Bank Capacity and the Cost of Corporate Liquidity Insurance*

Mario Cerrato†

Adam Smith Business School, University of Glasgow

Shengfeng Mei‡

Institute of Inner City Learning, University of Wales Trinity Saint David

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Abstract

How do intermediary balance-sheet constraints shape the pricing for corporate liquidity insurance? Using central bank asset purchases as exogenous capacity shocks, this paper asks whether a shareholder funding-risk distortion is consistent with debt-overhang incentives. Employing a triple-difference design comparing credit lines to term loans, we document that relaxing balance-sheet constraints are associated with a narrower pricing wedge given state-contingent funding stress. This effect is concentrated in banks with high funding-risk exposure. A one-standard-deviation relaxation in constraints compresses the pricing wedge by 25–30 basis points during systemic shocks, providing an estimate of the pass-through of intermediary frictions into contingent liability spreads.

Keywords: Quantitative Easing, Central Bank, Debt Overhang, Credit Line

Classification codes: G01, G21, G28, G32, E44, E58

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†E-mail: mario.cerrato@glasgow.ac.uk, corresponding author

‡E-mail: s.mei@uwtsd.ac.uk

1 Introduction

A central function of financial intermediaries is the provision of liquidity insurance. Corporate credit lines allow firms to obtain funding precisely when external financing conditions deteriorate, thereby insuring firms against liquidity shortfalls during periods of stress. Yet because credit-line drawdowns increase during systemic disruptions (Sufi 2009, Campello et al. 2011, Acharya et al. 2013, Acharya & Steffen 2020, Brown et al. 2021), intermediaries providing these commitments must raise funding precisely when their own marginal funding costs are elevated. The provision of liquidity insurance, therefore, exposes intermediaries to a state-contingent funding-risk covariance that becomes particularly severe during systemic liquidity shocks.

An emerging literature shows that this covariance can generate distortions in the provision of contingent credit. In particular, Cooperman et al. (2025) show that the joint realization of credit-line drawdowns and elevated bank funding costs creates a shareholder funding-risk wedge consistent with debt-overhang mechanisms (Myers 1977). While existing work establishes the existence of this friction and its implications for contract design, much less is known about how intermediary balance-sheet capacity affects the price of liquidity insurance contracts. More broadly, it remains unclear whether policy interventions that relax intermediary balance-sheet constraints compress the price of contingent liquidity provision or merely stimulate aggregate lending activity.

For example, while Cooperman et al. (2025) establish that contingent credit provision exposes banks to a funding-risk covariance that generates an *ex ante* pricing wedge, our paper studies how the magnitude of this wedge varies with intermediary balance-sheet capacity and responds to policy-induced balance-sheet relief. In particular, we examine whether central-bank asset purchases compress the relative price of contingent liquidity provision by relaxing intermediary funding constraints. Whereas prior work primarily focuses on the existence of the funding-risk friction and its implications for contract structure and reference-rate design, we study how intermediary heterogeneity and monetary-policy interventions shape the pricing of liquidity insurance across lending contracts.

Our analysis suggests that credit-line spreads embed a state-dependent intermediary-capacity premium that varies systematically across banks and compresses when central-bank balance-sheet interventions relax funding constraints. We use large-scale asset purchases (APP/QE) as shocks to intermediary balance-sheet capacity and study how these interventions may influence the relative pricing of contingent and non-contingent corporate lending contracts.

Our analysis focuses on the distinction between revolving credit facilities and term loans. Revolvers provide contingent liquidity insurance because firms can draw funding during adverse states of the world, whereas term loans involve predetermined disbursement schedules and therefore contain substantially less state-contingent funding exposure. This distinction allows us to isolate the pricing of liquidity-insurance risk from broader movements in credit demand or aggregate lending conditions. If intermediary balance-sheet constraints are priced in contingent credit provision, then shocks that relax those constraints should compress credit-line pricing disproportionately relative to term-loan pricing, especially among intermediaries with greater *ex ante* funding-risk exposure.

We provide evidence consistent with this mechanism using contract-level syndicated loan data combined with intermediary funding-risk measures. First, increases in intermediary funding stress, measured using LIBOR–OIS spreads and bank CDS spreads, significantly raise credit-line pricing. Second, the sensitivity of credit-line pricing to funding stress appears to be less pronounced following large-scale asset purchases. Third, these effects are more visible among intermediaries with greater reliance on wholesale funding and weaker balance-sheet capacity prior to policy interventions.

To sharpen identification, we employ a difference-in-difference-in-differences (DDD) design exploiting three dimensions of variation: (i) cross-sectional exposure to central-bank asset purchases, (ii) differences between contingent and non-contingent lending contracts, and (iii) time variation in systemic funding stress. The key identifying comparison contrasts the relative pricing of revolvers and term loans across intermediaries differentially exposed to balance-sheet relief following APP interventions. Because term loans lack meaningful covariance between funding costs and drawdown demand, they provide a benchmark for isolating the intermediary-capacity component embedded in liquidity-insurance pricing.

Our evidence suggests that corporate credit lines are priced not only as lending contracts, but also as intermediary-provided liquidity insurance whose premium depends on the shadow cost of intermediary balance-sheet capacity. Intermediaries facing tighter funding constraints charge significantly higher spreads on contingent lending during stress periods, and these premia compress when central-bank interventions relax balance-sheet constraints. Economically, a one-standard-deviation relaxation in intermediary constraints is associated with a reduction in the contingent-credit pricing wedge by approximately 25–30 basis points.

One might worry that our results are specific to the COVID-19 pandemic. We address this concern in three ways. First, we show that conventional QE during normal market conditions (QE3, 2012) had no effect on the contingent credit wedge (Table 5). Second, our falsification test using a pseudo-QE date (June 2017) shows no effect, ruling out a generic time trend (Table 6). Third, we replicate the main pattern using the 2008 financial crisis (Online Appendix OA9), suggesting the mechanism operates in any systemic funding stress episode. Thus, the COVID-19 episode serves as a particularly severe stress test of the intermediary capacity channel, not the sole source of identification.

The paper contributes to several strands of literature. First, we contribute to the literature on corporate liquidity insurance and credit lines (Sufi 2009, Berg et al. 2016, 2017, Cooperman et al. 2025). Whereas existing work primarily studies liquidity demand, contract structure, and the existence of funding-risk distortions, we study how intermediary balance-sheet capacity determines the pricing of contingent liquidity provision. Our evidence highlights an intermediary-capacity channel through which the price of liquidity insurance varies over the financial cycle.

Second, we contribute to the literature on intermediary asset pricing and funding frictions (Andersen et al. 2019, Du et al. 2018, 2023, Fleckenstein & Longstaff 2020, Burnside & Cerrato 2023, Cerrato & Mei 2024). This literature shows that intermediary funding constraints generate pricing distortions across financial markets. We extend this insight to corporate credit markets and provide evidence that intermediary balance-sheet constraints appear to affect the pricing of contingent corporate credit contracts.

Third, we contribute to the literature on monetary-policy transmission through intermediary balance sheets. Existing work studies how large-scale asset purchases affect aggregate lending and financial conditions. We find that these interventions also appear to influence the pricing of liquidity insurance by compressing the state-contingent funding-risk premium embedded in revolving credit facilities. Our findings, therefore, point to a balance-sheet transmission channel operating specifically through contingent credit provision.

Finally, we develop a simple balance-sheet model in which shareholders bear losses when funding must be raised at elevated spreads during systemic stress. While prior work derives the *ex ante* funding-risk wedge associated with contingent lending, we study how this wedge adjusts when intermediary balance-sheet constraints are unexpectedly relaxed. In the model, asset purchases reduce both funding spreads and the covariance between funding costs and drawdown demand, lowering the price of liquidity insurance. The model rationalizes the empirical finding that the contingent-credit pricing wedge is largest among intermediaries closest to funding constraints.

The rest of the paper proceeds as follows. Section 2 describes the data. Section 3 presents the main empirical design and results. Section 4 provides additional analyses and robustness tests. Section 5 develops the model. Section 6 concludes.

2 Data and Statistics

2.1 Data

We use data on individual loan facilities from the WRDS–Reuters' DealScan database (Loan Pricing Corporation DealScan). DealScan provides information on US firms as well as global non-US firms. In this paper, we focus on loans to US corporations.[1] We restrict the sample to newly originated facilities and re-negotiations (amendments).[2] We exclude drawdowns on pre-existing commitments because the spread on those contracts was set ex-ante and does not reflect post-shock pricing equilibrium. Following Acharya et al. (2013), we exclude utilities, quasi-public entities, and financial firms. Specifically, we drop firms with SIC codes in 6000–6999, 4900–4999, and above 8999. Our sample covers January 2015 through December 2022, including the COVID-19 pandemic. We focus on the COVID-19 shock.

We also collect 3-month, 6-month, and 12-month London Interbank Offered Rate (LIBOR) and overnight indexed swap (OIS) rates from Bloomberg.[3] The difference between these two rates is commonly regarded as a proxy for the wholesale bank funding spread (Cooperman et al. 2025). Following Burnside & Cerrato (2023), we also collect 5-year credit default swap (CDS) spreads from Bloomberg for 12 representative banks across the two markets. Appendix A provides details on these 12 banks. Our study uses monthly data unless specified otherwise.

Following the literature on credit line pricing (Berg et al. 2016, 2017), we use *All-in Spread Drawn* (AISD) as a core component of borrowing cost, while acknowledging and controlling for undrawn fees as a separated dependent variable or comprehensive usage-weighted spreads in different drawdown assumptions[4]. AISD is the spread over the benchmark interest rate (LIBOR in our case) plus the facility fee. It reflects the borrower's cost of drawing down the credit line. We collect information on loan size, maturity, loan purpose, and the number of lenders from DealScan to capture facility characteristics in the US loan

[1] In DealScan, we use the variable *Country*, which describes borrowers' home countries, to define US loans. Figure OA2.1 in Online Appendix OA2 shows that European banks mainly lend to European firms and US banks mainly lend to US firms.

[2] In DealScan, we use a variable *Tranche O/A* to identify newly originated facilities, that is, *Tranche O/A* = *Origination*.

[3] To save space, we report results using 6-month and 12-month LIBOR; results using 3-month LIBOR are similar and available upon request.

[4] See Online Appendices.

markets. These variables are widely used in the literature on US and European loan markets (see Carey & Nini 2007; Berg et al. 2016; Berg et al. 2017; Ma et al. 2024).

Table 1 presents summary statistics for our primary variables. Panel A reports 6-month and 12-month LIBOR–OIS spreads. Over our sample period, funding costs average approximately 33 basis points (6-month) and 48 basis points (12-month). We also utilize banks' CDS spreads as an alternative measure of funding costs (see Burnside & Cerrato 2023), which average 65 basis points over the same period. Burnside & Cerrato (2023) interpret this measure as a proxy for dealers' funding costs—specifically a funding-value-adjustment (FVA) component—as distinct from broader market-wide spreads.

Panels B and C report summary statistics for loan- and bank-level variables, respectively. Within the US sample, the average *All-in Spread Drawn* (AISD) is 301 basis points. Crucially, we observe a significant pricing wedge between facility types: Credit Line (revolver) pricing averages 245 basis points, while Term Loan pricing is substantially higher at 356 basis points. This gap primarily reflects differences in borrower composition Berg et al. (2017); our identification strategy focuses on the within-borrower, within-bank variation around policy shocks to isolate the funding-risk component. The average *All-in Spread Undrawn* (AISU) for the sample is 26.5 basis points. Revolvers constitute approximately 49% of the US facilities in our sample, and the average loan maturity is 4.8 years.

Panel C highlights bank-level heterogeneity essential for our identification. High-exposure banks, characterized by their treasury-to-asset ratios, hold an average of 3.4% of their balance sheets in treasury assets. The sample BHCs are well-capitalized with a mean leverage ratio of 89% and a deposit-to-asset ratio of 41%. Overall, these characteristics are consistent with the US corporate lending benchmarks reported in Berg et al. (2017).

Panel D introduces borrower-level characteristics that are critical for controlling for credit risk. Borrowers in our sample exhibit a mean leverage ratio of 68% and an Altman's Z-Score of 2.15, suggesting the average borrower is of speculative-grade quality. They are also large firms, with a mean ln(Total Assets) of 8.88, and maintain a return on assets (Net Income/TA) of 1.0%. Explicitly accounting for these borrower-specific metrics allows us to isolate the effect of bank-side funding shocks from changes in borrower creditworthiness, ensuring our results are driven by the supply-side transmission mechanism.

Table 1. **Summary Statistics**

This table presents summary statistics for the variables used in our analysis. Panel A describes market-wide funding costs and credit risk. Panel B reports loan-level characteristics from DealScan. Panel C details bank-level balance sheet exposures and policy controls. Panel D provides summary statistics for borrower-specific characteristics including leverage, profitability, and credit risk (Altman's Z-Score). All continuous variables are winsorized at the 1% and 99% levels. Variable definitions are provided in Appendix A.

Variable	N	Mean	Std. Dev.	Min	0.25	Median	0.75	Max
Panel A: Bank Funding Cost and Market Risk								
LIBOR-OIS 6M (bps)	104,297	33.231	18.504	6.773	22.367	29.050	44.110	101.000
LIBOR-OIS 12M (bps)	104,297	47.794	21.362	13.553	37.656	46.650	59.800	99.218
CDS Index 5Y (bps)	104,297	64.756	19.386	36.198	46.618	61.453	79.652	115.142
Panel B: Loan Characteristics								
All In Spread Drawn (bps)	87,084	301.119	184.547	30.000	150.000	250.000	410.000	1,075.000
Credit Line Price (bps)	42,889	244.870	147.861	17.500	125.000	200.000	325.000	880.000
Term Loan Price (bps)	44,195	355.713	199.792	50.000	200.000	325.000	475.000	1,155.000
All In Spread Undrawn (bps)	29,842	26.506	19.498	1.750	12.500	25.000	37.500	225.000
Revolver (dummy)	87,084	0.493	0.500	0.000	0.000	0.000	1.000	1.000
Panel C: Bank and Policy Characteristics								
Treasury Assets / Total Assets	48,950	0.034	0.027	0.000	0.013	0.027	0.049	0.124
Deposits / Total Assets	48,950	0.409	0.136	0.082	0.322	0.446	0.501	0.811
ln(Bank Total Assets)	48,950	19.985	1.548	15.458	18.793	20.067	21.389	22.090
Bank Leverage	48,950	0.891	0.021	0.799	0.880	0.892	0.905	0.933
Loans / Total Assets	48,950	0.487	0.168	0.098	0.357	0.515	0.635	0.878
ln(Gov. Support Index)	40,721	3.860	0.393	1.651	3.666	3.933	4.127	4.226
Panel D: Borrower Characteristics								
Borrower Leverage (TL/TA)	23,765	0.679	0.287	0.042	0.543	0.650	0.807	4.770
Net Income / Total Assets	23,765	0.010	0.053	-0.485	0.001	0.010	0.021	0.734
ln(Borrower Total Assets)	23,765	8.876	1.810	0.316	7.646	8.881	10.086	14.702
Altman's Z-Score	21,658	2.150	3.518	-51.754	0.899	1.605	2.637	30.690

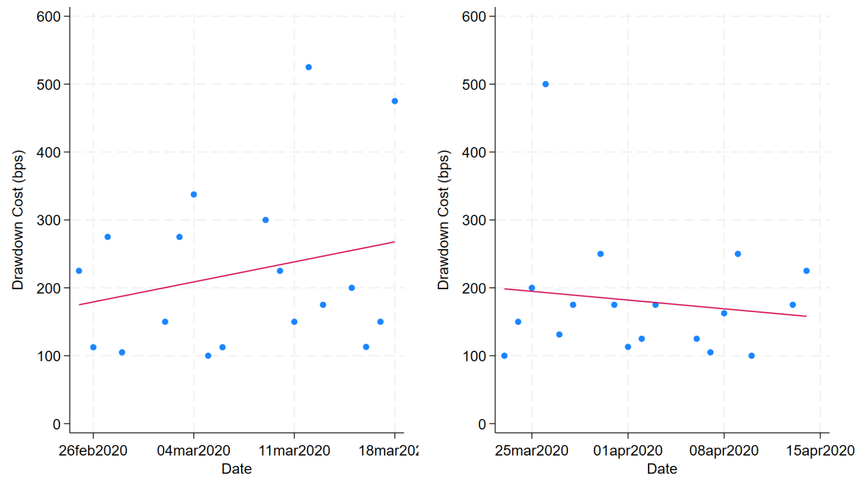
2.2 Preliminary Statistics

Figure 1a presents the average price of credit lines in the US before and after the Fed implemented the Asset Purchase Program (APP). We choose March 20 as the cutoff date because the Fed began APP on March 23, 2020. There is a noticeable change in slope following the implementation of APP, suggesting that credit lines became cheaper.

