)} \lim_{J\to\infty} \sum_{j=1}^{J} j \left(\frac{1-\delta}{1+i}\right)^j \tag{E2}$$

$$= \frac{1+i}{i+\delta}. \tag{E3}$$

INTERNET APPENDIX

Online Appendix A A Three-Period Model

This appendix develops a simple three-period model that illustrates the mechanisms of a loan moratorium in a transparent way. Time is discrete, $t = 1, 2, 3$. There is a representative firm (borrower) and a representative bank (lender). One non-storable good is produced and consumed.

Online Appendix A.1 Preferences, endowments, and contracts

The firm receives endowments

$$y_1 = 0, \qquad y_2 = 1, \qquad y_3 = 1.$$

Its preferences are

$$U_f \;=\; u(c_1) + \beta v(c_2) + \beta^2 v(c_3), \qquad 0 < \beta < 1, \tag{A1}$$

with

$$u(c) = Ac, \qquad v(c) = Ac - \frac{\phi}{2}c^2, \qquad A > \phi > 0. \tag{A2}$$

The bank is risk-averse but does not discount across periods:

$$U_b \;=\; u(\tilde{c}_1) + v(\tilde{c}_2) + v(\tilde{c}_3), \tag{A3}$$

with the same u and v.

In period 1 the firm borrows a long-term loan $b > 0$ at price $q \in (0, 1)$. The firm receives qb units of the good in period 1. In the benchmark without default, the promised repayments are

$$\frac{b}{2} \text{ in period 2}, \qquad \frac{b}{2} \text{ in period 3}.$$

Online Appendix A.2 Liquidity shock and moratorium

In period 2 the firm may be hit by a liquidity shock with probability $\pi \in (0, 1)$. If the shock occurs, a fraction $\ell \in [0, 1]$ of period-2 resources is illiquid and cannot be used in that period, but becomes available in period 3. We assume that the endowment itself is not destroyed, only its timing of use is affected.

Online Appendix A.2.0.1 No moratorium. Without the policy, the firm must always repay $\frac{b}{2}$ in each of periods 2 and 3, regardless of the shock. Let c_t denote the firm's consumption:

- Period 1: $c_1 = qb$.
- Period 2:
$$c_2 = \begin{cases} 1 - \dfrac{b}{2}, & \text{no shock,} \\ 1 - \dfrac{b}{2} - \ell, & \text{shock.} \end{cases}$$
- Period 3:
$$c_3 = \begin{cases} 1 - \dfrac{b}{2}, & \text{no shock,} \\ 1 - \dfrac{b}{2} + \ell, & \text{shock.} \end{cases}$$

Online Appendix A.2.0.2 Moratorium. Under the moratorium, if the liquidity shock occurs in period 2, the firm can postpone that period's repayment. For simplicity, we assume that deferred payments do not accrue interest. Thus:

- If *no shock* occurs, the firm repays as in the benchmark: $\frac{b^p}{2}$ in each of periods 2 and 3.
- If a *shock* occurs, the firm repays nothing in period 2 and the full amount b^p in period 3.

Hence consumption with the policy is:

- Period 1: $c_1^p = qb^p$.
- Period 2:
$$c_2^p = \begin{cases} 1 - \dfrac{b^p}{2}, & \text{no shock,} \\ 1 - \ell, & \text{shock.} \end{cases}$$
- Period 3:
$$c_3^p = \begin{cases} 1 - \dfrac{b^p}{2}, & \text{no shock,} \\ 1 + \ell - b^p, & \text{shock.} \end{cases}$$

Online Appendix A.3 Firm's problem without default

We first abstract from default so that all promised repayments are honored. Prices q are taken as exogenous in this subsection.

Online Appendix A.3.1 No moratorium

Using the consumption profiles above, the firm's expected utility as a function of b is

$$\begin{aligned} U_f(b) = u(qb) &+ \beta\big[(1-\pi)v(1-\tfrac{b}{2}) + \pi v(1-\tfrac{b}{2}-\ell)\big] \\ &+ \beta^2\big[(1-\pi)v(1-\tfrac{b}{2}) + \pi v(1-\tfrac{b}{2}+\ell)\big]. \end{aligned} \tag{A4}$$

Using $u(c) = Ac$, $v(c) = Ac - \frac{\phi}{2}c^2$ and $v'(c) = A - \phi c$, differentiation with respect to b yields:

$$\begin{aligned}\frac{\partial U_f(b)}{\partial b} = Aq &- \frac{\beta}{2}\big[(1-\pi)(A - \phi(1-\tfrac{b}{2})) + \pi(A - \phi(1-\tfrac{b}{2}-\ell))\big] \\ &- \frac{\beta^2}{2}\big[(1-\pi)(A - \phi(1-\tfrac{b}{2})) + \pi(A - \phi(1-\tfrac{b}{2}+\ell))\big]. \end{aligned} \tag{A5}$$

Collecting terms and simplifying,

$$\frac{\partial U_f(b)}{\partial b} = Aq - \frac{\beta+\beta^2}{2}\Big[A - \phi\Big(1-\tfrac{b}{2}\Big)\Big] + \frac{\beta^2-\beta}{2}\,\pi\,\phi\,\ell. \tag{A6}$$

Setting this equal to zero and solving for b yields

$$b_d(q) = \frac{2}{\phi(\beta+\beta^2)}\Big[2Aq - A(\beta+\beta^2) + \phi\big(\beta+\beta^2+\pi\ell\,\beta(\beta-1)\big)\Big]. \tag{A7}$$

This demand function is linear in the loan price q.

Online Appendix A.3.2 With moratorium

Under the moratorium, the firm's expected utility as a function of b^p is

$$\begin{aligned} U_f^p(b^p) = &\; u(qb^p) \\ &+ \beta\big[(1-\pi)v(1-\tfrac{b^p}{2}) + \pi v(1-\ell)\big] \\ &+ \beta^2\big[(1-\pi)v(1-\tfrac{b^p}{2}) + \pi v(1+\ell-b^p)\big]. \end{aligned} \tag{A8}$$

Differentiating with respect to b^p:

$$\begin{aligned}\frac{\partial U_f^p(b^p)}{\partial b^p} &= Aq - \frac{\beta(1-\pi)}{2}\big(A - \phi(1-\tfrac{b^p}{2})\big) - \frac{\beta^2(1-\pi)}{2}\big(A - \phi(1-\tfrac{b^p}{2})\big) \\ &\quad - \beta^2\pi\big(A - \phi(1+\ell-b^p)\big) \\ &= Aq - \frac{A}{2}\big[\beta(1-\pi) + \beta^2(1+\pi)\big] \\ &\quad + \frac{\phi b^p}{4}\big[\beta(1-\pi) + \beta^2(1+3\pi)\big] \\ &\quad + \frac{\phi}{2}\big[\beta(1-\pi) + \beta^2(1-3\pi-2\pi\ell)\big]. \end{aligned} \tag{A9}$$

Setting this to zero and solving for b^p gives

$$b_d^p(q) = \frac{2}{\phi\big[\beta(1-\pi)+\beta^2(1+3\pi)\big]}\Big\{A\big[\beta(1-\pi)+\beta^2(1+\pi)-2q\big] + \phi\big[\beta(1-\pi)+\beta^2(1-3\pi-2\pi\ell)\big]\Big\}. \tag{A10}$$

This expression is also linear in q. When $\pi = 0$ (the shock never occurs), a shock is never realized and the moratorium is irrelevant; in that case (A10) collapses to (A7).

Online Appendix A.4 Bank's problem without default

The bank's endowments are normalized such that its consumption in the absence of lending is $(\tilde{c}_1, \tilde{c}_2, \tilde{c}_3) = (1, 1, 1)$.

Online Appendix A.4.1 No moratorium

If the bank extends a loan b at price q, its consumption profile is

$$\tilde{c}_1 = 1 - qb, \qquad \tilde{c}_2 = 1 + \frac{b}{2}, \qquad \tilde{c}_3 = 1 + \frac{b}{2}.$$

The bank's utility is

$$U_b(b) = u(1-qb) + v\big(1+\tfrac{b}{2}\big) + v\big(1+\tfrac{b}{2}\big). \tag{A11}$$

Differentiating and setting the first-order condition to zero gives

$$\begin{aligned}\frac{\partial U_b(b)}{\partial b} &= -Aq + \frac{1}{2}\big(A - \phi(1+\tfrac{b}{2})\big) + \frac{1}{2}\big(A - \phi(1+\tfrac{b}{2})\big) \\ &= -Aq + A - \phi - \frac{\phi b}{2} = 0,\end{aligned} \tag{A12}$$

so the bank's loan supply without the policy is

$$b_s(q) = 2\,\frac{A(1-q)-\phi}{\phi}. \tag{A13}$$

Online Appendix A.4.2 With moratorium

Under the moratorium, the firm's repayments become state-contingent, but from the bank's point of view the period-2 and period-3 cash flows are:

- No shock (probability $1-\pi$): receive $\frac{b^p}{2}$ at $t=2$ and $\frac{b^p}{2}$ at $t=3$.
- Shock (probability π): receive 0 at $t=2$ and b^p at $t=3$.