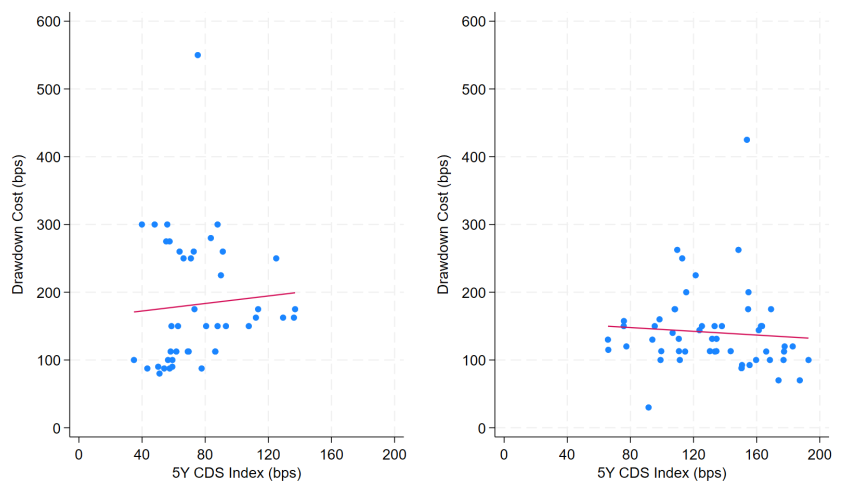
In Figure 1b, we estimate the relationship between credit line prices and funding costs before and after the Fed implemented APP. We use the average CDS spread of the largest 12 US and European banks as an alternative measure of funding costs.[5] Results are broadly consistent when using the LIBOR–OIS spread. This analysis uses daily data. We again see a change in slope following the implementation of APP.

[5]The 12 banks include JP Morgan, Morgan Stanley, Wells Fargo, Citi, BofA, Goldman Sachs, BNP Paribas, Societe Generale, Barclays, NatWest, Credit Agricole, and Banco Santander.

In Figure OA8.1 in Online Appendix OA8, we estimate the same relationship, but we now match credit line prices to the CDS spreads of the lead bank, which restricts the sample. The slope of the fitted line declines after the Fed implemented APP. Figure OA8.2 shows a similar pattern for March 2020. This preliminary graphical evidence suggests that the Fed affected credit line pricing through banks' funding costs. We study this mechanism empirically in the next sections.



(a). Drawdown Price over Time



(b). Drawdown Price vs. CDS Spreads

Figure 1. Loan Pricing Dynamics and Credit Risk (US Market). This figure analyzes the daily average drawdown price (*All-In Spread Drawn*) in the US market one month before and after the Fed's QE announcement. **Panel A** plots daily prices over time (blue spots) with a fitted trend (red line). **Panel B** plots the drawdown price against average 5-year CDS spreads to illustrate the relationship between loan pricing and market-implied credit risk. In both panels, the left subplots represent the pre-QE period and the right subplots represent the post-QE period.

Cooperman et al. (2025) show theoretically that credit line prices are driven by the covariance between credit line drawdowns and banks' funding costs. In their framework, this covariance reflects the fact that credit-line drawdowns occur precisely when intermediary funding conditions deteriorate. Empirically, we proxy for intermediary funding stress using banks' CDS spreads and, alternatively, the LIBOR–OIS spread.

Did the Fed reduce funding costs through APP? Although the answer seems intuitive, given prior studies on QE programs (Krishnamurthy & Vissing-Jorgensen 2011), much of that literature focuses on reductions in term premia rather than wholesale funding rates. We therefore plot banks' funding costs over our full sample period. Figure 2a shows funding spreads at 6-month and 1-year maturities (following Cooperman et al. 2025, we use 6-month and 12-month LIBOR–OIS spreads). We see that around the time the WHO declared the COVID-19 outbreak (March 2020), 6-month LIBOR–OIS spreads (solid blue line) peaked at 100 basis points, while 12-month spreads (dashed red line) approached 90 basis points. Spreads dropped quickly after central banks' APP.[6]

To shed further light on the dynamics of LIBOR and OIS rates around APP, we also plot the underlying 6-month (and 12-month) LIBOR and the corresponding OIS rates. Figure 2b shows the 6-month LIBOR (solid blue line) and the OIS rate (dashed red line). We observe a sharp decline in the OIS rate, which is consistent with investors moving into safe assets such as Treasury bills (He et al. 2022).

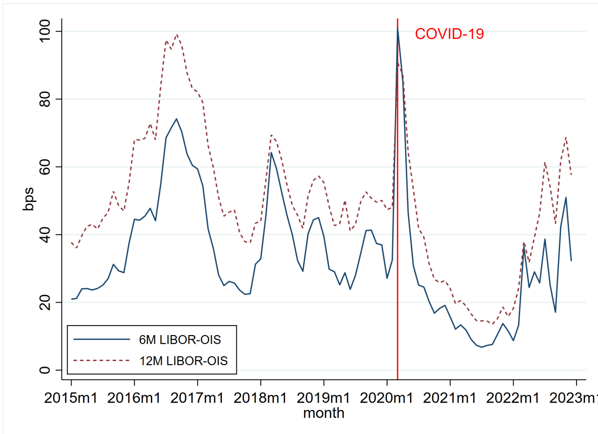
We complement these results by using CDS spreads as an alternative measure of banks' funding costs. Specifically, we use the 5-year CDS spreads of large US and European banks. These data are collected from Bloomberg for 12 primary US and European dealers.[7] Figure 2c plots CDS spreads over the sample period. Similar to Figure 2a, we observe a peak in March 2020, followed by a sharp decline. This evidence supports the conjecture that the Fed's APP reduced banks' funding costs; in this sense, our results complement prior work that studies QE primarily as a monetary policy tool.

2.3 Event Study

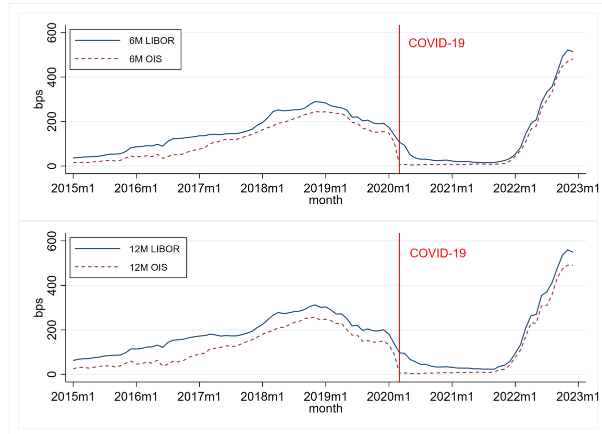
To reinforce the evidence in the previous section, we design a high-frequency event study using the CDS spreads of the banks listed in Appendix A as a measure of banks' funding costs (Burnside & Cerrato 2023, Cerrato & Mei 2024). We consider a narrow window around the Federal Reserve's APP announcements (March 17 to March 26) to mitigate concerns regarding confounding factors. We utilize hourly bank CDS

[6]According to Federal Reserve (2020, Mar 23), Fed announced a large Asset Purchase Program to support financial markets, starting on March 23, 2020.

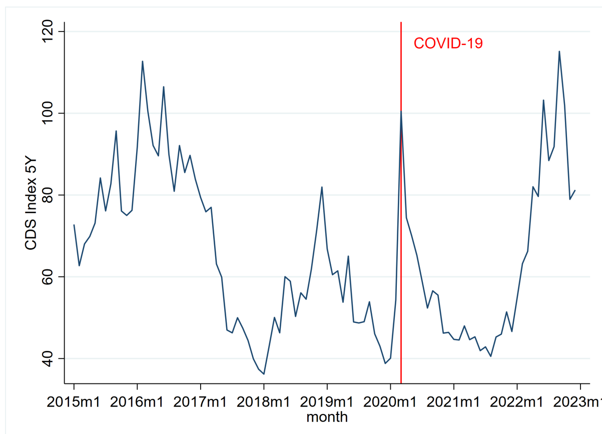
[7]These 12 banks include JP Morgan, Morgan Stanley, Wells Fargo, Citi, Bank of America, Goldman Sachs, BNP Paribas, Société Générale, Barclays, NatWest, Crédit Agricole, and Banco Santander.



(a). LIBOR-OIS Spreads



(b). LIBOR and OIS Levels



(c). 5-Year Bank CDS Index

Figure 2. Financial Market Indicators around the COVID-19 Pandemic. This figure plots monthly market indicators centered on the COVID-19 liquidity shock. **Panel A** displays the 6-month (blue solid) and 12-month (red dashed) LIBOR-OIS spreads. **Panel B** shows the individual levels of LIBOR and OIS rates for 6-month and 12-month maturities. **Panel C** plots the average 5-year CDS index for 12 representative banks. In all panels, the vertical red solid line denotes the WHO's announcement of the COVID-19 pandemic in March 2020.

data from Bloomberg.[8]

Figure 3 presents the intraday CDS index scatter plot and fitted lines for this window. Consistent with our primary findings, US banks' funding costs spiked during the initial COVID-19 shock but reversed sharply following the Federal Reserve's intervention. Specifically, the slope coefficient before the March 23 announcement is 13.34 basis points (with a t-statistic of 11.40). Following the QE announcement, the slope coefficient shifts significantly to -23.30 basis points (with a t-statistic of -17.77), indicating a rapid stabilization of bank funding markets.

[8] The Federal Reserve announced a significant policy rate cut and massive quantitative easing measures on March 23, 2020 (Federal Reserve 2020, Mar 16).

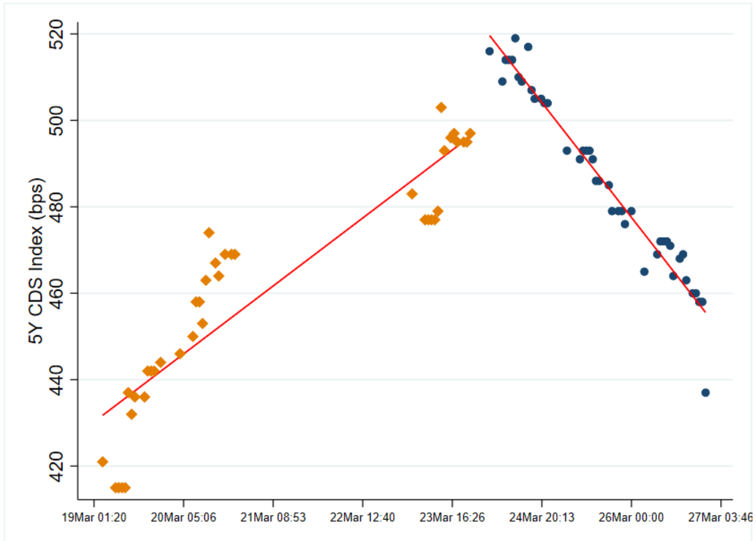


Figure 3. Intraday CDS Index: US Market. This figure plots the intraday 5-year CDS index for US banks in a narrow window surrounding the Federal Reserve's QE announcement in March 2020. The yellow diamond markers represent the CDS spreads prior to the central bank intervention on March 23. The blue circle markers represent the CDS spreads following the intervention. The red solid lines represent the fitted trend lines for each sub-period.

2.4 Funding Cost Mitigation

In this section, we examine whether central bank APP was associated with lower banks' funding costs. Using daily data, we regress changes in LIBOR–OIS (and CDS) spreads on an indicator equal to one in APP periods (March 2020 and May 2020). Equation 1 presents the specification.

$$\Delta LIBOR\text{–}OIS_t = \alpha_0 + \alpha_1 CB_t + \varepsilon_t \tag{1}$$

where $Spread_t$ denotes different measures of banks' funding costs, including 6-month LIBOR–OIS spreads, 12-month LIBOR–OIS spreads, and the CDS index at time t.[9] CB_t is a dummy equal to one for the period after central banks' APP.

Table 2 reports the results. The negative and statistically significant coefficients in columns (1) and (2) suggest that central bank intervention reduced funding costs. For example, the estimated coefficient implies a 13-basis-point decline in the 6-month LIBOR–OIS spread and a 20-basis-point decrease in the 12-month LIBOR–OIS spread. Overall, these results are consistent with the view that banks' funding costs were lower following QE.

[9]The CDS index is the monthly average of 12 representative banks' 5-year CDS spreads.

We also proxy funding costs using CDS spreads and estimate the analogous specification:

$$\Delta CDS\ Index_t \quad = \quad \alpha_0 + \alpha_1 CB_t + \varepsilon_t \tag{2}$$

The results are reported in column (3) of Table 2. Consistent with the LIBOR–OIS results, QE appears to lower funding costs.

Table 2. **Funding Costs and Central banks' QE**

This table estimates banks' funding costs at the start of QE. The dependent variables are changes in 6-month LIBOR-OIS spread (column (1)), 12-month LIBOR-OIS spread (column (2)), and 5-year CDS Index (column (3)) representing banks' funding costs. The independent variable is a dummy equal to one after the central banks' asset purchases in March 2020. Standard errors are in parentheses. *, **, and *** represent significance at the 10%, 5%, and 1% level, respectively. Variable definitions can be found in Appendix A.

	ΔLIBOR-OIS 6M	ΔLIBOR-OIS 12M	ΔCDS Index 5Y
	(1)	(2)	(3)
CB	-1.896**	-1.591*	-2.070**
	(0.909)	(0.883)	(0.905)
Constant	1.318*	1.246*	1.519**
	(0.722)	(0.702)	(0.720)
Observations	125	125	125
R^2	0.034	0.026	0.041

3 Balance Sheet Heterogeneity and Loan Pricing

3.1 Main Design

To isolate the impact of bank funding costs on credit pricing, we exploit the Federal Reserve's March 2020 Asset Purchase Program (APP) as a laboratory for exogenous liquidity provision. Our empirical strategy is motivated by the theoretical friction emphasized by Cooperman et al. (2025): credit lines, unlike term loans, involve stochastic drawdowns that co-vary positively with a lender's cost of funds. Because term loans involve fixed disbursements, they are sensitive only to the marginal cost of capital, whereas credit lines carry an additional 'covariance risk' premium. If this mechanism is operative, the funding-cost relief provided by the APP should disproportionately reduce the relative price of credit lines versus term loans, with the effect being most pronounced for banks whose balance-sheet structures make them highly sensitive to the shock. We examine this prediction using a triple-difference (DDD) specification across a sample of 146 US bank holding companies (BHCs) with assets exceeding $10,bn, interacting the post-APP period with a credit-line indicator and a bank-level measure of APP exposure. In addition, we control for fiscal-policy interventions using the Oxford COVID-19 Government Response Tracker (OxCGRT) Government Support Index. Therefore, we capture this mechanism using a triple-difference specification that directly tests this prediction by interacting (i) the post-APP period, (ii) a credit-line indicator, and (iii) bank-level APP exposure.

Our triple-differences (DDD) specification exploits the timing of the Federal Reserve's APP, cross-sectional variation in loan contract types, and ex-ante heterogeneity in lender exposure. Specifically, we estimate the following fully saturated model:

$$AISD_{i,j} = \beta_1(QE_i \times Revolver_i \times Exposure_j) + \Gamma'\mathbf{W}_{i,j} + \gamma'\mathbf{Z}_j + \mu_b + \theta_{ind} + \eta_i + \varepsilon_{i,j} \tag{3}$$

where i and j index loan facilities and lenders, respectively. The dependent variable, $AISD_{i,j}$, is the all-in spread drawn (in basis points). QE_i is an indicator for facilities originated after the March 2020 announcement. $Revolver_i$ is a dummy variable equal to one for revolving credit facilities and zero for term loans. $Exposure_j$ is a time-invariant lender characteristic measuring ex-ante QE exposure, defined as either high Treasury-to-assets (Columns 1–2) or low deposit-to-assets (Columns 3–4) in Table 3. Banks holding more APP-eligible securities (e.g., Treasuries) experience larger valuation and funding relief from APP, leading to a larger reduction in the expected equity cost of drawdowns. We also use deposit shares as an alternative exposure measure to proxy for funding-structure sensitivity.