Thus the bank's consumption under the policy is

$$\tilde{c}_1^p = 1 - qb^p,$$

$$\tilde{c}_2^p = \begin{cases} 1 + \dfrac{b^p}{2}, & \text{no shock,} \\ 1, & \text{shock,} \end{cases} \qquad \tilde{c}_3^p = \begin{cases} 1 + \dfrac{b^p}{2}, & \text{no shock,} \\ 1 + b^p, & \text{shock.} \end{cases}$$

Expected utility is

$$\begin{aligned} U_b^p(b^p) = u(1 - qb^p) &+ \left[(1-\pi)v(1 + \tfrac{b^p}{2}) + \pi v(1)\right] \\ &+ \left[(1-\pi)v(1 + \tfrac{b^p}{2}) + \pi v(1 + b^p)\right]. \end{aligned} \tag{A14}$$

Differentiating with respect to b^p:

$$\begin{aligned} \frac{\partial U_b^p(b^p)}{\partial b^p} &= -Aq + \frac{1-\pi}{2}\big(A - \phi(1 + \tfrac{b^p}{2})\big) + \frac{1-\pi}{2}\big(A - \phi(1 + \tfrac{b^p}{2})\big) \\ &\quad + \pi\big(A - \phi(1 + b^p)\big) \\ &= -Aq + A - \phi - \frac{\phi(1+\pi)}{2} b^p. \end{aligned} \tag{A15}$$

The first-order condition therefore implies

$$b_s^p(q) = \frac{2\big[A(1-q) - \phi\big]}{\phi(1+\pi)}. \tag{A16}$$

For $\pi = 0$, (A16) reduces to (A13), as the moratorium is never used.

Online Appendix A.5 Comparative statics without default

Equations (A7)–(A16) show that both the firm's loan demand and the bank's loan supply are linear in q, with the moratorium affecting both the intercept and the slope.

On the lender side, comparing (A13) and (A16) for any given price q with $b_s(q) > 0$ gives

$$b_s^p(q) = \frac{1}{1+\pi}\, b_s(q) < b_s(q),$$

i.e. the moratorium unambiguously reduces the supply of loans at a given price when default is ruled out.

On the borrower side, combining (A7) and (A10), the difference $b_d^p(q) - b_d(q)$ is an affine function of q. Differentiating with respect to q yields

$$\frac{\partial}{\partial q}\left[b_d^p(q) - b_d(q)\right] = \frac{4A\pi(1-3\beta)}{\beta\phi(\beta+1)\big(3\beta\pi + \beta - \pi + 1\big)}. \tag{A17}$$

For empirically relevant values $\beta > \frac{1}{3}$, this slope is negative, so there exists a unique cutoff price $\tilde{q}(\beta, \pi, \ell, A, \phi)$ such that

$$b_d^p(q) > b_d(q) \quad \Longleftrightarrow \quad q < \tilde{q}(\beta, \pi, \ell, A, \phi).$$

For sufficiently high prices (low expected returns), firms prefer to borrow less under the moratorium, whereas for sufficiently low prices (e.g. in high-risk states where q is low) the moratorium raises desired borrowing at a given price.

We illustrate these comparative statics numerically (Figure A1) and argue that in the calibrated infinite-horizon model XXX, equilibrium loan prices lie in the region where the moratorium increases desired borrowing at a given price.

Online Appendix A.6 Extension: default risk and endogenous pricing

The analysis above assumes away default and takes the loan price q as exogenous. We now extend the model to incorporate default risk and endogenous pricing.

Online Appendix A.6.1 Setup with default

Let y_2 and y_3 denote the firm's income in periods 2 and 3, respectively. For simplicity we assume (y_2, y_3) are i.i.d. draws from a distribution with cumulative distribution function $F(\cdot)$ and density $f(\cdot)$ on support $[\underline{y}, \bar{y}]$.

Default in period t entails a direct utility cost $C(y_t) \geq 0$ and implies that lenders receive a fraction $\rho \in [0, 1)$ of the promised payment instead of the full amount. In the no-policy case, promised repayments are $\frac{b}{2}$ in both periods; consumption levels in repayment and default states are:

$$\text{Repay: } c_t^R = y_t - \frac{b}{2}, \qquad \text{Default: } c_t^D = y_t - C(y_t).$$

We assume that in each period the firm chooses optimally whether to default, implying default thresholds $y_t^*(b)$ such that the firm is indifferent between repaying and defaulting at $y_t = y_t^*(b)$:

$$v\Big(y_t^*(b) - \tfrac{b}{2}\Big) = v\big(y_t^*(b) - C(y_t^*(b))\big), \qquad t = 2, 3. \tag{A18}$$

The firm repays if and only if $y_t \geq y_t^*(b)$ in period t.

Online Appendix A.6.2 Firm's problem with default (no moratorium)

With default, the firm's problem becomes

$$\begin{aligned}\max_{b>0} \quad U_f(b) = u\big(q(b)\,b\big) \\ &+ \beta\,\mathbb{E}_{y_2}\Big[\mathbf{1}_{y_2\geq y_2^*(b)}v\big(y_2-\tfrac{b}{2}\big)+\mathbf{1}_{y_2<y_2^*(b)}v\big(y_2-C(y_2)\big)\Big] \\ &+ \beta^2\,\mathbb{E}_{y_3}\Big[\mathbf{1}_{y_3\geq y_3^*(b)}v\big(y_3-\tfrac{b}{2}\big)+\mathbf{1}_{y_3<y_3^*(b)}v\big(y_3-C(y_3)\big)\Big], \end{aligned} \tag{A19}$$

where $q(b)$ is now the endogenous loan price (derived below).

Using the indicator functions, the expectations can be written as integrals. For a generic period $t \in \{2,3\}$,

$$\begin{aligned} E_t(b) &:= \mathbb{E}_{y_t}\Big[\mathbf{1}_{y_t\geq y_t^*(b)}v\big(y_t-\tfrac{b}{2}\big)+\mathbf{1}_{y_t<y_t^*(b)}v\big(y_t-C(y_t)\big)\Big] \\ &= \int_{y_t^*(b)}^{\bar{y}} v\Big(y-\tfrac{b}{2}\Big)f(y)\,dy + \int_{\underline{y}}^{y_t^*(b)} v\big(y-C(y)\big)f(y)\,dy. \end{aligned} \tag{A20}$$

To derive the first-order condition with respect to b, we differentiate each term carefully. The derivative of the period-1 term is

$$\frac{d}{db}u\big(q(b)b\big) = A\big[q(b)+bq'(b)\big].$$

For the period-t term, apply Leibniz's rule:

$$\begin{aligned}\frac{dE_t}{db} = -v\Big(y_t^*(b)-\tfrac{b}{2}\Big)f\big(y_t^*(b)\big)\frac{dy_t^*}{db} + \int_{y_t^*(b)}^{\bar{y}}\frac{\partial}{\partial b}v\Big(y-\tfrac{b}{2}\Big)f(y)\,dy \\ + v\big(y_t^*(b)-C(y_t^*(b))\big)f\big(y_t^*(b)\big)\frac{dy_t^*}{db}. \end{aligned} \tag{A21}$$

By construction of the default threshold,

$$v\Big(y_t^*(b)-\tfrac{b}{2}\Big) = v\big(y_t^*(b)-C(y_t^*(b))\big),$$

so the boundary terms cancel exactly:

$$-v\Big(y_t^*-\tfrac{b}{2}\Big)f(y_t^*)\frac{dy_t^*}{db} + v\big(y_t^*-C(y_t^*)\big)f(y_t^*)\frac{dy_t^*}{db} = 0.$$

Hence

$$\begin{aligned}\frac{dE_t}{db} &= \int_{y_t^*(b)}^{\bar{y}} \frac{\partial}{\partial b} v\Big(y - \tfrac{b}{2}\Big) f(y)\, dy \\ &= \int_{y_t^*(b)}^{\bar{y}} v'\Big(y - \tfrac{b}{2}\Big)\Big(-\frac{1}{2}\Big) f(y)\, dy \\ &= -\frac{1}{2}\int_{y_t^*(b)}^{\bar{y}} v'\Big(y - \tfrac{b}{2}\Big) f(y)\, dy. \end{aligned} \tag{A22}$$

Using $v'(c) = A - \phi c$ if desired, one can make this more explicit; for our purposes it is convenient to leave it as v'.

Collecting all terms, the firm's first-order condition is

$$\begin{aligned}\frac{dU_f}{db} = A\big[q(b) + bq'(b)\big] - \frac{\beta}{2}\int_{y_2^*(b)}^{\bar{y}} v'\Big(y - \tfrac{b}{2}\Big) f(y)\, dy \\ - \frac{\beta^2}{2}\int_{y_3^*(b)}^{\bar{y}} v'\Big(y - \tfrac{b}{2}\Big) f(y)\, dy = 0. \end{aligned} \tag{A23}$$

This implicitly defines the firm's optimal borrowing $b_d(q(b))$ in the defaultable environment.

Because $v(\cdot)$ is quadratic, the integrals in (A23) are polynomials in b (truncated moments of income), so (A23) is linear in b for given $q(b)$ and $q'(b)$. We do not need the explicit closed form in what follows.

Online Appendix A.6.3 Lender's pricing with default

To keep the pricing transparent, we assume that competitive lenders are risk-neutral with no intertemporal discounting.[23] The lender pays $q(b)b$ at $t = 1$ and receives state-contingent payoffs at $t = 2, 3$. In the no-policy case, the promised repayment is $\frac{b}{2}$ in each period. Lenders receive:

$$\text{Period } t: \quad \begin{cases} \frac{b}{2}, & \text{if the firm repays,} \\ \rho\frac{b}{2}, & \text{if the firm defaults,} \end{cases} \qquad t = 2, 3.$$

Let

$$P_t(b) := \Pr(y_t < y_t^*(b)) = F\big(y_t^*(b)\big)$$

denote the default probability in period t. Then the expected payoff in period t is

$$\begin{aligned}\mathbb{E}\Big[\tfrac{b}{2} \times (\mathbf{1}_{\text{repay}} + \rho\, \mathbf{1}_{\text{default}})\Big] &= \tfrac{b}{2}\Big[(1 - P_t(b)) + \rho P_t(b)\Big] \\ &= \tfrac{b}{2}\Big[1 - (1-\rho)P_t(b)\Big]. \end{aligned} \tag{A24}$$

[23] With a lender discount factor $\beta_b < 1$, all expressions below would be multiplied by β_b.

A zero-profit (no-arbitrage) condition for competitive lenders requires that the present value of these expected payoffs equals the outlay $q(b)b$. With no discounting on the lender side, we have

$$\begin{aligned} q(b) \cdot b &= \frac{b}{2}\Big[1 - (1-\rho)P_2(b)\Big] + \frac{b}{2}\Big[1 - (1-\rho)P_3(b)\Big] \\ &= \frac{b}{2}\Big[2 - (1-\rho)\big(P_2(b) + P_3(b)\big)\Big]. \end{aligned} \tag{A25}$$

Therefore the endogenous price as a function of b is

$$q(b) = 1 - \frac{(1-\rho)}{2}\big[P_2(b) + P_3(b)\big]. \tag{A26}$$

This immediately implies:

1. $q(b) < 1$ whenever default occurs with positive probability and recovery is incomplete ($\rho < 1$).
2. Since $P_t(b)$ is increasing in b (higher debt makes default more attractive and raises the default thresholds), we have

$$\frac{dq}{db} = -\frac{(1-\rho)}{2}\big[P_2'(b) + P_3'(b)\big] \leq 0.$$

Thus default risk depresses the loan price below the risk-free benchmark and makes it decreasing in the amount borrowed.

Online Appendix A.6.4 Moratorium with default (sketch)

Under the moratorium, repayment patterns and default thresholds become state-contingent, depending on whether the liquidity shock hits in period 2. Denote by:

- $y_2^{p*}(b^p)$: default threshold in period 2 when no shock (repayment $\frac{b^p}{2}$).
- $\tilde{y}_2^{p*}(b^p)$: default threshold in period 2 when the shock occurs (repayment 0 under the moratorium).
- $y_3^{p*}(b^p)$: default threshold in period 3 when no shock occurred (repayment $\frac{b^p}{2}$).
- $\hat{y}_3^{p*}(b^p)$: default threshold in period 3 when a shock occurred in period 2 (repayment b^p).

These thresholds satisfy indifference conditions analogous to the no-policy case, e.g.

$$v\big(y_2^{p*} - \tfrac{b^p}{2}\big) = v\big(y_2^{p*} - C(y_2^{p*})\big), \tag{A27}$$
$$v\big(\tilde{y}_2^{p*} - \ell\big) = v\big(\tilde{y}_2^{p*} - C(\tilde{y}_2^{p*})\big), \tag{A28}$$
$$v\big(y_3^{p*} - \tfrac{b^p}{2}\big) = v\big(y_3^{p*} - C(y_3^{p*})\big), \tag{A29}$$
$$v\big(\hat{y}_3^{p*} + \ell - b^p\big) = v\big(\hat{y}_3^{p*} - C(\hat{y}_3^{p*})\big). \tag{A30}$$

Let $P_2^p(b^p)$, $P_3^{p,a}(b^p)$ and $P_3^{p,b}(b^p)$ denote the corresponding default probabilities in period 2 (no shock), period 3 (no shock) and period 3 (with a shock), respectively. A zero-profit condition analogous to (A26) yields a pricing function

$$q^p(b^p) = \Psi\left(b^p; \pi, \rho, P_2^p(b^p), P_3^{p,a}(b^p), P_3^{p,b}(b^p)\right), \tag{A31}$$

where $\Psi(\cdot)$ is decreasing in each default probability argument. Because the moratorium relaxes liquidity constraints in bad states, it lowers default probabilities for given b^p, implying

$$q^p(b^p) > q(b) \quad \text{and} \quad \left|\frac{dq^p}{db^p}\right| < \left|\frac{dq}{db}\right| \quad \text{for a given level of debt.}$$

In other words, the price schedule under the policy is shifted up and is flatter (less steeply downward sloping) relative to the no-policy case.

Online Appendix A.6.5 Key comparative statics with default

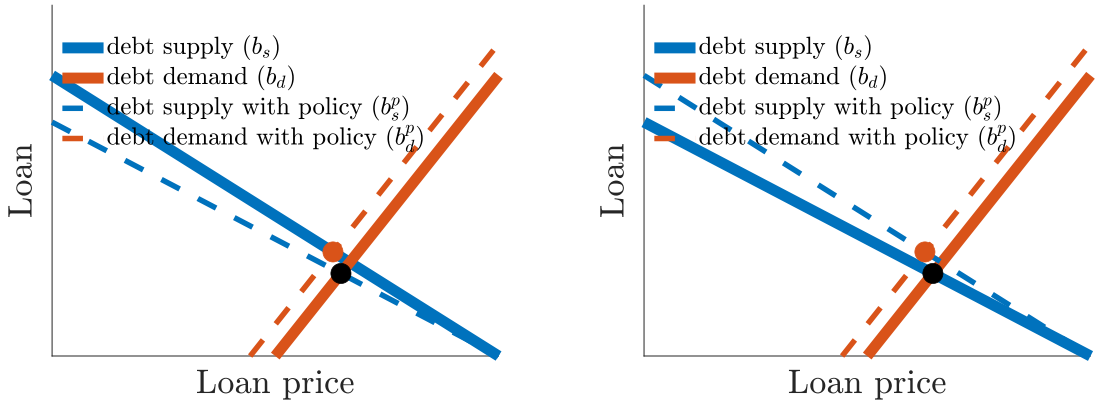
Combining (A23) with (A26) shows that default risk affects firm borrowing through two channels:

1. It drives a wedge between the firm's intertemporal preferences and the loan price, $q(b) < 1$, placing equilibrium prices in the region where the simple no-default model suggests that the moratorium can raise desired borrowing at a given price.

2. It makes $q(b)$ decreasing in b, so that higher borrowing worsens the terms of trade. By reducing default probabilities for given b, the moratorium flattens and shifts up $q(b)$ in crisis states, mitigating the adverse feedback from higher borrowing to higher spreads.

These mechanisms motivate the infinite-horizon quantitative model in the main text, where $q_t(b_t, y_t)$ is determined endogenously from lenders' Euler equations and default decisions, and where we quantify the general equilibrium effects of moratoria on borrowing, default, and real activity.

Figure A1: Demand and supply of loans with and without the policy.



(a) Default risk not accounted

(b) Default risk accounted

The horizontal axis plots the loan price q (inverse of the interest rate) and the vertical axis the loan amount b. Solid lines show debt supply b_s (blue) and debt demand b_d (orange) in an economy without a moratorium; dashed lines show the corresponding schedules with a moratorium, b_s^p and b_d^p. Panel (a) treats the loan price as exogenous and abstracts from default risk: for each q the moratorium increases firms' desired borrowing (outward shift in b_d) but reduces banks' willingness to lend (inward shift in b_s). Panel (b) allows prices to reflect endogenous default risk: the moratorium lowers default probabilities and flattens the supply schedule so that, in relevant states, lenders are willing to supply more credit at a given price while firm demand still shifts out. The black (orange) dot marks the equilibrium without (with) the moratorium in each case.

Online Appendix B Policy enforcement on existing loans

This section corroborates that the policy had the intended effect on *existing loans*, regarding the (i) suspension of debt repayments and (ii) reset of delinquency days. In particular, we focus on the effect of the policy during and after the quarter of treatment. We employ information on delinquency days, changes in expected payments, and the outstanding loan value (principal and interest) relative to Q1-2020 (i.e., one quarter before the policy was implemented).

Our results, presented in Table B1, correspond to sharp RDD estimates that consider eligible treated loans as the treatment group with ineligible loans as the control group. The first two columns confirm the results presented in Figure 2: past due days of loans receiving a moratorium are reduced on average by 108 days, while the change in expected loan payments are reduced by almost 90%. This confirms that the policy was effectively enforced and limited to the 1-3 month duration established in the regulation. As expected, the number of delinquency days remains lower than untreated loans, albeit in large magnitude. This is because, unlike loan repayments (flow variable), the number of delinquency days carries persistence (behaving more like a stock variable). Intuitively, a newly reset loan will take time (if any) to re-incur in nonperforming days.

Table B1: Repayment and delinquency days: Existent Loans

	During quarter of treatment			After quarter of treatment		
	Delinquency days	ΔPayment due	ΔLoan	Delinquency days	ΔPayment due	ΔLoan
Sharp-RD	-107.77***	-0.90***	0.076**	-174.19***	0.52***	-0.056*
	(8.7)	(0.10)	(0.037)	(0.09)	(16.9)	(0.034)
Observations	34,369	30,997	20,809	53,771	54,511	38,691
BW (in days)	47.7	34.7	25.6	40.0	10.9	27.0

Authors' calculations. The table shows the effect of the policy on repayment amount, delinquency days, and outstanding debt for existent loans during the quarter of treatment and after treatment ends. Estimates correspond to Sharp RD estimate in equation (4). Robust bias corrected standard errors in parentheses , *, **, ***, indicate significance at the 10%, 5%, and 1% respectively. The last row report the Bandwidth (BW) in days used to compute the local RD estimate. ΔPayment and ΔLoan represent the changes in payment and total debt balance computed as the growth rate of monetary payments and debt balance (principal+interests) at the end of each quarter relative to Q1-2020. The treatment quarter corresponds to existing loans receiving a moratorium in the second, third, or fourth quarter of 2020.