The vector $\mathbf{W}_{i,j}$ contains the full set of saturated interactions (all double interactions and main effects) required for DDD identification. $\mathbf{Z}_j$ is a vector of lender-level controls including log(*Total Assets*), *Bank Leverage*, *Loan/Assets*, and log(*Govt Support Index*). In particular, *Bank Leverage* is measured by $1 - Total\ Equity/Total\ Assets$, and *Govt Support Index* is the Oxford Government Support Index (OxCGRT) which tracks the intensity of government policy responses to the COVID-19 pandemic (Hale et al. 2021). To account for unobserved heterogeneity, we include fixed effects for the borrower (μ_b), two-digit SIC industry (θ_{ind}), and loan purpose (η_i). The coefficient of interest is β_1, which captures the differential effect of the QE shock on revolver pricing for highly exposed lenders relative to the control groups.

Did APP reduce the relative pricing of contingent credit at banks more exposed to APP relief? We focus on the results in Table 3. The triple-interaction coefficient reflects how APP exposure relates to the relative pricing of credit lines versus term loans. Because only credit lines embed covariance between funding costs and drawdowns, this differential effect isolates the debt-overhang wedge predicted by the model. The negative and economically large estimates (14–51) are consistent with the view that APP weakened the funding-cost covariance channel rather than merely lowering banks' overall funding rates. This pattern is consistent with our model, in which the pricing wedge is proportional to the expected wealth loss borne by bank shareholders when funding costs spike. A 10% increase in exposure lowers the price of a credit line by 1–5 basis points, which is economically meaningful. For example, given a mean AISD of about 301 basis points, a 5-basis-point reduction implies that the price of credit lines is lower by $(5/301)\times 100 \approx 2\%$.

In Online Appendix OA3, Tables OA3.1 and OA3.2 further support the mechanism by showing that the DDD pricing effect is stronger among banks with higher CDS spreads and among banks more reliant on deposit funding structures associated with greater funding risk. The effect of QE on credit line pricing also varies across policy episodes: it is strongest in periods of acute funding stress or market dysfunction (QE1, COVID) and absent when markets are functioning normally (QE3). This pattern is consistent with the wedge mechanism in this paper, which predicts that the pricing wedge depends on the covariance between funding costs and drawdowns.

To explore how bank leverage conditions the transmission of monetary policy, we split our sample into high- and low-leverage intermediaries based on the pre-shock median total liability-to-asset ratio. By doing so, we re-estimate our triple-difference design in Table 3 within these distinct subsamples. The results are presented in Table 4.

The estimates in Table 4 suggest that the pricing compression of corporate liquidity insurance heavily varies with the *ex-ante* fragility of the balance sheet constraint. When we define policy exposure as asset-side Treasury holdings (Columns (1) and (2)), the coefficients of main DDD term ($QE \times Revolver \times Exposure$) are negative and significant in two subsamples. For highly leveraged banks (Column (1)), central bank intervention is followed by a drop of 27 basis points in the price of a credit line at the 5 per cent significance level. However, lowly leveraged banks (Column (2)) merely have a drop of 21 basis points at the 10 per cent level. This asymmetry suggests that although asset-side balance sheet relief from central banks operates systematically, capital-constrained lenders (with higher leverage) experience a larger reduction than others.

When we move to the liability side, there is more robust evidence for our capacity premise. In Columns (3) and (4) of Table 4, we find that for highly leveraged lenders (Column (3)), the triple-difference coefficient is -27 basis points and is significant at 5 per cent level. This result is very similar to the one in Column (1) where we use Treasury holdings as policy exposure. By contrast, well-capitalized lenders (Column (4))

Table 3. **Difference-in-Difference-in-Difference Analysis**

This table reports estimates from a difference-in-difference-in-difference (DDD) specification. The sample covers a two-year window spanning one year before and one year after March 2020. The dependent variable is *All-In Spread Drawn (AISD)* in Columns (1) through (4). The key explanatory variables include a post-APP dummy equal to one after the central bank's quantitative easing (QE) announcement in March 2020 and zero otherwise, and a credit-line indicator equal to one for revolving credit facilities and zero for term loans. QE exposure is captured by time-invariant bank-level dummies constructed using pre-shock balance-sheet data. Specifically, banks are classified as highly exposed if their Treasury-to-asset ratio (Columns (1)–(2)) is above the pre-shock median, while the deposit-based exposure dummy (Columns (3)–(4)) equals one for banks with interest-bearing deposits below the pre-shock median. Control variables include the logarithm of bank total assets, loan facilities scaled by total assets, and the logarithm of the Oxford Government Support Index. All specifications include borrower, two-digit SIC industry, and loan-purpose fixed effects. The analysis is cross-sectional. Standard errors are reported in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. All variables are winsorized at the 1% and 99% levels. Variable definitions are provided in Appendix A.

Exposure Type	Treasury / Assets		Deposit / Assets	
	(1)	(2)	(3)	(4)
Main DDD Term				
QE × Revolver × Exposure	**-51.490***	**-27.094*****	**-17.781**	**-14.639**
	(28.951)	**(10.455)**	**(37.252)**	**(13.369)**
Lower-Order Terms & Interactions				
QE × Revolver	7.310	-11.049	-19.676	-19.793
	(26.637)	(9.629)	(35.610)	(12.874)
QE × Exposure	86.858***	20.722**	31.279	1.347
	(21.241)	(8.557)	(27.086)	(10.831)
Revolver × Exposure	1.222	3.805	-44.860	-6.964
	(25.839)	(9.290)	(33.664)	(12.060)
QE	36.888*	96.332***	82.187***	113.138***
	(21.040)	(12.903)	(26.890)	(14.580)
Revolver	-67.780***	-10.835	-26.555	-1.472
	(23.863)	(8.576)	(32.277)	(11.654)
QE Exposure	-73.612***	-7.443	-9.881	11.279
	(19.710)	(7.779)	(24.946)	(9.856)
Bank Controls				
log(Total Assets)	-11.742***	0.935	-13.624***	0.574
	(2.296)	(0.927)	(2.198)	(0.895)
Bank Leverage	-526.739***	18.239	-409.631**	25.577
	(169.123)	(66.279)	(161.673)	(63.630)
Loan / Total Assets	-114.643***	3.951	-99.178***	4.623
	(21.354)	(8.595)	(20.527)	(8.335)
Macro Controls				
log(Govt Support Index)	-21.851***	-18.571*	-22.481***	-18.146*
	(5.828)	(9.929)	(5.843)	(9.941)
Borrower FE	No	Yes	No	Yes
Industry & Purpose FE	No	Yes	No	Yes
Observations	4,378	4,282	4,378	4,282
Adjusted R^2	0.149	0.899	0.145	0.899

have merely 3 basis points (around 11 per cent of the one in Column (3)) drop in credit line pricing after asset purchase. Moreover, the coefficient lacks any statistical significance. This sharp divergence points to an important cross-sectional result: deposit-based exposure captures a different dimension of intermediary fragility, namely, reliance on non-deposit or wholesale funding sources that become particularly costly during systemic stress episodes.

Taken together, Table 4 suggests a distinction between two related channels. Treasury exposure appears to capture the direct balance-sheet relief associated with APP interventions, whereas deposit-based exposure may better proxy for the sensitivity of intermediary funding structures to leverage and rollover risk. In the later mechanism model section (Section 5), both mechanisms operate through the same state-contingent funding-cost wedge, but they act on different components of the intermediary's marginal balance-sheet constraint.

In a nutshell, we view the findings in Tables 3 and 4 as suggestive rather than definitive. The two exposure measures are imperfect proxies for intermediary constraints and may capture overlapping dimensions of balance-sheet heterogeneity. Nevertheless, the consistency in sign across specifications, together with the differential amplification patterns in both tables, supports the interpretation that asset purchase affected contingent credit pricing through intermediary balance-sheet capacity rather than through broad loan-market repricing alone.

3.2 Placebo and Falsification Tests

In this section, we conduct placebo tests to assess whether our main results are not driven by idiosyncratic trends or unobserved lender-specific shocks unrelated to the COVID-19 pandemic. We use the triple-differences (DDD) specification defined in Equation (3).

First, we re-estimate the model using the APP in September 2012. This is the third round of Quantitative Easing (QE3). While QE1 and QE2 are also significant, the availability of detailed Bank Holding Company (BHC) balance sheet information in the FR Y-9C filings is limited prior to 2012. Thus, QE3 provides the most reliable historical window for testing the mechanism highlighted in our paper. As shown in Table 5, the coefficient on the triple interaction $QE \times Revolver \times Exposure$ is statistically insignificant across all columns. This suggests that the relative pricing of credit lines versus term loans at more exposed banks remained stable during QE3. This absence of an effect is consistent with the model's mechanism. The wedge mechanism depends on the covariance between funding costs and drawdowns, which was not elevated during

Table 4. **Intermediary Leverage and Asset Purchases**

This table reports estimates from a difference-in-difference-in-difference (DDD) specification in Table 3, conditional on intermediary leverage. The sample covers a two-year symmetric window around the March 2020 COVID-19 shock. The dependent variable is *All-In Spread Drawn (AISD)* in basis points. The sample is split into high-leverage banks (Columns (1) and (3)) and low-leverage banks (Columns (2) and (4)) based on the pre-shock median lender liabilities-to-asset ratio. Intermediary exposure is measured using two metrics: Treasury Asset Exposure (Columns (1)–(2)), where highly exposed banks have a pre-shock Treasury-to-asset ratio above the median; and Deposit Dependence Exposure (Columns (3)–(4)), where the exposure dummy equals one for banks with pre-shock interest-bearing deposit ratios below the median. Control variables include the logarithm of bank assets, loan-to-asset ratios, and the logarithm of the Oxford Government Support Index. All specifications include borrower, two-digit SIC industry, and loan-purpose fixed effects. The analysis is cross-sectional. Standard errors are reported in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. All variables are winsorized at the 1% and 99% levels. Variable definitions are provided in Appendix A.

Exposure Type	Treasury / Assets		Deposit / Assets	
Bank Leverage Subsample	High Leverage	Low Leverage	High Leverage	Low Leverage
	(1)	(2)	(3)	(4)
Main DDD Term				
QE × Revolver × Exposure	**-27.163****	**-20.603***	**-27.089****	**-2.836**
	(13.233)	**(12.418)**	**(10.749)**	**(17.323)**
Lower-Order Terms & Interactions				
QE × Revolver	-17.048*	-2.295	-15.033**	-14.008
	(9.467)	(13.493)	(6.485)	(19.265)
QE × Exposure	14.222	24.662	19.036***	-19.218
	(11.276)	(16.104)	(6.736)	(16.232)
Revolver × Exposure	1.071	4.898	-6.202	-3.456
	(10.316)	(10.399)	(6.786)	(14.803)
QE	114.483**	53.913	108.291*	94.351**
	(56.161)	(38.304)	(55.851)	(37.505)
Revolver	-6.181	-14.397	0.493	-8.062
	(7.276)	(12.484)	(3.453)	(17.284)
QE Exposure	0.893	-14.766	1.759	21.702
	(9.845)	(15.577)	(4.368)	(16.422)
Bank Controls				
log(Total Assets)	0.646**	1.702*	0.614*	1.260
	(0.316)	(0.986)	(0.357)	(1.305)
Loan / Total Assets	1.761	34.774*	1.304	40.591*
	(2.547)	(18.311)	(2.666)	(21.922)
Macro Controls				
log(Govt Support Index)	-23.558	1.801	-23.364	0.820
	(31.174)	(44.440)	(31.148)	(44.813)
Borrower FE	Yes	Yes	Yes	Yes
Industry & Purpose FE	Yes	Yes	Yes	Yes
Observations	3,185	953	3,185	953
Adjusted R^2	0.892	0.877	0.892	0.876

the QE3 period. Therefore, QE3 should not materially affect the pricing wedge embedded in contingent credit, and our empirical results align with this prediction. These results suggest that the pricing effects in Table 3 are not a general feature of monetary easing (i.e. QE effects), but are specific to episodes in which QE alleviates funding stress that is directly relevant for the covariance channel. The absence of pricing effects in QE3 is consistent with Online Appendix OA1, which shows that Asset Purchase Programs conducted during periods of normally functioning markets do not generate large changes in funding stress conditions. Because the covariance-based wedge depends on funding stress, QE3 would not be expected to materially alter credit line pricing, and the empirical results align with this prediction.

Second, we conduct a falsification test by assigning a "pseudo-QE" date to June 2017, a period characterized by relative monetary policy stability and no major unconventional interventions. The results, reported in Table 6, reveal no significant effect for our key explanatory variable. The absence of a significant triple-interaction coefficient in this period alleviates concerns that our baseline findings might be artefacts of persistent differences in lender characteristics or secular trends in the pricing of revolving credit facilities relative to term loans. Collectively, these tests are consistent with the view that the credit-line pricing behavior documented in our main analysis is related to the specific APP measures implemented in March 2020.

3.3 Event Study

To support our identification strategy and trace the evolution of the treatment effect over time, we implement a series of event studies. We focus on the COVID-19 shock. To explicitly assess parallel trends, we estimate a monthly (and quarterly) dynamic triple-differences (DDD) model centered on the March 2020 shock. The specification is as follows:

$$AISD_{i,j,t} = \sum_{k=-12,k\neq-1}^{12} \beta_k(\mathbb{1}\{t=k\} \times Exposure_j \times Revolver_i) + \alpha_j + \gamma_t + \delta_i + \varepsilon_{i,j,t} \tag{4}$$

where i indexes loan facilities, b indexes banks, and t represents event time in months relative to March 2020 ($t = 0$). The key explanatory term is the interaction between an event-month (quarter) indicator ($\mathbb{1}\{t=k\}$), a pre-determined lender exposure dummy, and a revolver indicator. Exposure is defined as a binary indicator for banks with above-median pre-shock Treasury-to-asset or deposit-to-asset ratios. We utilize a symmetric window of 12 months before and after the event, omitting the month $t = -1$ to serve as the reference period.

Table 5. **Difference-in-Difference-in-Difference Analysis (QE3)**

This table reports estimates from a difference-in-difference-in-difference (DDD) specification. The sample covers a two-year window spanning one year before and one year after September 2012. The dependent variable is *All-In Spread Drawn (AISD)* in Columns (1) through (4). The key explanatory variables include a post-APP dummy equal to one after the central bank's quantitative easing (QE) announcement in September 2012 and zero otherwise, and a credit-line indicator equal to one for revolving credit facilities and zero for term loans. QE exposure is captured by time-invariant bank-level dummies constructed using pre-shock balance-sheet data. Specifically, banks are classified as highly exposed if their Treasury-to-asset ratio (Columns (1)–(2)) is above the pre-shock median, and zero otherwise, while the deposit-based exposure dummy (Columns (3)–(4)) equals one for banks with interest-bearing deposits below the pre-shock median. Control variables include the logarithm of bank total assets, loan facilities scaled by total assets, and the logarithm of the Oxford Government Support Index. All specifications include borrower, two-digit SIC industry, and loan-purpose fixed effects. The analysis is cross-sectional. Standard errors are reported in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. All variables are winsorized at the 1% and 99% levels. Variable definitions are provided in Appendix A.

Exposure Type	Treasury / Assets		Deposit / Assets	
	(1)	(2)	(3)	(4)
Main DDD Term				
QE × Revolver × Exposure	**16.470**	**0.099**	**-8.632**	**-13.946**
	(10.425)	**(4.972)**	**(19.936)**	**(9.513)**
Lower-Order Terms & Interactions				
QE × Revolver	4.913	-9.724***	19.317	3.216
	(6.658)	(3.552)	(19.216)	(9.206)
QE × Exposure	-2.770	0.131	33.365**	10.162
	(8.005)	(4.023)	(15.131)	(7.672)
Revolver × Exposure	-25.754***	-5.973*	-52.553***	-9.908
	(7.265)	(3.482)	(13.615)	(6.489)
QE	6.776	-4.661	-25.412*	-13.962*
	(5.193)	(3.869)	(14.565)	(7.892)
Revolver	-112.936***	-33.740***	-74.588***	-27.142***
	(4.607)	(2.529)	(13.101)	(6.273)
QE Exposure	27.466***	4.764	6.799	5.969
	(5.826)	(2.923)	(10.861)	(5.415)
Bank Controls				
log(Total Assets)	-7.359***	0.645	-6.739***	0.610
	(0.992)	(0.536)	(1.043)	(0.558)
Bank Leverage	-124.665	-12.639	-161.644*	-9.738
	(96.344)	(49.616)	(95.912)	(49.398)
Loan / Total Assets	-43.787***	-8.446*	-53.919***	-8.258*
	(9.237)	(4.969)	(9.008)	(4.864)
Borrower FE	No	Yes	No	Yes
Industry & Purpose FE	No	Yes	No	Yes
Observations	14,031	13,749	14,031	13,749
Adjusted R^2	0.144	0.823	0.144	0.823

Table 6. **Difference-in-Difference-in-Difference Analysis (Falsification)**

This table reports estimates from a difference-in-difference-in-difference (DDD) specification. The sample covers a two-year window spanning one year before and one year after June 2017. The dependent variable is *All-In Spread Drawn (AISD)* in Columns (1) through (4). The key explanatory variables include a post-APP dummy equal to one after the central bank's pseudo-QE date in June 2017 and zero otherwise, and a credit-line indicator equal to one for revolving credit facilities and zero for term loans. QE exposure is captured by time-invariant bank-level dummies constructed using pre-shock balance-sheet data. Specifically, banks are classified as highly exposed if their Treasury-to-asset ratio (Columns (1)–(2)) is above the pre-shock median, and zero otherwise, while the deposit-based exposure dummy (Columns (3)–(4)) equals one for banks with interest-bearing deposits below the pre-shock median. Control variables include the logarithm of bank total assets, loan facilities scaled by total assets, and the logarithm of the Oxford Government Support Index. All specifications include borrower, two-digit SIC industry, and loan-purpose fixed effects. The analysis is cross-sectional. Standard errors are reported in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. All variables are winsorized at the 1% and 99% levels. Variable definitions are provided in Appendix A.

Exposure Type	Treasury / Assets		Deposit / Assets	
	(1)	(2)	(3)	(4)
Main DDD Term (Falsification)				
Pseudo-QE × Rev × Exp	**11.965**	**7.275**	**-15.951**	**-15.074**
	(13.620)	**(7.242)**	**(19.372)**	**(10.271)**
Lower-Order Terms & Interactions				
Pseudo-QE × Revolver	-16.417	-14.428**	7.497	4.303
	(11.804)	(6.418)	(18.353)	(9.777)
Pseudo-QE × Exposure	-8.494	-6.044	37.607***	7.247
	(9.547)	(5.524)	(13.903)	(8.152)
Revolver × Exposure	-13.634	-14.169***	-43.571***	-19.351***
	(9.380)	(4.989)	(13.022)	(6.996)
Pseudo-QE	-2.343	-0.933	-42.349***	-12.184
	(8.161)	(7.010)	(13.166)	(9.355)
Revolver	-76.710***	-37.403***	-48.675***	-30.642***
	(8.121)	(4.418)	(12.292)	(6.645)
QE Exposure	-17.073**	6.730*	-23.917**	12.759**
	(6.928)	(4.019)	(9.551)	(5.731)
Bank Controls				
log(Total Assets)	-12.745***	-0.191	-14.937***	-0.548
	(1.498)	(0.900)	(1.330)	(0.802)
Bank Leverage	-562.605***	-92.428	-470.044***	-78.997
	(104.517)	(62.192)	(101.429)	(60.851)
Loan / Total Assets	-130.454***	-20.899***	-148.682***	-20.689***
	(12.079)	(7.502)	(12.070)	(7.467)
Borrower FE	No	Yes	No	Yes
Industry & Purpose FE	No	Yes	No	Yes
Observations	10,834	10,650	10,834	10,650
Adjusted R^2	0.106	0.772	0.108	0.772

The model incorporates bank fixed effects (α_j), time fixed effects (γ_t), and facility-level fixed effects (δ_i) to control for unobserved heterogeneity.

The coefficients β_k trace the dynamic difference in drawn spreads between revolvers and term loans for high-exposure banks relative to the same differential for low-exposure banks. The results of our dynamic estimation provide visual and statistical confirmation of our identification strategy.

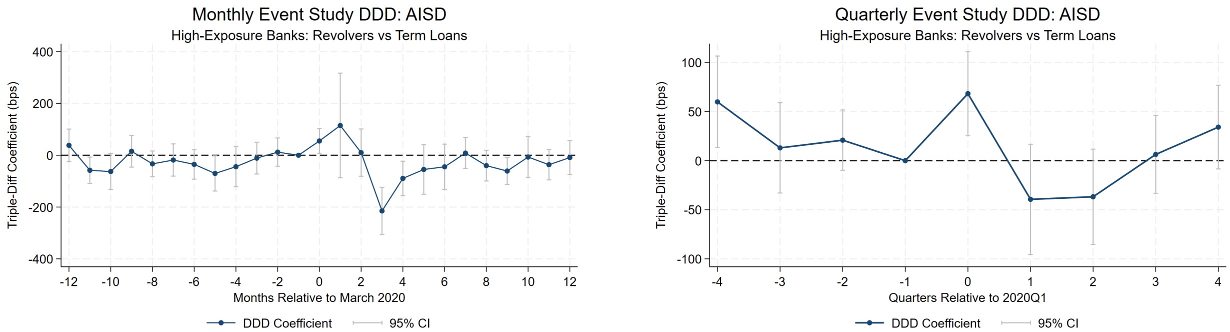
We first examine Figure 4a, which plots the monthly triple-difference coefficients (β_k) for the All-In-Spread-Drawn (AISD). The coefficients during the pre-announcement period ($k < 0$) are small in magnitude and statistically indistinguishable from zero. This flat pre-trend is noteworthy. The sharp decline in AISD for high-exposure banks beginning exactly at the APP period suggests that the pricing differential emerges with the policy shock, not before. This figure therefore supports the timing and dynamic structure of the DDD effect and shows that the Table 3 estimate is not driven by pre-existing trends.

Figure 4b replicates the DDD event study at quarterly frequency, reducing noise and making pre-trends easier to evaluate. The coefficients remain close to zero prior to the APP, reinforcing that exposure status is not proxying for persistent bank differences. The post-APP quarters show a sustained negative differential for high-exposure banks, consistent with a structural repricing of revolving credit lines. This figure provides a clean parallel-trends diagnostic and strengthens the credibility of the DDD estimates by confirming that the treatment effect appears discretely at the policy shock.

Figure 5a plots monthly AISD dynamics separately for high- and low-exposure banks. It provides a high-frequency view of the exposure-based pricing response. The similar pre-QE paths across exposure groups and divergence at QE support the assumption that exposure does not capture pre-existing pricing differences. This figure reinforces the exposure channel of the DDD results by showing that the pricing break aligns precisely with the asset purchases.

Finally, Figure 5b presents the same exposure-based event study as Figure 5a but aggregated quarterly. The smoothing clarifies that pre-QE trends are parallel and that the divergence emerges at the QE shock and persists thereafter. This pattern is consistent with the interpretation that QE was followed by a structural reduction in pricing for banks more exposed to funding-cost-sensitive assets. By supporting the exposure dimension of the design, Figure 5b strengthens the identifying assumption that the DDD results capture policy-driven heterogeneity rather than unobserved bank characteristics.

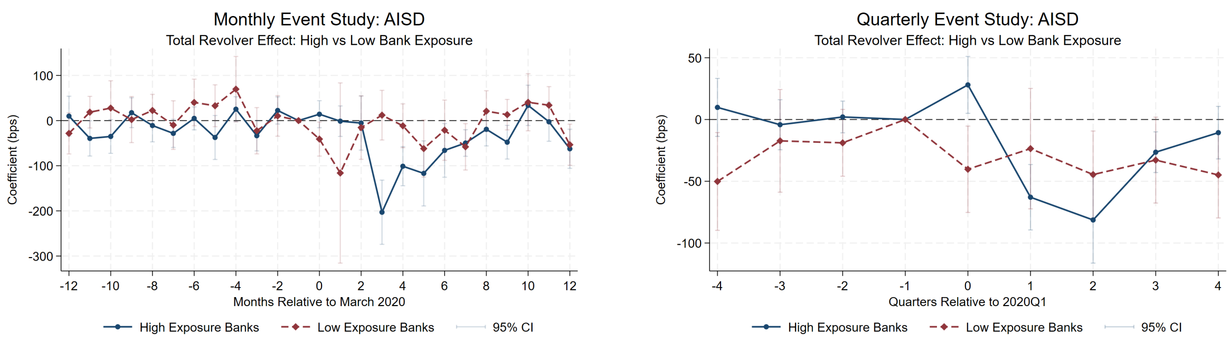
These dynamics in these event studies are reassuring for the identification and interpretation of the DDD results in Table 3 by demonstrating that the estimated treatment effect arises at the policy shock and is not driven by prior differences or trends.



(a). Monthly Frequency

(b). Quarterly Frequency

Figure 4. Event Study of Loan Pricing Dynamics around the March 2020 Shock. This figure plots the triple-difference (DDD) coefficients for the All-In-Spread-Drawn (AISD) at both monthly (Panel A) and quarterly (Panel B) frequencies, centered on the March 2020 liquidity shock ($t = 0$). The analysis estimates the incremental borrowing costs of revolvers relative to term loans for high-exposure banks (those with above-median pre-shock treasury-to-asset ratios). All coefficients are normalized relative to the period immediately preceding the shock ($t = -1$). Error bars represent 95% confidence intervals based on standard errors clustered at the lender level.



(a). Monthly Frequency

(b). Quarterly Frequency

Figure 5. Comparative Event Study of Loan Pricing: High vs. Low Exposure Banks. This figure presents the estimated coefficients for the All-In-Spread-Drawn (AISD) at both monthly (Panel A) and quarterly (Panel B) frequencies, centered on the March 2020 liquidity shock ($t = 0$). The plots display two distinct series: the blue solid line represents the effect for High-Exposure Banks (above-median pre-shock treasury asset ratios), while the red dashed line represents the effect for Low-Exposure Banks. Both series track the pricing differential of revolvers relative to term loans, normalized to the period immediately preceding the shock ($t = -1$). Shaded areas or vertical bars denote 95% confidence intervals with standard errors clustered at the lender level.

3.4 Borrowers' Credit Risk

In the baseline DDD specification (Table 3), we utilize a indicator variable, *Revolver*, to distinguish credit lines from term loans, the latter of which serve as a control group. The identifying assumption is that while term loans absorb common macroeconomic shocks, they lack the state-contingent funding covariance characteristic of credit lines. However, as noted in the literature (e.g., Berg et al. (2017)), revolvers and term loans may be selected by systematically different borrower populations: high-quality firms often use revolvers for backup liquidity, whereas lower-quality firms rely more heavily on term loans for immediate funding needs.

This selection raises a potential identification threat: the Asset Purchase Program (APP) might benefit these groups differently through a direct borrower liquidity channel rather than the bank-side debt-overhang channel we propose. Specifically, by expanding bank capacity, the APP could ease the supply of liquidity to high-quality revolver borrowers, while lower-quality term-loan borrowers (whose primary constraint is credit risk rather than bank capacity) benefit less. Such a mechanism could potentially generate the pricing patterns observed in our baseline results.

Furthermore, the COVID-19 shock introduced significant compositional shifts. Constrained firms may have lost access to revolvers and transitioned to term loans, while previously strong firms may have rushed to draw down revolvers, subsequently becoming *fallen angels* (Acharya & Steffen 2020). This shift in borrower quality could confound the comparison between revolver and term loan pricing upon which our DDD design relies.

To address these threats, Table 7 introduces time-varying borrower-level controls, including leverage, profitability, firm size, and credit risk measured by the Altman's Z-Score. The results in Table 7 suggest that our main findings are robust to these borrower-side concerns. The coefficients for the main DDD term ($QE \times Revolver \times Exposure$) remain negative and statistically significant across all specifications (Columns 1–4). Notably, the magnitude of the coefficient in Column 2 (-97.652) is even larger than in the baseline, suggesting that once we account for borrower-level heterogeneity, the impact of intermediary capacity on the liquidity insurance pricing wedge is even more pronounced. This evidence is consistent with the interpretation that the observed pricing compression operates through the bank funding-risk channel rather than being driven by shifts in borrower composition or demand.

4 Additional Analysis

This section presents additional patterns consistent with the mechanism: spread compression appears more pronounced in pricing components and contract types that load on funding-risk covariance, providing, in this way, mechanism-consistent supporting evidence for the results presented in the previous section.

To complement the exposure-based difference-in-difference-in-differences design, we provide within-loan and product-level comparisons that are consistent with the funding-cost channel underlying our main

Table 7. **Impact of QE on Borrower-Level Spreads**

This table reports estimates from a difference-in-difference-in-difference (DDD) analysis focusing on borrower-level characteristics. The dependent variable is the loan spread. Columns (1) and (2) use Treasury-to-assets as the QE exposure measure, while Columns (3) and (4) use Deposit-to-assets. Bank controls include size, leverage, and loan-to-asset ratios. Macro controls include the Government Support Index. Borrower controls include leverage, profitability, and credit risk (Altman's Z-Score). Standard errors are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Exposure Type	Treasury / Assets		Deposit / Assets	
	(1)	(2)	(3)	(4)
Main DDD Term				
QE × Revolver × Exposure	**-90.109**	**-97.652*****	**-61.890**	**-88.853****
	(55.237)	**(24.887)**	**(92.859)**	**(40.766)**
Lower-Order Interactions				
QE × Revolver	23.441	-39.256*	4.357	-36.505
	(51.900)	(23.833)	(91.006)	(39.942)
QE × Exposure	70.389	100.085***	4.325	41.682
	(44.248)	(20.320)	(79.185)	(35.368)
Revolver × Exposure	67.839	77.961***	26.042	66.209*
	(49.104)	(22.121)	(86.651)	(37.725)
Bank Controls				
ln(Total Assets)	1.655	1.404	-0.686	0.004
	(3.881)	(1.746)	(3.694)	(1.678)
Bank Leverage	-409.624	58.906	-366.435	72.573
	(293.177)	(130.487)	(291.797)	(131.061)
Loan / Total Assets	-59.604*	10.483	-50.766	12.556
	(33.690)	(14.992)	(33.342)	(14.966)
Macro Controls				
ln(Govt Support Index)	5.001	-113.720***	3.918	-113.960***
	(10.530)	(15.433)	(10.547)	(15.573)
Borrower Controls				
Borrower Leverage	44.374***	-384.061***	41.870***	-374.941***
	(11.812)	(108.522)	(11.828)	(109.930)
Net Income / TA	-128.158***	-387.701	-126.481***	-454.763
	(34.895)	(305.133)	(35.014)	(307.484)
ln(Borrower Assets)	-26.816***	-21.761	-26.926***	-19.189
	(2.009)	(30.005)	(2.017)	(30.524)
Altman's Z-Score	-4.780***	-87.506***	-4.778***	-91.659***
	(0.914)	(19.589)	(0.918)	(19.732)
Fixed Effects	No	Yes	No	Yes
Observations	941	930	941	930
Adjusted R^2	0.294	0.879	0.290	0.876

results. These specifications exploit variation across pricing components of the same credit facility and across loan types that differ in their sensitivity to bank funding risk. Because drawn spreads and revolving credit lines embed drawdown covariance risk, while undrawn commitment fees and term loans do not, the funding-cost wedge predicts larger post-APP pricing adjustments in the former. While these comparisons do not clearly identify APP effects, they offer checks on the mechanism we discussed and reinforce the interpretation of the exposure-based DDD results.

4.1 Difference-in-Differences (DID) Analysis

Our first DID specification uses undrawn prices as a control group. Undrawn prices are associated with maintaining access to credit without actively drawing down funds. Because undrawn commitments are off-balance-sheet items for banks, we expect APP to have a smaller (or insignificant) impact on undrawn prices relative to drawdown prices, which are on-balance-sheet exposures. This would be consistent with our earlier empirical evidence and the proposed mechanism.