On the other hand, the third column of Table B1 shows that the outstanding amount of the loan (principal and interest) increases by almost 8% for loans receiving a moratorium. This is consistent with a suspension of debt repayments which should raise the total debt.

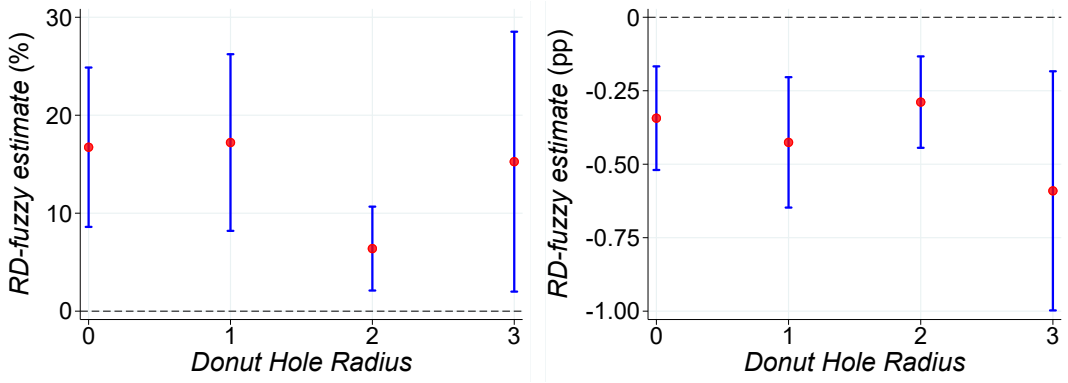
In addition, we trace the *same existing loans* two quarters after treatment to assess if: (i) the changes in delinquency behavior remain and (ii) the repayment schedule and total value of the debt fully adjust. As shown in the right part of the Table (last three columns), we observe that after treatment, delinquency days are still 174 days less for treated loans, while loan repayments increase by 52% to compensate for the time that the loan received moratorium. The last two results explain why we observe a 5.6% drop in the loan value for treated firms relative to non-eligible loans without moratorium.

Online Appendix C Additional Robustness Checks

Online Appendix C.1 Donut-Hole Test

In this exercise we evaluate the sensitivity of our benchmark results, when excluding observations in the close vicinity of the cutoff-point (1, 2, and 3 days before/after the actual cutoff, $X_{ij} = 0$). These observations are, in principle very informative, with similar values of the running variable. The test, however, checks for additional "bunching" of observations around the cutoff that the McCrary test (see Figure 1) might have potentially missed.

Figure C2: Donut-Hole Sensitivity Test



(a) Log(Loan) (b) Interest Rate

The figure shows the Donut-hole sensitivity test, excluding 1, 2, and 3 days before/after the cutoff. We employ data on new loans at the quarter of origination during 2020Q1-2021Q4. Panel (a) corresponds to the effect on the amount of the new loan (in logs of COP). Panel (b) shows the estimates on the interest rate for new loans. The zero-value radius (no holes) corresponds to our benchmark results.

Figure C2 shows similar results when excluding 1, 2, and 3 days before/after the actual cutoff, suggesting a lack of "bunching" of observations –at and close to– the cutoff-point.

Online Appendix C.2 Pre-existing differences: Stressed-Firms

In this section we evaluate whether loan and firm-level variables carried systematic differences before the debt moratorium policy took place. Table C2 presents Sharp RDD estimates, as exemplified in equation (2) for the quarter before the policy was enacted (2019Q4). As shown, all these variables are equally balanced across the running variable.

Table C2: Testing for pre-existing differences prior to the debt moratorium policy

Variable	RD Estimator	Robust Inference		Bandwidth (in days)	Observations
		p-value	95% Conf. Int.		
Log(Loan)	0.13	0.39	[-0.14, 0.36]	33.59	48,017
Interest	-0.00	0.78	[-0.01, 0.01]	40.73	47,202
Collateral	0.03	0.85	[-0.19, 0.24]	32.09	47,903
Maturity	0.07	0.59	[-0.58, 1.01]	27.38	39,884
Rating	-0.02	0.95	[-0.24, 0.25]	16.97	47,476
Ex-ante default	0.00	0.78	[-0.07, 0.05]	24.18	48,256
Ex-post default	-0.06	0.16	[-0.19, 0.03]	15.28	47,476
Past due days	4.51	0.34	[-5.31, 15.29]	54.19	48,256
Inv rate	-0.00	0.88	[-0.05, 0.06]	29.92	4,949
ΔOp Rev	0.22	0.29	[-0.26, 0.87]	21.83	6,519
ΔEmp	-0.19	0.32	[-0.58, 0.19]	42.62	16,745
ΔAssets	-0.07	0.36	[-0.26, 0.10]	48.89	17,001
ΔLiab	-0.03	0.66	[-0.31, 0.19]	39.12	16,875
ΔProfits	-0.02	0.81	[-0.19, 0.15]	56.85	15,215
ΔEquity	-0.09	0.10	[-0.22, 0.02]	55.96	17,001

Authors' calculations. The Table presents the Sharp RD estimates in equation (4) for loan and firm-level variables before the debt moratorium policy was implemented. Confidence intervals (column 4) and p-values (column 3) are computed using robust bias-corrected standard errors. Loan level variables are measured at the end of Q4-2019. Loan amount (in logs of COP) represents the outstanding debt balance of the loan, maturity is denoted in number of years, collateral is expressed as a percentage of the outstanding loan, credit rating is a categorical variable ranging from 1-5 where 5 is the highest rating, ex-ante default represents the expected default probability assigned to the loan by the bank, ex-post default is a dummy variable that takes the value of one if the loan has more than thirty days of delinquency at the end of the quarter, and past due days are the end of the quarter number of days the loan was delinquent. For firm-level variables, we use employment and balance sheet data for 2019. ΔEmp., ΔOp. Rev., ΔAssets and ΔLiab. denote yearly symmetric growth rates of the number of employees, operating revenues, total assets, and liabilities, respectively. The inv.rate represents the investment rate computed as the ratio of new purchases of buildings, plants, and equipment to total assets lagged one year. ΔProfits, ΔEquity are computed as the yearly change in gross profits and equity relative to the operating revenues and total assets lagged one year, respectively.

Online Appendix C.3 Excluding firms with Multiple Existing Loans

The results in Table C3 present RDD estimates for new loans restricting the sample to bank-firm pairs with a single *existing* loan relationship at the time that the debt moratorium policy was implemented. Similarly, Table C4 shows the results for firm-level outcomes; in this case, our sample includes only firms with a single *existing* loan when the moratorium policy started. Our aim with this exercise is twofold: (i) to exclude firms that ex-ante had multiple bank relationships, (ii) to exclude firms receiving multiple debt payment suspensions.

Table C3: RD Loan Outcomes: bank-firm pairs with single *existing* loan relationships

	Intensive	Extensive	Interest	Maturity	Collateral	Rating	Default Prob.	
	Log(Loan)	$\mathbb{1}\{\text{loan}\}$					Ex-ante	Ex-post
Fuzzy-RD	27.41**	1.61*	-0.73*	12.27	1.52	8.42*	-2.15	-3.28**
	(11.0)	(1.00)	(0.4)	(13.5)	(1.5)	(4.9)	(1.5)	(1.3)
	First Stage							
D_{ij}	0.09***	0.09***	0.12**	0.04	0.09***	0.08***	0.08***	0.09***
	(0.0)	(0.0)	(0.1)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)
Observations	32,411	65,909	32,411	32,411	32,411	32,411	32,411	64,120
BW (in days)	16.9	12.8	7.6	12.0	12.9	19.9	20.5	17.9

Authors' calculations. Table show the estimates for the effect of the debt moratorium on new loan conditions for stressed firms. We exclude bank-firm pairs with multiple *existing* loan relationships. Estimates in the first row correspond to Fuzzy RD coefficient δ_1 in equation (4). The second row shows the first stage estimates for the probability of treatment (D_{ij}), as described in equation (2). Robust Bias-corrected standard errors in parentheses , *, **, ***, indicate significance at the 10%, 5%, and 1% respectively. The last row report the Bandwidth (BW) in days used to compute the local RD estimate. We employ data on new loan conditions during 2020Q1-2021Q4. To capture the intensive margin for new loans, we use the amount (in logs of COP) at the quarter of origination. The extensive margin of new loans is captured by a dummy taking the value of one in the quarter of origination. Maturity is denoted in number of years, collateral is expressed as percentages of the loan amount, credit rating is a categorical variable from 1-5 where 5 is the highest rating, ex-ante default represents the expected default probability assigned to the loan by the bank, and ex-post default is a dummy variable that takes the value of one if the loan has more than thirty days of delinquency at the end of each quarter. The interest rate, maturity, collateral, rating of new loans, and ex-ante default are measured only at the quarter of origination of the loan. All columns control for bank, quarter, and two-digit industry code fixed effects. For the intensive margin (first column) and the interest rate (third column), we control for the balance of the existing loan and its interest rate at the end of Q1-2020, respectively.