We design the following difference-in-differences (DID) analysis:

$$\begin{aligned} \textit{Loan Prices}_{i,t} &= \alpha + \beta_1 \textit{Post QE}_t + \beta_2 \textit{Treatment}_i + \beta_3 (\textit{Post QE}_t \times \textit{Treatment}_i) \\ &\quad + \gamma' \mathbf{X}_{i,t} + \xi_t + \mu_i + \eta_i + \varepsilon_{i,t} \end{aligned} \tag{5}$$

where $\textit{Loan Prices}_{i,t}$ denotes the price for borrower i at time t, combining the credit line drawdown price (AISD) and the undrawn fee (AISU). $\textit{Post QE}_t$ is a time dummy equal to one for the six months after March 2020 (the onset of QE) and zero for the six months before. $\textit{Treatment}_i$ is a dummy equal to one for drawdown prices. $\textit{Post QE}_t \times \textit{Treatment}_i$ is the interaction term that captures the differential effect of QE on drawdown versus undrawn prices. $\mathbf{X}_{i,t}$ is a vector of control variables, including $\textit{ln(Loan Amount)}_{i,t}$, $\textit{Maturity 1-3yr}_{i,t}$, $\textit{Maturity 3-6yr}_{i,t}$, $\textit{Maturity} > \textit{6yr}_{i,t}$, $\textit{Secured}_{i,t}$, and $\textit{ln(\# Lenders)}_{i,t}$. ξ_t denotes time fixed effects, μ_i denotes borrower fixed effects, and η_i denotes loan-purpose fixed effects.

β_3 is the coefficient of interest. A statistically significant β_3 indicates that APP has a differential effect on drawdown prices. We expect this coefficient to be negative, as APP should mitigate banks' funding costs and reduce drawdown prices more than undrawn prices. Panel A in Table 8 report the estimates. Without controls and fixed effects, β_3 is about -36 basis points, implying that drawdown prices fell by 36 basis points relative to undrawn prices following APP. With controls and fixed effects, drawdown prices still fall by 22 basis points.

We now consider term loans. Term loans differ from credit lines in their structure, offering fixed disbursement and repayment schedules rather than state-contingent drawdowns. As also noted in Cooperman et al. (2025), term loans do not generate meaningful covariance between funding costs and usage. By incorporating term loan prices into the DID framework, we provide an additional comparison group that helps differentiate out common variation in funding costs.

We replace the control group in Equation 5 with term loan prices. β_3 remains the coefficient of interest and captures the differential effect on drawdown prices relative to term loan prices. We again expect a negative coefficient. Panel B in Table 8 report the results. The estimate of β_3 is -37 basis points without controls and fixed effects and -26 basis points with the full set of controls and fixed effects. These magnitudes suggest that APP reduced drawdown prices by 37 basis points (or 26 basis points when controlling for borrower and loan characteristics), similar to the previous case. This reduction is economically meaningful for the price of liquidity insurance.

In sum, economically, this pattern is consistent with the funding-cost channel: drawn exposures and revolving facilities embed on-balance-sheet liquidity provision and drawdown covariance risk, making their pricing more sensitive to changes in banks' marginal funding conditions. The table therefore indicates that the observed spread compression tends to be concentrated in the contract segments predicted by the model, reinforcing the mechanism underlying the exposure-based DDD results while serving as within-contract and product-level supporting evidence rather than standalone identification.

Table OA11.1 in Online Appendix OA11 uses the same specification but takes the WHO announcement (March 11, 2020) as the start of the shock. The results are not materially different from those in Table 8.

To provide further evidence, we conduct counterfactual experiments using alternative APP announcements. We consider QE3 by the Federal Reserve in September 2012 and the Asset Purchase Program by the European Central Bank (ECB) in March 2015 as policy shocks in the US and Europe, respectively. As discussed above, these programs were primarily intended for conventional monetary policy purposes, and there was no clear market dysfunction. Taking the US market as an example, Figure OA1.1 in Online Appendix OA1 shows that the capital ratios of large dealers (from He et al. (2017)) were already declining when QE3 started. Consistent with our mechanism, we therefore expect no significant impact of QE on reducing credit line prices. Tables OA12.1 and OA12.2 in Online Appendix OA12 report the results for the US and European markets, respectively. These results suggest that QE in this period increased—rather than decreased—credit line prices.

Table 8. **DID Analysis**

This table shows differences-in-differences estimates. The sampling period contains six months before the central bank's APP in March 2020 and six months after. The dependent variable is loan price. The time dummy is equal to one, indicating the period after March 2020 and zero otherwise. The treatment dummy is equal to one indicating the treatment group and drawdown price across all columns, and zero indicating the control group, which is the undrawn fee in Panel A and the term loan price in Panel B. The control variables contain a logarithm of facility amount, dummies indicating 1-3 years, 3-6 years, and over 6 years maturities, a dummy indicating whether a facility is secured, and a logarithm of lender numbers. Standard errors are in parentheses. *, **, and *** represent significance at the 10%, 5%, and 1% level, respectively. All variables are winsorized at 1% and 99%. Variable definitions can be found in Appendix A.

	(1)	(2)	(3)	(4)
Panel A: Treatment = Drawdown Price; Control = Undrawn Fee				
Post QE × Treatment	**-36.002*****	**-24.460*****	**-32.059*****	**-22.194*****
	(4.361)	**(3.749)**	**(3.922)**	**(3.549)**
Post QE	0.571	2.260	14.250***	4.346
	(0.590)	(8.542)	(2.038)	(8.173)
Treatment	220.525***	193.260***	194.358***	181.813***
	(3.220)	(2.661)	(2.740)	(2.523)
Observations	7,616	7,616	7,615	7,615
R^2	0.446	0.648	0.586	0.695
Panel B: Treatment = Drawdown Price; Control = Term Loan Price				
Post QE × Treatment	**-36.871*****	**-35.608*****	**-21.539*****	**-25.732*****
	(8.250)	**(7.101)**	**(6.653)**	**(6.118)**
Post QE	1.440	49.456***	21.663***	45.787***
	(7.028)	(13.778)	(5.668)	(11.670)
Treatment	-103.005***	-57.986***	-65.912***	-39.871***
	(5.269)	(4.602)	(4.723)	(4.458)
Observations	8,261	8,261	8,258	8,258
R^2	0.105	0.417	0.422	0.567
Fixed Effects and Controls (Both Panels)				
Loan Controls	No	No	Yes	Yes
Maturity FE	No	No	Yes	Yes
Time FE	No	Yes	No	Yes
Industry & Purpose FE	No	Yes	No	Yes

4.2 Propensity Score Matching (PSM) Analysis

The difference-in-differences comparisons in the previous section rely on the assumption that treated and control contracts are comparable along observable dimensions. However, these loan types may differ systematically in size, maturity, collateralization, and borrower characteristics, which could confound simple DID estimates. To address this concern, this section implements propensity score matching (PSM) to construct a control group of contracts that closely resembles the treated contracts along observable co-variates prior to the policy shock. By reweighting the sample to balance observable characteristics, the PSM design mitigates concerns that the estimated pricing differentials are driven by compositional differences rather than by contract structure and funding-cost sensitivity. We include all firm-level control variables from the DID model in Equation 5, as well as fixed effects.

We use the predicted probabilities of the logit model as the propensity scores and employ the kernel density matching method. The kernel densities of the treated and the control groups before and after matching are shown in Figure 6.

Table 9 shows the results of the PSM analysis. Particularly, Panel A reports parameters estimated from the logit model used in evaluating the propensity scores for drawdown prices versus undrawn fees. Panel B shows the efficiency of the propensity score matching process. The differences between the two groups are statistically significant for many variables before matching (Column (3)), while they turn insignificant for all variables after the matching process (Column (6)). They suggest our matching is efficient. Panel C of Table 9 reports the estimate of Equation 5 by using the matched sample. We start with the DID model without control variables and fixed effects in Column (1) and add them to the rest of the columns. The variable of interest is the interaction term *Post QE* × *Treatment*, which is significant and negative in all columns. These results are again consistent with the mechanism studied in the previous sections.

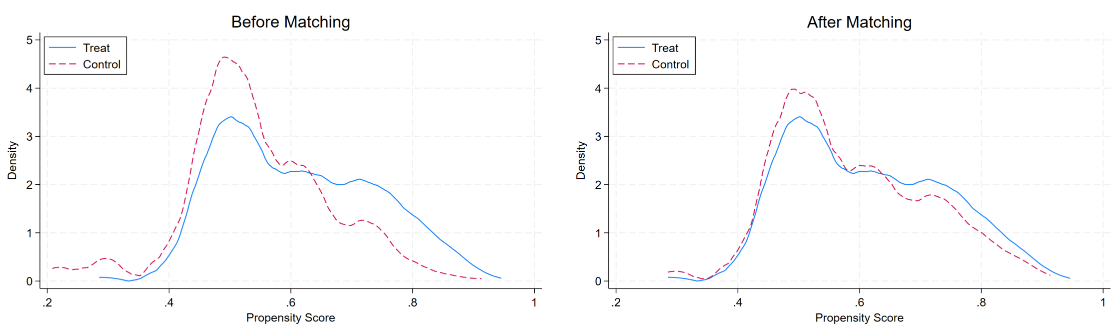


Figure 6. Kernel Density Before and After Matching. This figure plots the kernel density before (the upper plot) and after matching (the lower plot). The horizontal axis represents the propensity scores, and the vertical axis represents the kernel density. The solid blue line represents the treated group (drawdown prices), while the dashed red line represents the control group (undrawn fees).

Next, we use term loan prices as a control group. We use the logit model to proxy for the propensity scores, along with the kernel density matching method. Figure 7 depicts the kernel densities of the treated and the untreated groups before and after matching. The kernel density plots of propensity scores before and after matching illustrate the effectiveness of the procedure. Prior to matching, the distributions of propensity scores for treated and control contracts show noticeable separation, indicating that the two groups differ sys-

Table 9. **PSM-DID Analysis (Drawdown Price versus Undrawn Fee)**

This table shows propensity score matching estimates. The sampling period contains six months before the central bank's QE in March 2020 and six months after. In Panel A, the dependent variable is a dummy equal to one indicating the treated group, drawdown price, and zero indicating the control group, undrawn fee. The co-variate variables contain a logarithm of facility amount, dummies indicating 1-3 years, 3-6 years, and over 6 years maturities, a dummy indicating whether a facility is secured, and a logarithm of lender numbers. Panel B shows the descriptive statistics before and after matching. Panel C shows the DID estimates based on the matched sample. The dependent variable includes drawdown prices and undrawn fees. The time dummy is equal to one, indicating the period after March 2020 and zero otherwise. Columns (2) and (4) include year-month, two-digit SIC industry, and loan purpose fixed effects. Standard errors are in parentheses. *, **, and *** represent significance at the 10%, 5%, and 1% level, respectively. All variables are winsorized at 1% and 99%. Variable definitions can be found in Appendix A.

Panel A: Determinants of Drawdown Price (Logit)

Dependent Variable:	I(Drawdown Price = 1)			
ln(Loan Amount)	-0.142***	(0.033)	Pseudo R^2	0.052
Maturity 1-3Y	0.149	(0.100)	Observations	7,564
Maturity 3-6Y	0.139*	(0.079)	Time FE	Yes
Maturity >6Y	1.324***	(0.490)	Industry FE	Yes
Secured	0.096	(0.073)	Purpose FE	Yes
ln(# Lenders)	-0.291***	(0.060)		

Panel B: Descriptive Statistics Before and After Matching

Sample:	Pre-Match Diff.	Post-Match Diff.
ln(Loan Amount)	-0.514***	-0.022
Maturity 1-3Y	0.006	-0.005
Maturity 3-6Y	0.062***	0.007
Maturity >6Y	0.006***	0.001
Secured	0.083***	0.016
ln(# Lenders)	-0.298***	-0.026

Panel C: PSM-DID Estimates (Matched Sample)

	(1)	(2)	(3)	(4)
Post QE × Treatment	**-34.947*****	**-22.839*****	**-27.907*****	**-18.651*****
	(4.369)	**(3.764)**	**(3.935)**	**(3.561)**
Post QE	1.667***	0.633	10.830***	4.661
	(0.594)	(8.441)	(2.055)	(8.168)
Treatment	218.219***	192.943***	193.231***	181.170***
	(3.224)	(2.655)	(2.748)	(2.514)
ln(Loan Amount)	No	No	Yes	Yes
Secured	No	No	Yes	Yes
ln(# Lenders)	No	No	Yes	Yes
Maturity FE	No	No	Yes	Yes
Fixed Effects	No	Yes	No	Yes
Observations	7,471	7,471	7,471	7,471
R^2	0.443	0.640	0.583	0.690

tematically in observable characteristics. After matching, the two densities overlap closely, demonstrating improved co-variate balance and a more comparable control group.

The DID regressions on the matched sample continue to indicate larger post-QE pricing declines for funding-cost-sensitive contracts (drawn exposures and revolving credit lines), confirming that the results are not driven by differences in contract composition or borrower attributes. Thus, the PSM analysis adds to the body of evidence consistent with the observed pricing adjustments, which reflect the funding-cost channel rather than selection into contract type, reinforcing, in this way, the mechanism-consistent evidence with the exposure-based DDD findings.

Table 10, Panel A shows the parameters estimated from the logit model used to calculate propensity scores. Panel B assesses the efficiency of the propensity score matching, showing that the differences between the two groups are significant for many variables before matching (Column (3)) but become insignificant for all variables after matching (Column (6)). Panel C of Table 10 shows the estimates of Equation 5 using the matched sample. The analysis starts with the model without control variables and fixed effects in Column (1),and it adds them in the subsequent columns.

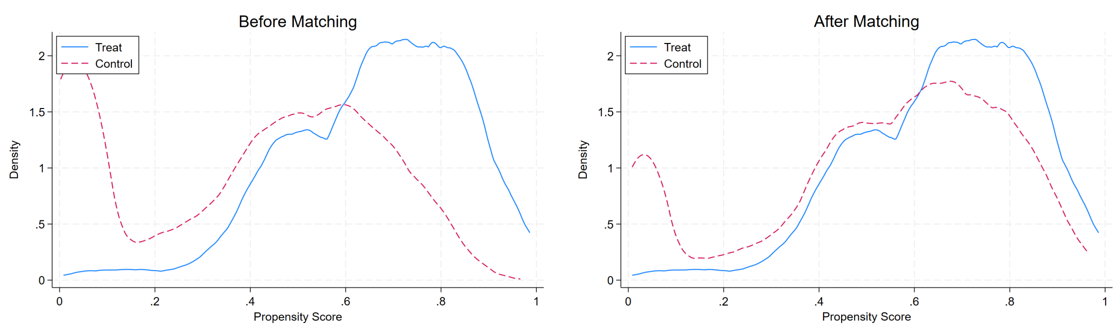


Figure 7. Kernel Density Before and After Matching. This figure plots the kernel density before (the upper plot) and after matching (the lower plot). The horizontal axis represents the propensity scores, and the vertical axis represents the kernel density. The solid blue line represents the treated group (drawdown prices), while the dashed red line represents the control group (term loan prices).

5 A Mechanism Model

This section presents a bank's balance sheet model to study the mechanism behind our empirical results. We first present a summary of the main theoretical result in Cooperman et al. (2025). This will define the general framework of our model. Our framework builds on the funding-risk covariance channel emphasized by Cooperman et al. (2025), but focuses on how intermediary balance-sheet constraints and policy-induced balance-sheet relief affect the price of this wedge across lending contracts

Table 10. **PSM-DID Analysis (Drawdown Price versus Term Loan Price)**

This table shows propensity score matching estimates. The sampling period contains six months before the central bank's QE in March 2020 and six months after. In Panel A, the dependent variable is a dummy equal to one indicating the treated group, drawdown price, and zero indicating the control group, term loan prices. The co-variate variables contain a logarithm of facility amount, dummies indicating 1-3 years, 3-6 years, and over 6 years maturities, a dummy indicating whether a facility is secured, and a logarithm of lender numbers. Panel B shows the descriptive statistics before and after matching. Panel C shows the DID estimates based on the matched sample. The dependent variable includes drawdown prices and term loan prices. The time dummy is equal to one, indicating the period after March 2020 and zero otherwise. Columns (2) and (4) include year-month, two-digit SIC industry, and loan purpose fixed effects. Standard errors are in parentheses. *, **, and *** represent significance at the 10%, 5%, and 1% level, respectively. All variables are winsorized at 1% and 99%. Variable definitions can be found in Appendix A.