Table C4: RD Firm Outcomes: Firms with single *existing* loan relationships

	ΔEmp.	Inv.rate	ΔOp. Rev.	Δ Assets	ΔLiab.	ΔProfit	ΔEquity
Fuzzy-RD	1.50	0.19***	5.72***	1.83*	2.01***	1.37***	1.11
	(1.090)	(0.047)	(1.157)	(1.079)	(0.712)	(0.319)	(0.708)
	First Stage						
D_{ij}	0.17***	0.20***	0.25***	0.14***	0.18***	0.21***	0.14***
	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)
Observations	10,389	5,830	19,133	18,122	17,965	17,769	18,122
BW (in days)	23.2	10.0	7.0	14.8	10.5	9.1	14.6

Authors' calculations. Table show the estimates for the effect of the debt moratorium on firm level variables for stressed firms. We exclude firms with multiple *existing* loan relationships. Estimates in the first row correspond to the Fuzzy RD coefficient δ_1 in equation (4). The second row shows the first stage estimates for the probability of treatment (D_{ij}) described in equation (2). Robust Bias-corrected standard errors clustered at the firm's province in parentheses , *, **, ***, indicate significance at the 10%, 5%, and 1% respectively. The last row report the Bandwidth (BW) in days used to compute the local RD estimate. We use employment and balance sheet data for firms during 2020-2021. ΔEmp., ΔOp. Rev., ΔAssets and ΔLiab. denote yearly symmetric growth rates of the number of employees, operating revenues, total assets, and liabilities, respectively. Inv.rate represents the investment rate computed as the ratio of new purchases of buildings, plants, and equipment to total assets lagged one year. ΔProfit, ΔEquity are computed as the yearly change in gross profits and equity relative to the operating revenues and total assets lagged one year, respectively. All columns control for bank and two-digit industry codes' fixed effects.

Online Appendix C.4 Controlling for existing credit risk prior to the policy

Tables C5 and C6 show the RD estimates for new loans and firm outcomes controlling for the exisitng credit rating prior to the policy. Intuitively, controlling for firms' credit rating on *existing* loans should absorb any effect of the debt moratorium coming from the "artificial" boost in credit ratings to firms receiving suspension of payments on existent loans.

Table C5: RD New Loans: Controlling for firms' credit risk

	Intensive	Extensive	Interest	Maturity	Collateral	Rating	Default Prob.	
	Log(Loan)	$\mathbb{1}\{\text{loan}\}$					Ex-ante	Ex-post
Fuzzy-RD	32.19*	0.70	-1.07**	12.11***	3.82**	0.58	-0.22	-5.34***
	(19.5)	(0.94)	(0.5)	(4.0)	(1.8)	(2.5)	(0.8)	(1.9)
	First Stage							
D_{ij}	0.07**	0.08***	0.10**	0.13***	0.10***	0.13***	0.12***	0.08***
	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)
Observations	35,072	70761	35,072	35,072	35,072	35,072	35,072	71,750
BW (in days)	15.6	14.4	7.5	19.9	14.2	19.2	17.6	16.1

Authors' calculations. Table show the estimates for the effect of the debt moratorium on new loan conditions for stressed firms controlling for the existing credit rating prior to the policy. Estimates in the first row correspond to Fuzzy RD coefficient δ_1 in equation (4). The second row shows the first stage estimates for the probability of treatment (D_{ij}), as described in equation (2). Robust Bias-corrected standard errors in parentheses , *, **, ***, indicate significance at the 10%, 5%, and 1% respectively. The last row report the Bandwidth (BW) in days used to compute the local RD estimate. We employ data on new loan conditions during 2020Q1-2021Q4. To capture the intensive margin for new loans, we use the amount (in logs of COP) at the quarter of origination. The extensive margin of new loans is captured by a dummy taking the value of one in the quarter of origination. Maturity is denoted in number of years, collateral is expressed as percentages of the loan amount, credit rating is a categorical variable from 1-5 where 5 is the highest rating, ex-ante default represents the expected default probability assigned to the loan by the bank, and ex-post default is a dummy variable that takes the value of one if the loan has more than thirty days of delinquency at the end of each quarter. The interest rate, maturity, collateral, rating of new loans, and ex-ante default are measured only at the quarter of origination of the loan. All columns control for bank, quarter, and two-digit industry code fixed effects. For the intensive margin (first column) and the interest rate (third column), we control for the balance of the existing loan and its interest rate at the end of Q1-2020, respectively.

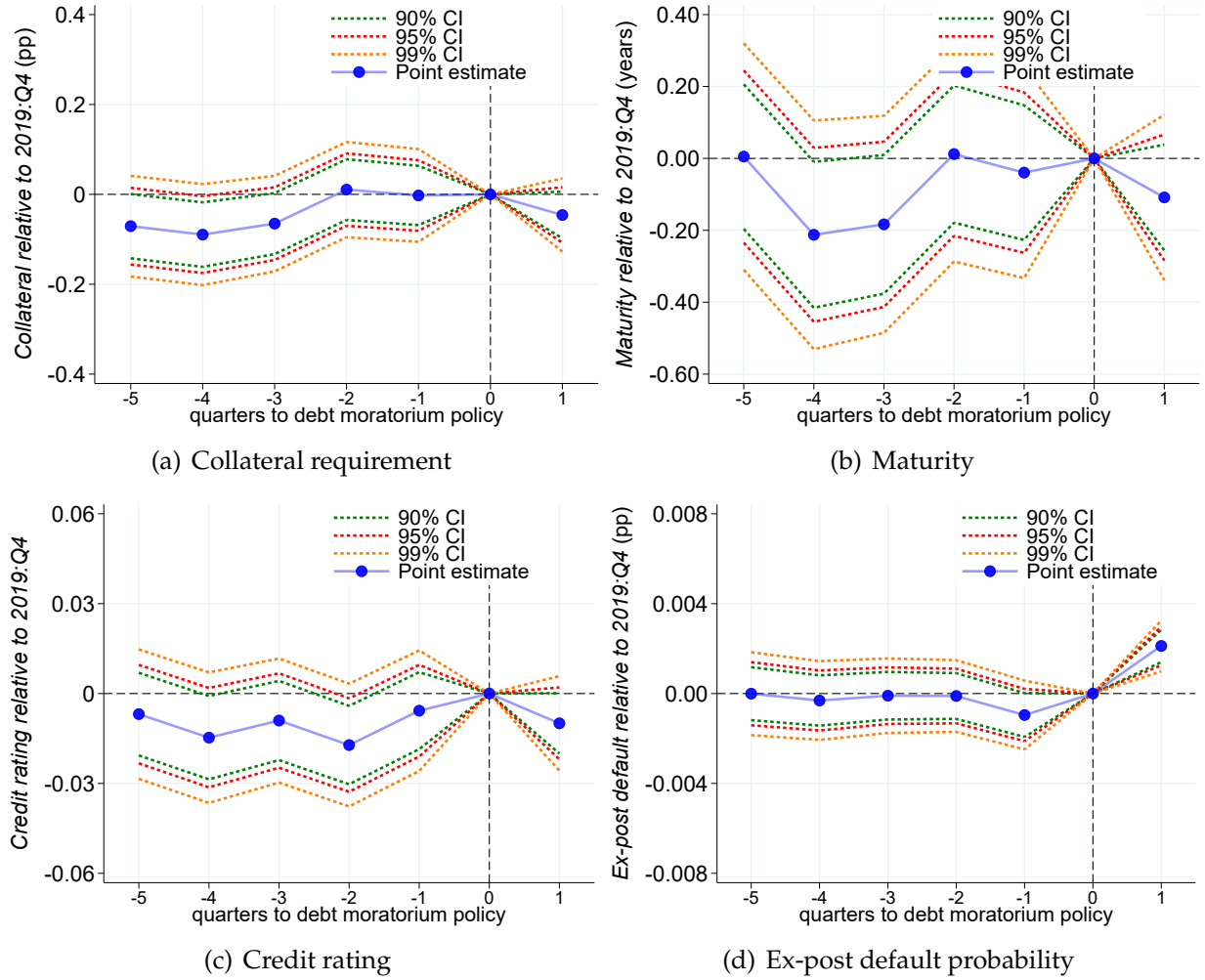
Table C6: RD Firm Outcomes: Controlling for firms' credit risk

	ΔEmp.	Inv.rate	ΔOp. Rev.	Δ Assets	ΔLiab.	ΔProfit	ΔEquity
Fuzzy-RD	3.55*	0.11*	2.87***	1.24*	1.58***	4.63*	0.80*
	(2.0)	(0.1)	(0.6)	(0.6)	(0.5)	(2.5)	(0.4)
	First Stage						
D_{ij}	0.10**	0.25***	0.45***	0.16***	0.21***	0.22***	0.16***
	(0.0)	(0.0)	(0.1)	(0.0)	(0.0)	(0.0)	(0.0)
Observations	15,379	11,386	31,786	30,887	30,660	29,762	30,887
BW (in days)	22.9	9.4	6.3	14.2	9.3	9.7	14.3

Authors' calculations. Table show the estimates for the effect of the debt moratorium on firm level variables for stressed firms controlling for the existing credit rating prior to the policy. Estimates in the first row correspond to the Fuzzy RD estimate in equation (4). The second row shows the first stage estimates for the probability of treatment (D_{ij}) described in equation (2). Robust Bias-corrected standard errors clustered at the firm's province in parentheses , *, **, ***, indicate significance at the 10%, 5%, and 1% respectively. The last row report the Bandwidth (BW) in days used to compute the local RD estimate. We employ firm's balance sheet data for 2020-2021 to measure firm outcomes. ΔEmp., ΔOp. Rev., ΔAssets and ΔLiab. denote yearly symmetric growth rates of number employees, operating revenues, total assets and liabilities, respectively. Inv.rate represent the investment rate computed as the ratio of new purchases of buildings, plant and equipment to total assets lagged one year. ΔProfit, ΔEquity are computed as the yearly change in gross profits and equity relative to the operating revenues and total assets lagged one year, respectively. In all columns we control for bank and two-digit industry codes fixed effects.

Online Appendix D Checking for Parallel Trends: Non-Stressed Firms

Figure D3: Event Study Analysis: Other Loan level outcomes



(a) Collateral requirement

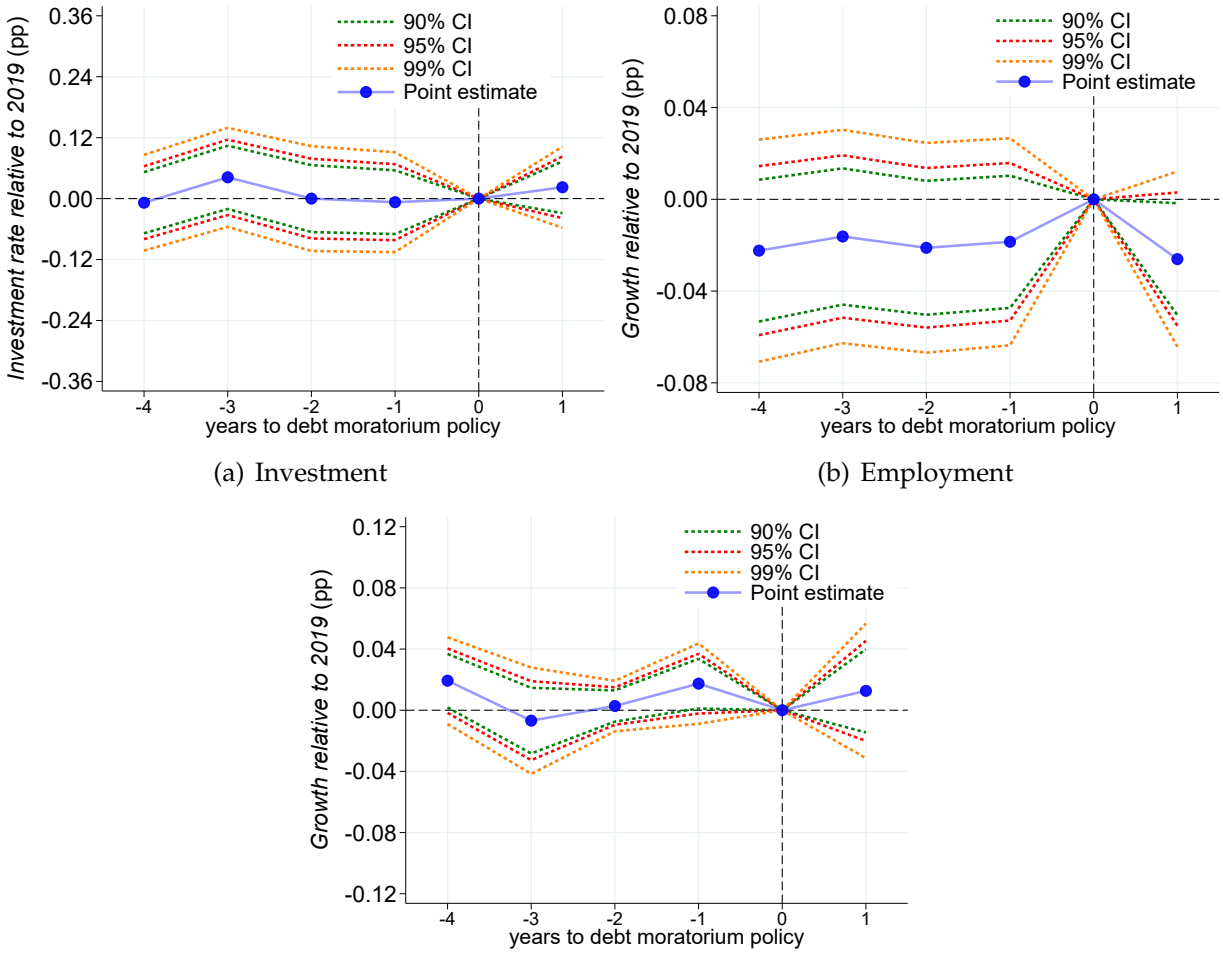
(b) Maturity

(c) Credit rating

(d) Ex-post default probability

Figure plots the point estimates and confidence intervals for the lead (ϕ_{-1},..,ϕ_{-5}) and contemporaneous (β) coefficients of equation (C1). We employ data on new loans at the quarter of origination during 2018Q4-2021Q4. Panel (a) shows the results for collateral requirement. Panel (b) maturity. Panel (c) credit rating. Panel (d) ex-post default probability.

Figure D4: Event Study Analysis: Firm level outcomes I



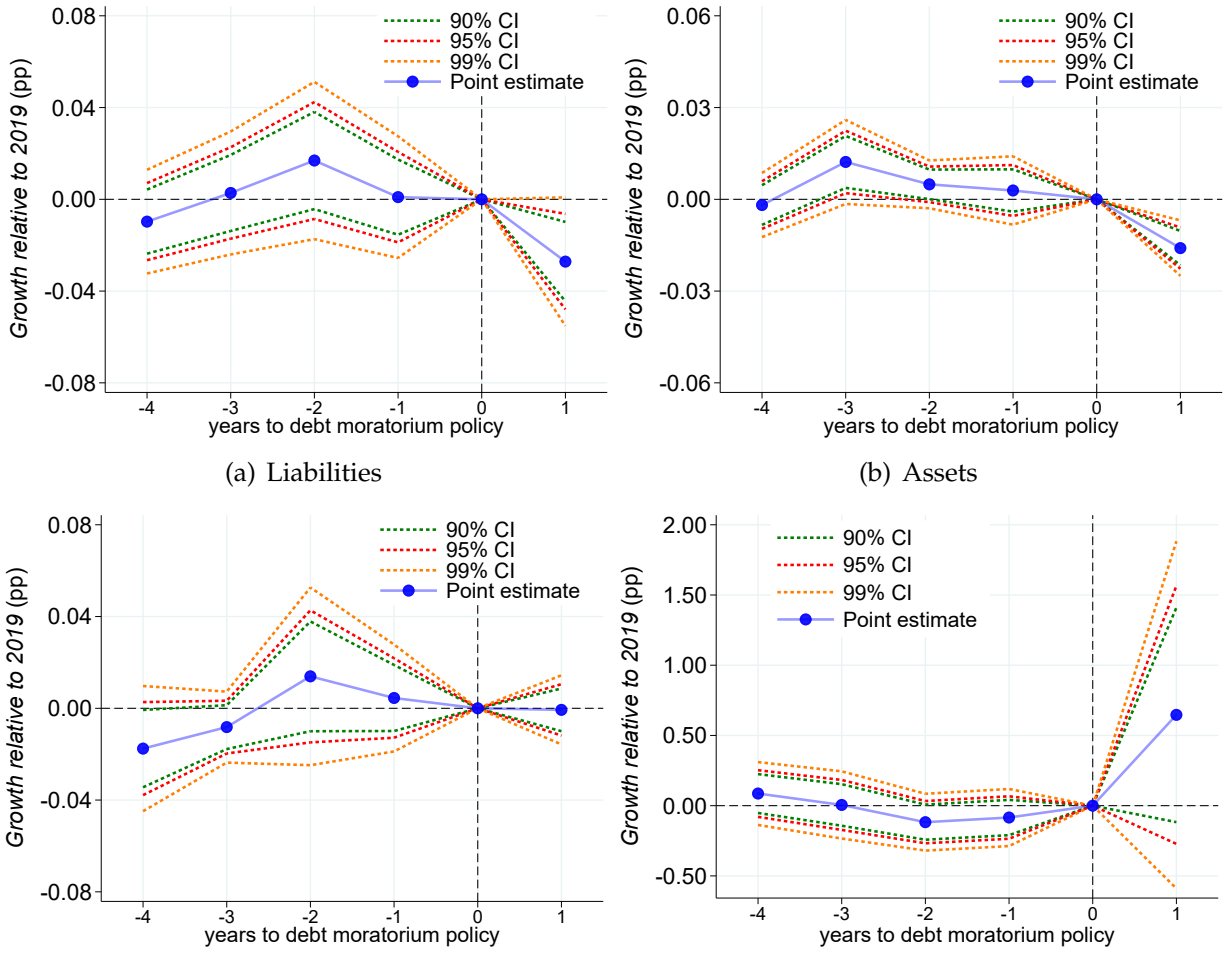
(a) Investment

(b) Employment

(c) Operating Revenue

Figure plots the point estimates and confidence intervals for the lead (ϕ_{-1},..,ϕ_{-4}) and contemporaneous (β) coefficients of equation (C1). We use employment and balance sheet data for firms during 2015-2021. Panel (a) shows the results for investment rate. Panel (b) and (c) for the growth rate of employment and operating revenues, respectively.