Panel A: Determinants of Drawdown Price (Logit)

Dependent Variable:	I(Drawdown Price = 1)			
ln(Loan Amount)	0.122***	(0.032)	Pseudo R^2	0.235
Maturity 1-3Y	-0.994***	(0.108)	Observations	8,211
Maturity 3-6Y	-0.132	(0.097)	Time FE	Yes
Maturity >6Y	-4.290***	(0.206)	Industry FE	Yes
Secured	0.064	(0.070)	Purpose FE	Yes
ln(# Lenders)	0.099*	(0.056)		

Panel B: Descriptive Statistics Before and After Matching

Sample:	Pre-Match Diff.	Post-Match Diff.
ln(Loan Amount)	0.126***	0.262***
Maturity 1-3Y	-0.020***	0.005
Maturity 3-6Y	0.150***	-0.024
Maturity >6Y	-0.270***	-0.002
Secured	-0.193***	-0.021**
ln(# Lenders)	0.232***	0.221***

Panel C: PSM-DID Estimates (Matched Sample)

	(1)	(2)	(3)	(4)
Post QE × Treatment	**-38.071*****	**-34.268*****	**-20.907*****	**-24.255*****
	(8.315)	**(7.160)**	**(6.729)**	**(6.179)**
Post QE	-1.403	39.427***	19.528***	40.304***
	(7.056)	(12.909)	(5.740)	(11.282)
Treatment	-101.945***	-57.940***	-64.728***	-39.753***
	(5.349)	(4.622)	(4.751)	(4.448)
ln(Loan Amount)	No	No	Yes	Yes
Secured	No	No	Yes	Yes
ln(# Lenders)	No	No	Yes	Yes
Maturity FE	No	No	Yes	Yes
Fixed Effects	No	Yes	No	Yes
Observations	8,065	8,065	8,065	8,065
R^2	0.105	0.415	0.422	0.564

5.1 Baseline Model from Cooperman et al. (2025)

Figure 8 summarizes the model. At the start date ($t = 0$), the bank and the corporate borrower start negotiation on the fixed spread $s(L) > 0$ of the total committed amount of credit lines L, over the variable reference rate $R \equiv r + S$, where r and S represent the risk-free rate and the bank's credit spread, respectively. We endogenize this spread by defining a funding schedule $S = S(\eta)$, where η represents the bank's leverage. Crucially, we assume this schedule is both increasing and convex: $\partial S/\partial \eta > 0$ and $\partial^2 S/\partial \eta^2 > 0$. The convexity of the funding cost represents the intensifying agency frictions and liquidity risks that arise as a bank's balance sheet capacity is depleted. In *normal* states (low η), the funding spread is relatively insensitive to leverage, while in *stressed* states (high η), the marginal cost of funding escalated rapidly, reflecting the market's heightened sensitivity to the bank's solvency and distance-to-default[10]. The structural micro-foundation for this relationship is provided in Section 5.3.

In this model, there is a risk-neutral bank. At $t = 1$, the information of risk-free rate (r) and credit spread (S) is revealed, and the borrower draws down an amount $q = q(L)$. Let φ represents the deposit reflow fraction. Crucially, we follow Kashyap et al. (2002) and Gatev & Strahan (2006) by acknowledging that φ is a state-dependent variable rather than a structural constant. While φ may be lower during idiosyncratic bank stress, it typically surges during systemic crises (such as the COVID-19 pandemic) due to 'flight-to-safety' flows. For the purposes of our calibration, we set $\varphi \approx 0.84$, reflecting the high degree of deposit reflow observed in large banks during the APP period.

We assume that at $t = 1$, $-\varphi q + \delta(1+r)\varphi q = 0$, where $\delta = 1/(1+r)$[11]. This creates a *Net Funding Gap* logic: for every dollar drawn ($q = 1$), the bank receives φ in deposits and must fund the remaining undeposited fraction $(1-\varphi)$ in the wholesale market (we assume the unsecured market) at the credit spread S over the risk-free rate r[12]. Assume also a risk-based capital requirement C for bank shareholders to fund the asset[13]. Importantly, even though only $(1-\varphi)$ is funded via wholesale debt, the bank incurs the regulatory capital charge C on the *entire* asset q. Thus, the total funding requirement that the bank must source at a cost is $(1-\varphi)q + Cq \approx (1+C)(1-\varphi)q$[14]. Therefore, our framework preserves the possibility of regulatory

[10] This assumption is consistent with empirical evidence (see Burnside & Cerrato (2023)) and theoretical implication (see He & Krishnamurthy (2013)) in literature.

[11] This assumption states that the bank receiving deposits at $t = 1$ and repaying at $t = 2$ costs nothing for the deposited fraction of corporate drawn funds, φq.

[12] Note that our bank is of LIBOR-quality as we do not study in this paper the effect of risk-insensitive rates like the new SOFR on funding costs

[13] See Favara et al. (2022) and Basel Committee on Banking Supervision (2018).

[14] While C represents the marginal capital requirement for new drawdowns, η captures the bank's aggregate leverage ratio. In

frictions such as leverage ratio requirements.

At $t = 2$, the borrower's credit line and the bank's wholesale funding mature. The borrower needs to pay back to the bank q with a fee s over the reference rate $r + S$; the bank needs to repay the cost of wholesale funding $(1+C)(1-\varphi)q$ with the spread S. In Cooperman et al. (2025), the bank can pay the depositor and the wholesale funding market only if it stays solvent at $t = 2$. Again, as in Cooperman et al. (2025), we shall assume that the bank will not default before the loan's maturity.

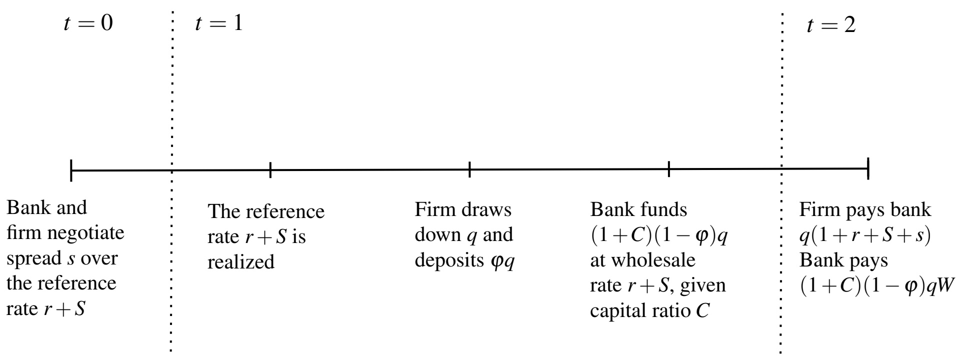


Figure 8. Timeline of model

Andersen et al. (2019) and Cooperman et al. (2025) define the risk-neutral value of the equity to the bank's shareholders at time $t = 1$ as

$$G = \underbrace{p_1[\delta(1+r+S+s)q - q]}_{\text{Profit on Drawdowns}} - \underbrace{p_1\delta(1+C)(1-\varphi)qS}_{\text{Debt Overhang Costs}} \tag{6}$$

where p_1 is the bank's probability of survival at time $t = 2$ conditional on the information at time $t = 1$ and $\delta = 1/(1+r)$ is the discount factor. For the largest banks $p_1 \sim 1$. The first term in the above equation is the bank's discounted marginal profit on the credit line drawdowns. The last term is the shareholders' cost to finance an additional line. This is a debt-overhang cost for financing via the wholesale market $(1-\varphi)q$ at the spread S. Let π and τ define the profit and the cost, respectively, as

$$\pi = p_1[\delta(1+r+S+s)q - q] \quad \text{and} \quad \tau = p_1\delta(1+C)(1-\varphi)qS\,.$$

Bank shareholders' break-even value implies $\mathbb{E}(G) = 0$. It turns out that the expected profit would contain funding costs. That is, $\mathbb{E}[\pi] = \mathbb{E}[\tau]$. Note that for large banks, $\delta p_1 qS(1+C) \sim 1$, and the largest

equilibrium, the regulatory constraints may bind such that $\eta \leq 1/C$.

part of that cost arises as a consequence of funding cost. Rearranging equation 6, we obtain the credit line price function as:

$$s = \frac{\mathbb{E}[\delta p_1 q S((1+C)(1-\varphi)-1)]}{\mathbb{E}[\delta p_1 q]}. \tag{7}$$

Since the covariance between the drawdowns q and the credit spread S dominates the change of the total cost, with the rest of the parameters constant, it also determines the change of credit line price s in equation 7.

Note that the key equation, in our context, is the one associating debt overhang cost for shareholders (τ) with the covariance between the bank's credit spread and drawdowns. The larger (more positive) the covariance, the larger the price of the credit line will be. Our empirical analysis supports this prediction.

What happens when central banks implement QE? Our empirical results suggest that QE is affecting (reducing) funding costs and banks' credit spreads. This will have a beneficial effect on credit line prices. Our findings are broadly consistent with this view. In the next section, we use a bank's balance sheet approach to show the mechanism.

5.2 Shareholders' Debt Overhang

We only consider two time spots $t = 1, 2$, which are when the drawdowns occur (and the bank faces funding costs) and when the loan is repaid (and the bank pays back its short-term bond). The price of the bank's asset is A_1 at time $t = 1$. In the survival scenario (probability p_1), the asset price is A_2^+ at $t = 2$. We assume that the bank issues a credit-risky zero-coupon bond at time $t = 1$ with a 1-year maturity. At time $t = 2$, the bank repays the bond whose value is D_2. Suppose that no credit line drawdowns have occurred. In this case, the bank shareholders will receive the residual of the assets after the bank pays the debt D_2

$$E_1 = \frac{(A_2^+ - D_2)p_1}{1+r} \tag{8}$$

where E_1 is the equity value when there is no credit line drawdown. The shareholders receive zero in the default scenario, with probability $1 - p_1$.

Consider, instead, the case when the firm draws down from the credit line at time $t = 1$. In this case, the funding cost for this new asset is $(1+C)(1-\varphi)q$, which consists of regulatory cost and the fraction of drawdowns that the bank's client chooses to deposit into the same bank account. Let $F_1 = (1+C)(1-\varphi)q$. It follows that $F_2 = (1+r+S)F_1$ is the bank's amount at time $t = 2$.

Cooperman et al. (2025) and Andersen et al. (2019) show that the majority of the debt overhang cost originates from funding costs, which is the number of undeposited drawdowns $(1-\varphi)q$ and the funding spread S. To understand this, consider this simple example where the funding cost per dollar is 100 basis points, and the capital ratio requirement is 6%. In this case, the regulatory costs to the bank, on top of funding costs, are 6

Therefore, we can reasonably assume that $F_1 \sim (1-\varphi)q$, where $(1-\varphi)q$ is related to the bank's funding costs when issuing new debt to finance drawdowns. We assume that the new debt of the bank ranks *pari passu* with the bank's existing debt D_2 (or legacy debt), and the volume of the new debt is sufficiently small that it has little impact on the bank's survival probability p_1. The face value of the new debt, that is, a fair price to new creditors (that is, the net present value (NPV) of this debt is zero), should satisfy

$$\frac{F_2}{1+r+S} = \frac{F_2^*}{1+r}, \tag{9}$$

where F_1^* is the face value of the risk-free new debt to the creditors at time $t = 1$ and $F_2^* = F_1^*(1+r)$ is the payoff to them at time $t = 2$, with $F_2^* < F_2$. Rearranging the above equation provides:

$$F_2 - F_2^* = \frac{F_2^* S}{1+r}. \tag{10}$$

How does the new debt issuance affect bank shareholders' equity value? At time $t = 2$, the bank will receive the payment of the loan, F_2^*. Shareholders' equity value will be non-zero only if the bank stays solvent. Let $\widehat{E}_1$ and $\widehat{E}_2$ denote the equity value at time $t = 1, 2$, respectively, and suppose they satisfy $\widehat{E}_2 = \widehat{E}_1(1+r)$. In the solvent state, the shareholders receive the residual after the bank pays the new and legacy creditors

$$\widehat{E}_1 = \frac{\widehat{E}_2}{1+r} = \frac{(A_2^+ + F_2^* - D_2 - F_2)p_1}{1+r}. \tag{11}$$

Compared to the case of no credit line drawdowns, the change in shareholders' wealth is

$$\Delta W_E = \widehat{E}_1 - E_1 = \frac{(F_2^* - F_2)p_1}{1+r}. \tag{12}$$

where ΔW_E denotes the change in the shareholders' equity value of the bank. Considering the difference between F_2 and F_2^* in Equation 10, we can rewrite it as

$$\Delta W_E = -\frac{F_2^* S p_1}{(1+r)^2}. \tag{13}$$

One can easily see that ΔW_E is negative. This implies that the shareholders face a wealth loss when providing a new credit line. This wealth loss is what we define as debt overhang costs.

Plugging this wealth shift term into the credit line price function, we can see how QE affects credit line prices via debt overhang costs:

$$\begin{aligned}
\frac{\partial s}{\partial S} &= \frac{\partial s}{\partial \Delta W_E} \cdot \frac{\partial \Delta W_E}{\partial S} \\
&= \left(-\frac{(1+r)^2 \mathbb{E}\left[\delta q\left((1+C)(1-\varphi)-1\right)\right]}{F_2^* \mathbb{E}[\delta p_1 q]}\right) \cdot \left(-\frac{F_2^* p_1}{(1+r)^2}\right) \\
&= \frac{p_1 \mathbb{E}\left[\delta q\left((1+C)(1-\varphi)-1\right)\right]}{\mathbb{E}[\delta p_1 q]} > 0.
\end{aligned} \tag{14}$$

Appendix B provides a proof. Therefore, as changes in the credit spread lead to a wealth loss for banks' shareholders and, consequently, change credit line prices, by mitigating funding costs via QE, central banks can mitigate that cost and affect the prices of credit lines. Our empirical results are broadly consistent with this.

Is shareholders' wealth loss a cost to shareholders? To see this, let us re-call F_1, that is, $F_1 = (1+C)(1-\varphi)q$, and plug it into the ΔW_E. In Appendix B, we provide evidence that the loss amount of the shareholders' equity value (that is, $|\Delta W_E|$) is consistent with the debt overhang cost τ. Having established the sensitivity of credit line prices to the funding spread ($\partial s/\partial S$), we now endogenize S through the lens of leverage constraints to show how central bank asset purchases transmit through the bank's balance sheet. As defined in the previous section, the funding spread is an increasing function of the bank's leverage, $S = S(\eta)$, where $\partial S/\partial \eta > 0$. By applying the chain rule to the result in Equation (14), we can express the total sensitivity of credit line pricing to the bank's financial constraints:

$$\frac{\partial s}{\partial \eta} = \underbrace{\frac{\partial s}{\partial S}}_{\text{Debt Overhang}} \times \underbrace{\frac{\partial S}{\partial \eta}}_{\text{Marginal Funding Cost}} > 0 \tag{15}$$

Equation (15) suggests that the leverage η serves as the fundamental driver of the credit line spread. In this framework, the shareholder debt-overhang cost (τ) acts as the structural transmission mechanism: it defines the rate at which marginal increases in leverage-induced funding costs are passed through to the corporate borrower.

Given $\partial^2 S/\partial\eta^2 > 0$, it follows that $\partial^2 s/\partial\eta^2 > 0$[15]. This is consistent with the sensitivity of credit line prices to balance sheet shocks being state-dependent: banks with higher initial leverage face a more severe pass-through of funding costs into credit line spreads. During idiosyncratic or systemic shocks (for example, during systemic liquidity crises or the COVID-19 shock), the covariance between drawdowns and funding-cost wedge becomes particularly acute for these banks, as they operate on the steeper portion of the $S(\eta)$ curve.

5.3 The Central Bank Channel and Leverage Constraints

Section 5.2 established that credit line spreads incorporate a funding-risk wedge arising from the covariance between drawdowns and crisis-state funding costs. We now outline a micro-foundation for this wedge by endogenizing the marginal funding spread faced by leveraged intermediaries. In particular, we model how intermediary leverage and wholesale-funding dependence amplify the pass-through from funding stress into contingent credit pricing.

We follow Gertler & Karadi (2011) and establish a simple APP-specific model to provide a structural foundation for the funding spread S. We model the bank's wholesale funding costs as a function of leverage-induced agency frictions. Consider a representative bank j at $t = 1$ holding long-term assets A_j, financed by equity N_j and short-term wholesale debt D_j:

$$A_j = N_j + D_j \tag{16}$$

The bank's leverage is defined as $\eta \equiv A_j/N_j$. Wholesale creditors supply funds only if the bank's continuation value is sufficiently high to mitigate the incentive to divert assets. Let V_j denote the bank's franchise value, representing the present value of future net profits accruing to shareholders. Under the assumption

[15] Appendix B provides a proof.

that shareholders can divert a fraction $\lambda \in (0,1)$ of assets, the incentive-compatibility condition is:

$$V_j \geq \lambda A_j \tag{17}$$

As leverage increases, wholesale creditors become more exposed to these agency problems and the bank's diminishing balance-sheet capacity. Consequently, they demand higher compensation, which we characterize through an increasing funding schedule:

$$S = S(\eta), \quad \text{with } \frac{\partial S}{\partial \eta} > 0 \tag{18}$$

Equation (18) implies that as leverage rises, short-term debt becomes increasingly difficult to roll over, forcing a higher spread, consistent with the findings by Burnside & Cerrato (2023).