Figure D5: Event Study Analysis: Firm level outcomes II



(a) Liabilities

(b) Assets

(c) Profits

(d) Equity

Figure plots the point estimates and confidence intervals for the lead (ϕ_{-1},..,ϕ_{-4}) and contemporaneous (β) coefficients of equation (C1). We use balance sheet data for firms during 2015-2021. Panel (a), (b), (c), and (d) shows the results for the growth rate of liabilities, assets, profits, and equity, respectively.

Online Appendix E Numerical approximation algorithm

Continuing from Section Appendix E.2, we compute a stationary competitive equilibrium by iterating jointly on firms' value functions and the associated loan price schedules until convergence. The iteration stops when the sup-norm distance between successive iterates of all equilibrium objects is below 10^{-5}.

State space, grids, and expectations. Let the individual state be $x \equiv (b_m, b, k, A, p)$, where b denotes standard debt, b_m moratoria debt, k capital, A productivity, and p the global liquidity/premium shock. We discretize (b_m, b, k, A) on equally spaced grids with $N_{b_m} = N_b = 25$, $N_k = 25$, and $N_A = 31$ nodes. Expectations over next-period productivity are evaluated using $N_\varepsilon = 50$ Gauss–Legendre quadrature nodes, and expectations over p' are computed using the Markov transition matrix for p.

Equilibrium computation

1. **Initialization.** Construct grids and transition objects. Initialize $(V_0^R, V_0^D, q_0, q_{m,0})$ as follows:

   - **Static labor and output.** For each state $x = (b_m, b, k, A, p)$, we compute the intratemporal labor choice $\ell^\star(A, k)$ and the associated output $y^\star(A, k)$. Given production
   $$y(A, k, \ell) = Ak^{\alpha_k}\ell^{1-\alpha_k},$$
   and preferences
   $$u(c, \ell) = \frac{\tilde{c}^{1-\sigma}}{1-\sigma}, \qquad \tilde{c} \equiv c - \eta\frac{\ell^\omega}{\omega},$$
   the labor first-order condition is obtained from
   $$\frac{\partial}{\partial \ell} u\left(c(\ell), \ell\right) = u_{\tilde{c}}(\tilde{c})\left(\frac{\partial c}{\partial \ell} - \eta\ell^{\omega-1}\right) = 0,$$
   which implies (since $u_{\tilde{c}}(\tilde{c}) = \tilde{c}^{-\sigma} > 0$)
   $$\frac{\partial c}{\partial \ell} = \eta\ell^{\omega-1}.$$
   Because labor affects consumption only through contemporaneous production on this intratemporal margin, $\partial c/\partial \ell = \partial y/\partial \ell$. Moreover,
   $$\frac{\partial y}{\partial \ell} = (1-\alpha_k)Ak^{\alpha_k}\ell^{-\alpha_k}.$$
   Hence $\ell^\star(A, k)$ solves
   $$(1-\alpha_k)Ak^{\alpha_k}\ell^{-\alpha_k} = \eta\ell^{\omega-1},$$

so that

$$\ell^\star(A,k) = \left(\frac{(1-\alpha_k)Ak^{\alpha_k}}{\eta}\right)^{\frac{1}{\alpha_k+\omega-1}}, \qquad y^\star(A,k) \equiv y\left(A,k,\ell^\star(A,k)\right).$$

- **Initial repayment value.** Using $y^\star(A,k)$, define a feasible consumption proxy under repayment as

$$c^{R,0}(x) \equiv y^\star(A,k) - \Big(k' - (1-\delta_k)k\Big)\Big|_{k'=k} - \kappa b - \kappa_m b_m - g(p).$$

Let $\tilde{c}^{R,0}(x) \equiv c^{R,0}(x) - \eta\frac{\ell^\star(A,k)^\omega}{\omega}$. We set

$$V_0^R(x) \equiv \frac{\left(\tilde{c}^{R,0}(x)\right)^{1-\sigma}}{1-\sigma}.$$

- **Initial default value.** Under default, effective productivity is $A_{\text{eff}}(A) \equiv (1-\phi(A))A$, where $\phi(A) \in [0,1]$ is the output cost in the main text. Compute

$$\ell^\star\big(A_{\text{eff}}(A),k\big) = \left(\frac{(1-\alpha_k)A_{\text{eff}}(A)k^{\alpha_k}}{\eta}\right)^{\frac{1}{\alpha_k+\omega-1}},$$

$$y^\star\big(A_{\text{eff}}(A),k\big) \equiv y\left(A_{\text{eff}}(A),k,\ell^\star\big(A_{\text{eff}}(A),k\big)\right).$$

Define

$$c^{D,0}(x) \equiv y^\star\big(A_{\text{eff}}(A),k\big) - g(p), \qquad \tilde{c}^{D,0}(x) \equiv c^{D,0}(x) - \eta\frac{\ell^\star\big(A_{\text{eff}}(A),k\big)^\omega}{\omega},$$

and set

$$V_0^D(x) \equiv \frac{\left(\tilde{c}^{D,0}(x)\right)^{1-\sigma}}{1-\sigma}.$$

- **Initial price schedules.** Initialize the price schedules at the corresponding terminal objects from the finite-horizon economy:

$$q_0(x) = q^{\text{term}}(x) = 0, \qquad q_{m,0}(x) = q_m^{\text{term}}(x) = 0.$$

- For each state $x = (b_m, b, k, A, p)$, compute $\ell^\star(A,k)$ and $y^\star(A,k)$. Define a feasible consumption proxy under repayment as

$$c^{R,0}(x) \equiv y^\star(A,k) - \Big(k' - (1-\delta_k)k\Big)\Big|_{k'=k} - \kappa b - \kappa_m b_m - g(p).$$

Set

$$V_0^R(x) \equiv u\big(c^{R,0}(x)\big) - \eta\frac{\ell^\star(A,k)^\omega}{\omega}.$$

- Under default, let effective productivity be $A_{\text{eff}}(A) \equiv (1 - \phi(A))A$, where $\phi(A) \in [0,1]$ is the output cost in the main text. Compute $\ell^\star(A_{\text{eff}}(A), k)$ and $y^\star(A_{\text{eff}}(A), k)$, and define

$$c^{D,0}(x) \equiv y^\star(A_{\text{eff}}(A), k) - g(p), \qquad V_0^D(x) \equiv u\big(c^{D,0}(x)\big) - \eta \frac{\ell^\star(A_{\text{eff}}(A), k)^\omega}{\omega}.$$

- Initialize the price schedules $q_0(x) = q_{m,0}(x) =$ as the corresponding terminal objects from the finite-horizon economy .

2. **Main fixed-point iteration.** For $n = 0, 1, 2, \ldots$ repeat the following steps:

   (a) **Value function update given prices.** At each grid point $x = (b_m, b, k, A, p)$, compute the repayment and default values.
   Repayment branch:

$$V_{n+1}^R(x) = \max_{(b_m', b', k') \in \mathcal{X}(x)} \left\{ u\big(c^R(x; b_m', b', k')\big) - \eta \frac{\ell^\star(A, k)^\omega}{\omega} + \beta \mathbb{E}\left[V_n(x') \mid x, (b_m', b', k') \right] \right\},$$

   where $V_n(\cdot) \equiv \max\{V_n^R(\cdot), V_n^D(\cdot)\}$, $x' = (b_m', b', k', A', p')$, and the expectation is computed using quadrature for A' and the Markov transition for p' with interpolation over off-grid states.
   Default branch: Compute $V_{n+1}^D(x)$ from the default Bellman equation in the main text (using $A_{\text{eff}}(A)$ and the appropriate law of motion for post-default states), with the same expectation/interpolation operator.

   (b) **Optimization routine at each state.** To solve the repayment maximization robustly in the presence of kinks and occasionally binding constraints, we use a global-to-local procedure:

      i. *Coarse search:* evaluate the repayment objective on a coarse rectangular grid with 40 nodes in each choice dimension (b_m', b', k'), restricted to $\mathcal{X}(x)$.
      ii. *Univariate refinement:* for each coarse triple, hold (b_m', k') fixed and refine b' using Brent's method, initialized at the triple's b' and bracketed by adjacent grid nodes along the b' dimension.
      iii. *Joint refinement:* starting from the best refined candidate, apply a BOBYQA derivative-free routine to refine the maximizer jointly in (b_m', b', k'). We implement maximization by applying these routines to the negative of the objective. This approach is robust to non-differentiabilities induced by the repayment/default switch and occasionally binding constraints; see Önder (2023).

   Record the resulting policy functions $(b_{m,n+1}'(x), b_{n+1}'(x), k_{n+1}'(x))$ and the associated value $V_{n+1}^R(x)$.

   (c) **Default decision and overall value.** Update the default indicator and overall value at each state:

$$d_{n+1}(x) = \mathbf{1}\left\{ V_{n+1}^D(x) \geq V_{n+1}^R(x) \right\}, \qquad V_{n+1}(x) = \max\{V_{n+1}^R(x), V_{n+1}^D(x)\}.$$

(d) **Price schedule update.** Given $(d_{n+1}, b'_{n+1}, b'_{m,n+1}, k'_{n+1})$, update $(q_{n+1}, q_{m,n+1})$ using the equilibrium pricing equations in the main text (equations (11)–(14)). Expectations in pricing are evaluated using the same transition objects and interpolation as in the value-function step.