In the aggregate, let A denote the total supply of long-term assets and N the total equity in the banking sector. Suppose the central bank implements an Asset Purchase Program (APP), purchasing a fraction $\psi \in [0,1]$ of the asset supply. Unlike private banks, the central bank finances these purchases with risk-free liabilities and is not subject to private incentive constraints. The market-clearing condition for the remaining assets held by leverage-constrained private banks is:

$$(1-\psi)A = \eta N \tag{19}$$

Differentiating Equation (19) with respect to ψ yields $\partial \eta / \partial \psi = -A/N < 0$. Combining this with our previous results, the total effect of monetary policy on the price of credit lines is given by:

$$\frac{ds}{d\psi} = \underbrace{\frac{\partial s}{\partial S}}_{\text{Debt Overhang}} \times \underbrace{\frac{\partial S}{\partial \eta}}_{\text{Marginal Funding Cost}} \times \underbrace{\frac{\partial \eta}{\partial \psi}}_{\text{Asset Purchase Fraction}} < 0 \tag{20}$$

Because $\partial S/\partial \eta$ is increasing in leverage, the model generates a clear cross-sectional prediction: the impact of QE is amplified for banks with higher leverage. By reducing the aggregate leverage required of the private sector ($\partial \eta / \partial \psi < 0$), central bank asset purchases provide the greatest marginal relief to those banks positioned on the most convex part of the funding schedule. This theoretical result is consistent with our empirical findings and the evidence in Burnside & Cerrato (2023), suggesting that QE transmits most effectively through the *constrained bank* channel by flattening the prohibitive funding-cost wedge faced by highly leveraged intermediaries.

The interaction between the funding wedge and balance sheet constraints gives rise to a clear prediction for the cross-section of APP pass-through. By differentiating Equation (20) with respect to bank characteristics, we obtain:

Proposition 1 *The wedge compression effect ($|ds/d\psi|$) is non-uniformly distributed:*

1. *It is **stronger** for banks with higher pre-shock leverage (η), as these banks operate on the steeper, more convex portion of the $S(\eta)$ funding schedule.*

2. *It is **stronger** for banks with lower deposit stickiness (lower φ). Because these banks must fund a larger fraction $(1-\varphi)$ of drawdowns in wholesale markets, they are more exposed to the funding-risk wedge that APP mitigates.*

This prediction directly addresses the state-contingent nature of the liquidity insurance wedge. Even if the deposit fraction φ is counter-cyclical (dropping during the COVID-19 shock), the relief provided by APP is most valuable to those banks whose funding models are most sensitive to the S spread.

5.4 Calibration and Quantitative Pass-through

To evaluate the economic significance of the bank capacity channel, we calibrate the model using parameters derived from the US banking sector's experience during the COVID-19 "dash-for-cash" (Acharya & Steffen 2020). The core of this exercise is the *Net Funding Gap* logic: when a corporate borrower draws down funds, a significant fraction is immediately deposited back into the same bank, creating a natural hedge (Kashyap et al. 2002).

Following the empirical findings of Li et al. (2020), who analyze the unprecedented \$482 billion explosion in C&I lending in March 2020, we set the deposit reflow fraction $\varphi \approx 0.84$. This value is derived from their finding that for large US banks, every dollar of loan drawdown was matched by approximately 84 cents of new deposit inflows from the same pool of commitment-exposed firms. Consequently, the bank's net wholesale funding requirement is only $(1-\varphi)q \approx 0.16$ given $q = 1$.

However, the bank must still maintain a regulatory capital buffer C on the entire drawn asset q. We set $C = 0.06$ (reflecting a 6% Supplementary Leverage Ratio (SLR) or risk-based capital target). The total capital-strained base for the debt-overhang cost τ is thus $(1+C)(1-\varphi)q$. We simulate the impact of Federal Reserve capacity shocks (QE and liquidity facilities) by contrasting two scenarios for the wholesale funding spread S:

Scenario A (Pre-QE Stress): The bank faces a wholesale spread $S_A = 120$ bps, reflecting the acute dollar funding stress of mid-March 2020.

Scenario B (Post-QE Relief): The expansion of the Fed balance sheet (which provided \$900 billion in additional reserves) compresses the spread to $S_B = 25$ bps.

Table 11 summarizes the results. Our calibration produces an estimate of a direct wedge compression of 16.11 basis points. While this accounts for a substantial portion of the 25–30 bps effect estimated in our empirical triple-difference design, the remaining gap reflects the relaxation of broader "shadow costs." As Li et al. (2020) document, aggregate deposit inflows actually grew twice as fast as lending, meaning banks were flooded with liquidity. This surplus of "safe" funding, combined with the Fed's regulatory relief (such as temporary SLR exemptions), likely provided additional capacity relief beyond the direct reduction in marginal wholesale spreads modeled here.

Table 11. **Calibration of US Shareholder Funding-Risk Wedge (τ)**

This table presents the calibration parameters and calculated debt-overhang costs for US banks. Scenario A represents a stressed market environment (Pre-QE), and Scenario B represents a relieved environment (Post-QE). The reflow fraction φ is calibrated using the ratio of the deposit-to-commitment coefficient (0.0531) to the loan-to-commitment coefficient (0.0634) reported in Li et al. (2020) for large banks. τ represents the basis-point wealth loss to shareholders per dollar of drawdown.

Parameter	**Symbol**	**Scenario A (Stressed)**	**Scenario B (Relief)**
Panel A: Input Parameters			
Drawdown Amount	q	1.00	1.00
Deposit Reflow Fraction	φ	0.84	0.84
Marginal Capital Requirement	C	0.06	0.06
Wholesale Funding Spread	S	120 bps	25 bps
Panel B: Calculated Components			
Net Funding Gap	$1-\varphi$	0.16	0.16
Effective Funding Base	$(1+C)(1-\varphi)$	0.1696	0.1696
Debt Overhang Cost (τ)		**20.35 bps**	**4.24 bps**
Panel C: Economic Impact			
Total Wedge Compression	$\Delta\tau$	**16.11 bps**	

6 Conclusion

This paper examines how Asset Purchase Programs (APPs) relate to the pricing of contingent corporate liquidity through banks' balance-sheet risk. We argue that credit line spreads appear to embed a state-contingent funding-risk distortion consistent with a debt-overhang mechanism: when banks' funding costs rise precisely in the states in which firms draw on committed lines, equity holders internalize losses from issuing funding at elevated spreads, generating a pricing wedge in contingent credit. Using contract-level data from the United States and Europe, we document that drawn spreads on credit lines are significantly more sensitive to funding stress than comparable term loans, consistent with this shareholder funding-risk channel.

Our central contribution is to provide evidence that large-scale asset purchases are associated with a mitigation of this distortion in a state-dependent manner. During the peak of the COVID-19 shock, central bank asset purchases reduced the sensitivity of credit line pricing to funding stress, particularly among banks with greater exposure to funding risk. In contrast, we find no comparable effects during conventional quantitative easing episodes conducted in normally functioning markets. These results suggest that asset purchases operate not merely by lowering the level of funding costs, but by attenuating the covariance between funding stress and drawdowns that drives the debt-overhang wedge in contingent lending.

To rationalize these empirical findings, we develop a parsimonious framework in which asset purchases reduce the covariance between funding costs and liquidity demand, thereby mitigating the shareholder funding-risk wedge embedded in credit line pricing. The model clarifies why such effects arise during episodes of market dysfunction but not during periods of normal financial conditions.

Corporate treasurers should recognize that credit line costs vary with bank balance-sheet capacity: during stress, banks with larger Treasury holdings offer cheaper liquidity insurance. Bank risk managers can benefit from holding APP-eligible assets, which reduce the pass-through of funding shocks into loan pricing. Policymakers, meanwhile, should note that QE's impact on contingent credit is state-dependent, especially during acute stress and absent in normal times.

Overall, our evidence suggests that the design and timing of unconventional monetary interventions matter for the cost of corporate liquidity insurance. By alleviating balance-sheet risk distortions in stressed states, Asset Purchase Programs can reduce the price of contingent credit and influence firms' access to liquidity when it is most valuable.

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Appendices

A Description of Variables

Table A1. **Variable Definitions and Data Sources**

Variable	Description	Source
Panel A: Loan-Level Variables		
All-In Spread Drawn	The sum of the spread over LIBOR/EURIBOR and the annual facility fee, measured in basis points.	DealScan
All-In Spread Undrawn	The sum of the commitment fee and the annual facility fee, measured in basis points.	DealScan
Revolver	Indicator variable equal to one for revolving credit facilities (e.g., "Revolver/Line $\geq$ 1 Yr.", "364-Day Facility") and zero otherwise.	DealScan
Facility Amount	The total facility amount in millions of USD, based on the "Deal Amount Converted" field.	DealScan
Maturity	Loan tenor measured in years (Tenor Maturity / 12).	DealScan
Maturity Dummies	Indicator variables for specific maturity brackets: 1–3 years, 3–6 years, and $>$ 6 years.	DealScan
Secured	Indicator variable equal to one if the facility is secured by collateral and zero otherwise.	DealScan
ln(#Lenders)	The natural logarithm of the number of syndicate members in the facility.	DealScan
Loan Purpose	Indicator variables based on the "Deal Purpose" field, categorized into: General, Acquisition, Investment, Ship/Aircraft, Refinancing, Real Estate, and Dividend Recapitalization.	DealScan
Panel B: Bank-Level Variables		
Treasury / Assets	U.S. Treasury securities and U.S. Government agency obligations (BHCKB558) scaled by total assets.	FR Y-9C
Deposit / Assets	Quarterly average of interest-bearing deposits (BHCK3517) scaled by total assets.	FR Y-9C

Continued on next page

Table A1 – continued from previous page

Variable	Description	Source
Total Assets	Quarterly average of total bank assets (BHCK3368).	FR Y-9C
Loan / Assets	Quarterly average of total loans and leases (BHCK3516) scaled by total assets.	FR Y-9C
Bank Leverage	One minus total equity capital (BHCK3519) divided by total assets (BHCK3368).	FR Y-9C
Panel C: Borrower-Level Variables		
Borrower Leverage	Total liabilities (LTQ) scaled by total assets (ATQ).	Compustat
Net Income / TA	Quarterly net income or loss (NIQ) scaled by total assets (ATQ).	Compustat
Borrower Assets	Total assets (ATQ) of the borrower.	Compustat
Altman's Z-Score	A measure of credit risk calculated as: $1.2X_1 + 1.4X_2 + 3.3X_3 + 0.6X_4 + 1.0X_5$, where X_1 is working capital/TA, X_2 is retained earnings/TA, X_3 is EBIT/TA, X_4 is market equity/total liabilities, and X_5 is sales/TA.	Compustat
Panel D: Macro and Market Variables		
Asset Purchases	The natural logarithm of the Federal Reserve's monthly total asset holdings.	BIS
LIBOR-OIS Spread	The spread between the 6-month (or 12-month) LIBOR rate and the corresponding Overnight Index Swap (OIS) rate.	Bloomberg
CDS Index	The average monthly 5-year CDS spreads of 12 representative U.S. and European banks. The 12 banks include JP Morgan, Morgan Stanley, Wells Fargo, Citi, BofA, Goldman Sachs, BNP Paribas, Societe Generale, Barclays, NatWest, Credit Agricole, and Banco Santander.	Bloomberg
Govt Support Index	The Oxford Government Support Index (OxCGRT), tracking the intensity of government policy responses.	Hale et al. (2021)

Note: This table defines the variables used in the empirical analysis. Lender data from FR Y-9C are matched to DealScan facilities using the Lender Parent Name, the lead arranger's ultimate Bank Holding Company (BHC). Borrower data from Compustat are matched to DealScan using the Roberts DealScan-Compustat Linking Database (Chava & Roberts 2008). All continuous variables are winsorized at the 1% and 99% levels.

B Proof

B.1 Partial Derivative of Credit Line Price to Wealth Loss

We begin by expressing the change in shareholders' wealth, ΔW_E, as a function of the funding spread S. From Equation (13):

$$\frac{\partial \Delta W_E}{\partial S} = -\frac{F_2^* p_1}{(1+r)^2} < 0. \tag{B1}$$

The negative sign indicates that an increase in the bank's funding spread leads to a proportional loss in shareholder wealth, representing the debt overhang burden. Rearranging Equation (13) to isolate S:

$$S = -\frac{(1+r)^2 \Delta W_E}{F_2^* p_1}. \tag{B2}$$

Substituting this into the credit line pricing function in Equation (7), we obtain:

$$s = -\frac{(1+r)^2 \mathbb{E}\left[\delta q \Delta W_E \left((1+C)(1-\varphi)-1\right)\right]}{F_2^* \mathbb{E}[\delta p_1 q]}. \tag{B3}$$

Differentiating s with respect to the wealth shift ΔW_E:

$$\frac{\partial s}{\partial \Delta W_E} = -\frac{(1+r)^2 \mathbb{E}\left[\delta q \left((1+C)(1-\varphi)-1\right)\right]}{F_2^* \mathbb{E}[\delta p_1 q]} < 0. \tag{B4}$$

The negative derivative confirms that greater shareholder wealth loss (a more negative ΔW_E) results in higher credit line spreads, as shareholders require compensation for the funding cost wedge. By the chain rule:

$$\frac{\partial s}{\partial S} = \frac{\partial s}{\partial \Delta W_E} \cdot \frac{\partial \Delta W_E}{\partial S} = \frac{p_1 \mathbb{E}\left[\delta q \left((1+C)(1-\varphi)-1\right)\right]}{\mathbb{E}[\delta p_1 q]}. \tag{B5}$$

Assuming $(1+C)(1-\varphi) > 1$ (a necessary condition for $s > 0$), it follows that $\partial s / \partial S > 0$.

B.2 Identity of Wealth Loss and Debt Overhang

We now prove that the magnitude of the wealth loss $|\Delta W_E|$ is identically equal to the debt overhang cost τ. Given $F_1 = (1+C)(1-\varphi)q$ and $F_2 = (1+r+S)F_1$, the face value of risk-neutral debt F_2^* is:

$$F_2^* = \frac{(1+r)F_2}{1+r+S} = (1+r)(1+C)(1-\varphi)q. \tag{B6}$$

Substituting F_2^* into the expression for the absolute wealth shift:

$$|\Delta W_E| = \frac{F_2^* S p_1}{(1+r)^2} = \frac{(1+r)(1+C)(1-\varphi)qSp_1}{(1+r)^2} = \delta(1+C)(1-\varphi)qSp_1. \tag{B7}$$

Recalling the definition of τ from Section 5, we confirm:

$$|\Delta W_E| = \tau. \tag{B8}$$

B.3 Proof of Convexity and State-Dependent Pass-Through

To establish that highly leveraged banks are more sensitive to policy shocks, we examine the second derivative of the price s with respect to leverage η. Let $s = f(S(\eta))$. By the chain rule:

$$\frac{\partial s}{\partial \eta} = \frac{\partial s}{\partial S}\frac{\partial S}{\partial \eta}. \tag{B9}$$

Differentiating again with respect to η:

$$\frac{\partial^2 s}{\partial \eta^2} = \underbrace{\frac{\partial^2 s}{\partial S^2}}_{\text{Term A}} \left(\frac{\partial S}{\partial \eta}\right)^2 + \underbrace{\frac{\partial s}{\partial S}}_{\text{Term B}} \frac{\partial^2 S}{\partial \eta^2}. \tag{B10}$$

From the derivation in Section B.1 of this Appendix, s is linear in S (the marginal profit and cost terms are linear in the spread). Thus, $\partial^2 s/\partial S^2 = 0$, causing Term A to vanish. We are left with:

$$\frac{\partial^2 s}{\partial \eta^2} = \frac{\partial s}{\partial S}\frac{\partial^2 S}{\partial \eta^2}. \tag{B11}$$

Given that $\partial s/\partial S > 0$ and the funding schedule is convex ($\partial^2 S/\partial \eta^2 > 0$), it follows that $\partial^2 s/\partial \eta^2 > 0$.