(e) **Convergence check.** Compute

$$\Delta_n = \max\left\{\|V^R_{n+1} - V^R_n\|_\infty, \|V^D_{n+1} - V^D_n\|_\infty, \|q_{n+1} - q_n\|_\infty, \|q_{m,n+1} - q_{m,n}\|_\infty\right\}.$$

If $\Delta_n < 10^{-5}$, stop; otherwise set $n \leftarrow n+1$ and repeat.

(f) **Local search.** Invoke local search methods within the neighborhood of the obtained candidate optima (b', b'_m, k') for each state x in the previous step by restricting the search to a neighborhood around it. This reduces computation time while preserving robustness.

Simulation

With the converged equilibrium objects (V^R, V^D, q, q_m) and policy rules, we simulate the model as follows:

1. Set the number of simulated samples to $N = 2000$, the sample length to $T = 1501$, and the burn-in to $T_0 = 500$.

2. For each sample $n = 1, \ldots, N$, draw sequences of shocks $(\varepsilon_t, p_t)_{t=1}^T$ from the assumed processes. We fix the random seed and, when comparing counterfactuals, reuse the same shock draws across experiments.

3. Initialize each sample at $A_0 = \mathbb{E}[A]$, set p_0 to its mean (no liquidity stress), set $(b_{m,0}, b_0) = (0, 0)$, and set k_0 equal to the model's steady-state capital.

4. Discard the first T_0 observations of each simulated path and compute moments using $t = T_0 + 1, \ldots, T$.

Online Appendix F Coupon Structure and Debt Moratorium

In Figures F6 and F7 (Online Appendix F), we visualize the payment structure of standard loans and moratorium loans, respectively, assuming that $\delta = \delta_m$ for ease of exposition. Blue large circles represent coupon payments of moratorium loans while black dots represent coupon payments of standard loans depicted in Figure F6. Notice in Figure F7 that when the payments are suspended at time $t+1$ during a stress episode, the firm does not make any coupon payments. When the sress episode is over, the coupon accrue interest rate of r_m and the firm pays the coupon plus interest which in this case becomes $e^{r_m}\kappa$.

Figure F6: Coupon structure of standard loans.

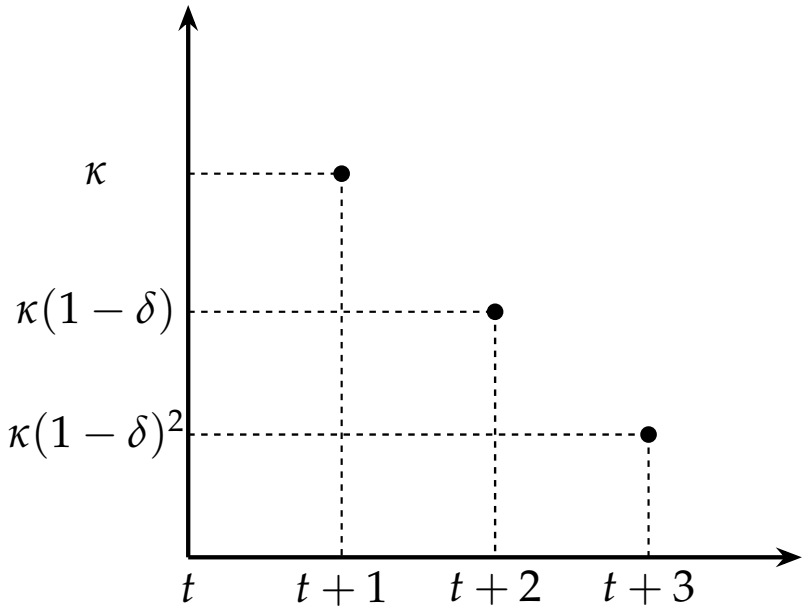


Figure F7: Coupon structure of the moratorium loans are denoted by blue dots while standard loans are denoted by black dots.

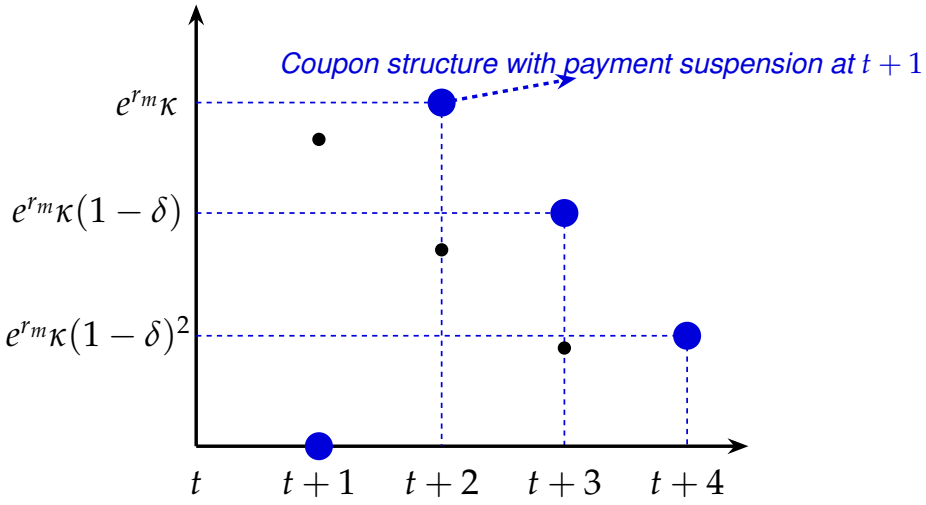


Table F7: Summary of the model environment.

Agents	Representative household owns the firm and chooses consumption, labor, investment, borrowing, and default. Competitive, risk–neutral international lenders price loans taking firm policies as given.
Exogenous states	$s_t = (A_t, p_t)$: TFP A_t and global condition $p_t \in \{p_L, p_H\}$. TFP: $\log A_t = (1-\rho)\mu + \rho \log A_{t-1} + \varepsilon_t$, $\varepsilon_t \sim N(0, \sigma_\varepsilon^2)$. Global stress: p_t follows a two–state Markov chain; stress begins with $\pi_{LH}(A_t)$ and ends with π_{HL}.
Endogenous states	k_t: capital; b_t: standard long–term debt; $b_{m,t}$: moratorium long–term debt; delinquency status.
Controls	$c_t, L_t, k_{t+1}, b_{t+1}, b_{m,t+1}, d_t \in \{0,1\}$ (default), with $i_t = k_{t+1} - (1-\delta_k)k_t$.
Preferences	$E_0 \sum_{t=0}^{\infty} \beta^t u(c_t, L_t)$, $u(c_t, L_t) = \dfrac{\left(c_t - \eta \frac{L_t^\omega}{\omega}\right)^{1-\sigma} - 1}{1-\sigma}$. GHH $\Rightarrow$ labor supply: $\eta L_t^{\omega-1} = w_t$.
Technology	Output: $y_t = A_t\left(k_t^{\alpha^k} L_t^{1-\alpha^k}\right)^\nu$, $\alpha^k \in (0,1)$, $\nu \in (0,1)$. Capital adjustment cost: $\frac{\Theta}{2}(k_{t+1} - k_t)^2$.
Long–term debt	Standard debt: coupon stream $\kappa(1-\delta)^{n-1}$, $\delta \in (0,1]$; law of motion $b_{t+1} = (1-\delta)b_t + m_t$. κ chosen so risk–free price is $(r+\delta)/(1+r)$. Moratorium debt: coupons decay at δ_m and can be suspended when $p_t = p_H$; suspended coupons grow at rate r_m and are repaid as $e^{r_m}\kappa_m$.
Budget: repayment	If $p_t = p_H$ (suspension): $c_t = y_t - \kappa b_t + q_t[b_{t+1} - b_t(1-\delta)] + q_{m,t}[b_{m,t+1} - b_{m,t}e^{r_m}] - (k_{t+1} - (1-\delta_k)k_t) - \frac{\Theta}{2}(k_{t+1} - k_t)^2$. If $p_t = p_L$ (no suspension): $c_t = y_t - \kappa b_t - \kappa_m b_{m,t} + q_t[b_{t+1} - b_t(1-\delta)] + q_{m,t}[b_{m,t+1} - b_{m,t}(1-\delta_m)] - (k_{t+1} - (1-\delta_k)k_t) - \frac{\Theta}{2}(k_{t+1} - k_t)^2$.
Default / delinquency	Default ($d_t = 1$): output loss $\phi(A_t) = \min\{\max(d_0 + d_1 A_t, 0), 1\}$, no new borrowing, $c_t = (1 - \phi(A_t))y_t - (k_{t+1} - (1-\delta_k)k_t) - \frac{\Theta_d}{2}(k_{t+1} - k_t)^2$. Firm exits delinquency with prob. ξ and repays fraction α of each loan.
Lender pricing	Risk–neutral, opportunity cost r. Standard and moratorium loan prices $q_t, q_{m,t}$ and delinquent prices $q_t^D, q_{m,t}^D$ satisfy no–arbitrage conditions given default and borrowing rules (see (11)–(14)).
Equilibrium	Sequences $\{c_t, L_t, k_t, b_t, b_{m,t}, d_t, w_t, q_t, q_{m,t}\}$ such that: (i) the household's recursive problem is solved; (ii) lenders' pricing equations hold; (iii) markets clear; (iv) default decisions satisfy $V^R(b_{m,t}, b_t, s_t) \geq V^D(b_{m,t}, b_t, s_t)$.