Online Appendix

(Not for publishing)

OA1 Asset Purchase Program when Market is Functioning

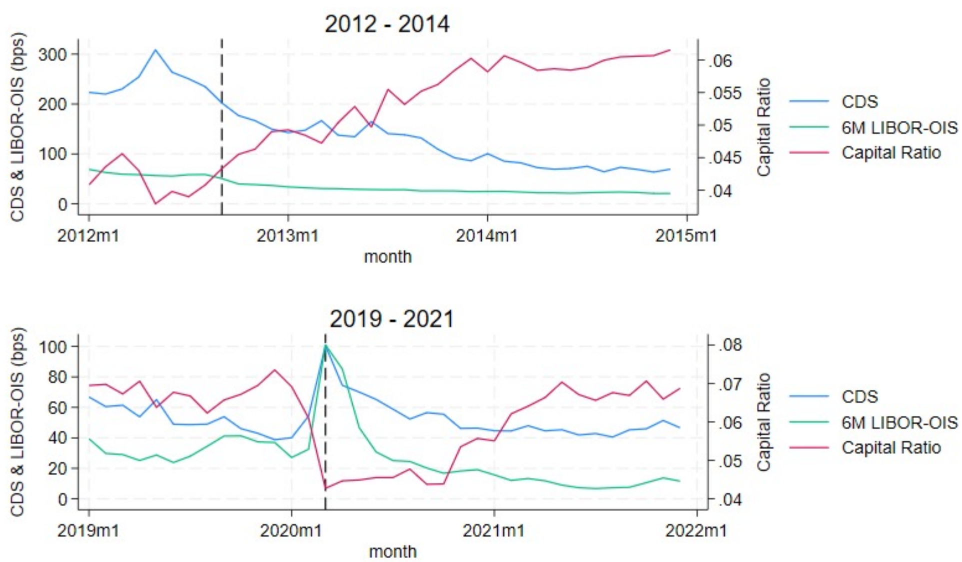

Figure OA1.1. Funding Costs and Capital Ratio. This figure plots the funding costs, measured by the mean of 12 banks' CDS spreads and the 6-month LIBOR-OIS spread, and the capital ratios from He et al. (2017). The upper plot samples the period from 2012-2014, and the vertical dashed line indicates the QE3 launched by the Federal Reserve (FED) in September, 2012. The lower plot samples the period from 2019-2021, and the vertical dashed line indicates the Asset Purchase Program launched by the FED in March 2020.

Table OA1.1. **Credit Line Prices and Funding Costs: 2012-2014**

This table estimates corporate borrowing fees and banks' short-term funding costs. The sampling period is from 2012-2014 after the QE2 (2010-2011) but before balance sheet normalization (2017-2019). The dependent variable is *All In Spread Drawn (AISD)* in columns (1) across (4), and *All In Spread Undrawn (AISU)* in columns (5) across (8). The independent variables include a shock dummy equal to one indicating the Federal Reserve initiated the $40 billion per month in MBS purchases in September 2012, 6-month and 12-month LIBOR-OIS spreads. The controls contain a logarithm of facility amount, dummies indicating 1-3 years, 3-6 years, and over 6 years maturities, a dummy indicating whether a facility is secured, and a logarithm of lender numbers. All columns include year-month, two-digit SIC industry, and loan purpose fixed effects. Standard errors are in parentheses. *, **, and *** represent significance at the 10%, 5%, and 1% level, respectively. All variables are winsorized at 1% and 99%. Variable definitions can be found in Appendix A.

Dependent Variable:	AISD (Drawn)				AISU (Undrawn)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
LIBOR-OIS 6M	0.087	0.087			0.020	0.020		
	(0.143)	(0.143)			(0.022)	(0.022)		
LIBOR-OIS 6M × CB		0.177				-0.012		
		(0.109)				(0.016)		
LIBOR-OIS 12M			0.063	0.063			0.015	0.015
			(0.103)	(0.103)			(0.016)	(0.016)
LIBOR-OIS 12M × CB				0.098				-0.009
				(0.071)				(0.011)
Loan Controls:								
ln(Loan Amount)	-26.01***	-26.01***	-26.01***	-26.01***	-2.35***	-2.35***	-2.35***	-2.35***
	(0.769)	(0.769)	(0.769)	(0.769)	(0.121)	(0.121)	(0.121)	(0.121)
Secured	41.41***	41.41***	41.41***	41.41***	12.14***	12.14***	12.14***	12.14***
	(1.421)	(1.421)	(1.421)	(1.421)	(0.222)	(0.222)	(0.222)	(0.222)
ln(#Lenders)	-34.29***	-34.29***	-34.29***	-34.29***	-1.55***	-1.55***	-1.55***	-1.55***
	(1.282)	(1.282)	(1.282)	(1.282)	(0.206)	(0.206)	(0.206)	(0.206)
Maturity Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry & Purpose FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	22,210	22,210	22,210	22,210	15,374	15,374	15,374	15,374
R^2	0.475	0.475	0.475	0.475	0.468	0.468	0.468	0.468

Table OA1.2. **Credit Line Prices and Funding Costs: 2013-2017 (Europe)**

This table estimates corporate borrowing prices on banks' funding costs. The sampling period is from 2013-2017 after the Outright Monetary Transactions (OMT) in 2012 but before the Resumption of APP in 2019. The dependent variable is *All In Spread Drawn (AISD)* in columns (1) across (4), and *All In Spread Undrawn (AISU)* in columns (5) across (8). The independent variables include a shock dummy equal to one indicating the European Central Bank (ECB) launched the Asset Purchase Program (APP) in March 2015, 6-month and 12-month LIBOR-OIS spreads. The controls contain a logarithm of facility amount, dummies indicating 1-3 years, 3-6 years, and over 6 years maturities, a dummy indicating whether a facility is secured, and a logarithm of lender numbers. All columns include year-month, two-digit SIC industry, and loan purpose fixed effects. Standard errors are in parentheses. *, **, and *** represent significance at the 10%, 5%, and 1% level, respectively. All variables are winsorized at 1% and 99%. Variable definitions can be found in Appendix A.

Dependent Variable:	AISD (Drawn)				AISU (Undrawn)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
LIBOR-OIS 6M	5.739	5.739			-2.456	-2.456		
	(4.654)	(4.654)			(4.266)	(4.266)		
LIBOR-OIS 6M $\times$ CB		1.990				-0.974		
		(1.712)				(1.642)		
LIBOR-OIS 12M			0.710	0.710			-0.304	-0.304
			(0.576)	(0.576)			(0.528)	(0.528)
LIBOR-OIS 12M $\times$ CB				0.211				-0.164
				(0.301)				(0.305)
Loan Controls:								
ln(Loan Amount)	-24.80***	-24.80***	-24.80***	-24.80***	-10.83***	-10.83***	-10.83***	-10.83***
	(1.094)	(1.094)	(1.094)	(1.094)	(0.901)	(0.901)	(0.901)	(0.901)
Secured	80.87***	80.87***	80.87***	80.87***	23.72***	23.72***	23.72***	23.72***
	(2.454)	(2.454)	(2.454)	(2.454)	(2.143)	(2.143)	(2.143)	(2.143)
ln(#Lenders)	-18.93***	-18.93***	-18.93***	-18.93***	-7.25***	-7.25***	-7.25***	-7.25***
	(2.074)	(2.074)	(2.074)	(2.074)	(1.752)	(1.752)	(1.752)	(1.752)
Maturity Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry & Purpose FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	8,441	8,441	8,441	8,441	2,117	2,117	2,117	2,117
R^2	0.608	0.608	0.608	0.608	0.746	0.746	0.746	0.746

OA2 Credit Line Suppliers for US and European Firms

This section shows that US and European banks are the main credit line suppliers for their countries' firms. Only a small fraction of credit comes from foreign suppliers in these two markets.

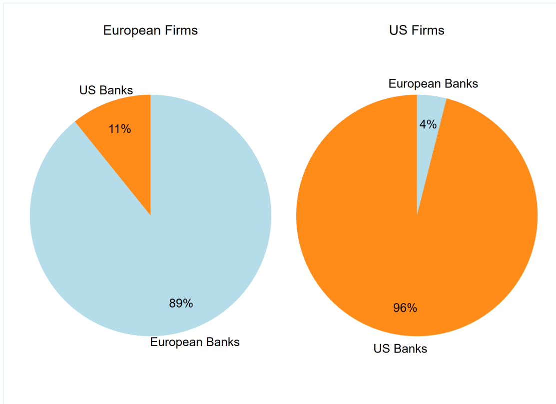

Figure OA2.1. Distribution of Credit Line Suppliers. This figure plots the distribution of credit line suppliers in European and US markets. The left plot shows the proportions of credit line suppliers in European market. The right plot shows the proportions of credit line suppliers in US market.

OA3 Supportive Evidence

Table OA3.1. **Difference-in-Difference Analysis Across Samples (CDS Spreads)**

This table reports estimates from a difference-in-difference (DID) specification. The sample covers a two-year window spanning one year before and one year after shocks. The shocks are defined as QE1 (Columns (1) & (2)), QE2 (Columns (3) & (4)), QE3 (Columns (5) & (6)), and COVID-19 (Columns (7) & (8)). The dependent variable is *All-In Spread Drawn (AISD)* in Columns (1) through (8). The key explanatory variables include a post-APP dummy equal to one after the central bank's quantitative easing (QE) announcement and zero otherwise, and a credit-line indicator equal to one for revolving credit facilities and zero for term loans. Specifically, banks are classified as highly exposed if their CDS spreads are above the median level across banks (Columns (1), (3), (5), and (7)) or lowly exposed the opposite (Columns (2), (4), (6), and (8)). The controls contain a logarithm of facility amount, dummies indicating 1-3 years, 3-6 years, and over 6 years maturities, a dummy indicating whether a facility is secured, and a logarithm of lender numbers. All specifications include bank fixed effects. The analysis is cross-sectional. Standard errors are reported in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. All variables are winsorized at the 1% and 99% levels. Variable definitions are provided in Appendix A.

Dependent Variable:	All-In Spread Drawn (AISD)							
Shock:	QE1		QE2		QE3		COVID-19	
CDS Exposure:	High	Low	High	Low	High	Low	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
QE × Revolver	**-14.732**	**-3.095**	**27.055****	**-5.119**	**19.273***	**10.549**	**-29.453****	**-24.708***
	(19.203)	**(16.759)**	**(11.300)**	**(9.394)**	**(11.226)**	**(11.677)**	**(14.083)**	**(14.444)**
QE	193.329***	170.105***	-82.645***	-34.035***	-56.109***	-3.843	56.042***	70.026***
	(24.157)	(16.739)	(14.590)	(12.170)	(13.842)	(15.568)	(18.342)	(21.431)
Revolver	-91.144***	-85.344***	-88.203***	-55.823***	-89.108***	-98.786***	-77.798***	-54.493***
	(11.423)	(8.503)	(8.607)	(6.184)	(8.399)	(8.824)	(12.321)	(10.320)
Loan Controls:								
ln(Loan Amount)	-7.524*	-2.747	-12.555***	-17.622***	-0.021	1.133	-14.937***	-13.458***
	(4.524)	(4.323)	(2.804)	(2.411)	(3.189)	(3.371)	(3.776)	(4.340)
Secured	107.688***	86.364***	76.538***	61.734***	93.667***	114.564***	124.410***	107.679***
	(9.787)	(7.410)	(5.118)	(4.161)	(5.863)	(5.616)	(9.028)	(9.559)
ln(#Lenders)	-45.694***	-33.262***	-62.693***	-42.399***	-85.598***	-68.980***	-38.643***	-35.215***
	(7.960)	(7.617)	(4.351)	(3.443)	(4.965)	(5.723)	(7.265)	(8.560)
Maturity Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,503	1,626	2,611	2,653	2,405	2,533	1,370	1,353
R^2	0.325	0.322	0.381	0.367	0.459	0.406	0.468	0.441

OA4 Debt Overhang Costs

OA4.1 US Market

In Section OA10.1, we find that the positive correlation between banks' short-term debt overhang cost and corporate borrowing cost can be weakened given central bank asset purchase. This section provides further analysis.

Table OA3.2. **Difference-in-Difference Analysis Across Samples (Deposit)**

This table reports estimates from a difference-in-difference (DID) specification. The sample covers a two-year window spanning one year before and one year after shocks. The shocks are defined as QE1 (Columns (1) & (2)), QE2 (Columns (3) & (4)), QE3 (Columns (5) & (6)), and COVID-19 (Columns (7) & (8)). The dependent variable is *All-In Spread Drawn (AISD)* in Columns (1) through (8). The key explanatory variables include a post-APP dummy equal to one after the central bank's quantitative easing (QE) announcement and zero otherwise, and a credit-line indicator equal to one for revolving credit facilities and zero for term loans. Specifically, banks are classified as highly exposed if their deposit-to-asset ratios are below the median level across banks (Columns (1), (3), (5), and (7)) or lowly exposed the opposite (Columns (2), (4), (6), and (8)). The controls contain a logarithm of facility amount, dummies indicating 1-3 years, 3-6 years, and over 6 years maturities, a dummy indicating whether a facility is secured, and a logarithm of lender numbers. All specifications include bank fixed effects. The analysis is cross-sectional. Standard errors are reported in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. All variables are winsorized at the 1% and 99% levels. Variable definitions are provided in Appendix A.

Dependent Variable:	All-In Spread Drawn (AISD)							
Shock:	QE1		QE2		QE3		COVID-19	
Deposit Exposure:	High	Low	High	Low	High	Low	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
QE × Revolver	**-5.186**	**1.051**	**17.903****	**0.218**	**16.090****	**-1.146**	**-46.018******	**-12.516**
	(15.005)	**(13.558)**	**(9.237)**	**(7.107)**	**(9.367)**	**(8.757)**	**(12.240)**	**(10.349)**
QE	141.457***	108.649***	-38.634***	-22.968***	-12.258	-1.224	64.347***	30.570***
	(13.627)	(12.522)	(8.507)	(6.130)	(8.120)	(7.596)	(11.191)	(8.756)
Revolver	-82.708***	-66.418***	-75.880***	-50.398***	-88.646***	-69.954***	-55.825***	-49.817***
	(7.905)	(8.800)	(6.565)	(5.087)	(6.869)	(6.586)	(8.712)	(7.587)
Loan Controls:								
ln(Loan Amount)	-1.073	-12.401***	-14.648***	-24.282***	1.243	-17.140***	-20.934***	-21.559***
	(4.374)	(4.140)	(2.292)	(2.081)	(2.764)	(2.721)	(3.226)	(3.830)
Secured	95.506***	77.224***	69.134***	47.886***	100.977***	66.655***	125.151***	98.408***
	(7.309)	(6.374)	(4.022)	(3.394)	(4.908)	(4.375)	(8.131)	(6.950)
ln(#Lenders)	-37.726***	-16.518**	-56.247***	-35.276***	-76.742***	-48.665***	-25.364***	-31.915***
	(7.284)	(6.556)	(3.352)	(3.222)	(4.495)	(4.428)	(6.500)	(7.093)
Maturity Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,008	2,339	3,689	4,006	3,667	4,042	1,982	2,177
R^2	0.323	0.254	0.380	0.311	0.429	0.306	0.388	0.399

Similar to equation OA10.1, we construct an OLS specification to regress borrowing costs on a CDS index, measuring banks' long-term overhang cost as follows:

$$
\begin{aligned}
Y_{i,t} \quad = \quad & \beta_0 + \beta_1 \textit{CDS Index}_t + \beta_2 \textit{CDS Index}_t \times CB_t + \beta_3 \textit{ln(Loan Amount)}_{i,t} \\
& + \beta_4 \textit{Maturity 1-3yr}_{i,t} + \beta_5 \textit{Maturity 3-6yr}_{i,t} + \beta_6 \textit{Maturity >6yr}_{i,t} + \beta_7 \textit{Secured}_{i,t} \\
& + \beta_8 \textit{ln(\#Lenders)}_{i,t} + \gamma X_{i,t} + \varepsilon_{i,t}
\end{aligned} \tag{OA4.1}
$$

where $Y_{i,t}$ denotes the outcome of interest, including credit line drawdown cost (*All In Spread Drawn*), undrawn fee (*All In Spread Undrawn*), and comprehensive borrowing costs (*UWS*). *CDS Index* represents long-term debt overhang pressure in the banking system, measured by the cross-sectional average of 12 representative banks' 5-year CDS spreads[16]. CB_t is a time dummy indicating the shock in March 2020 when central banks' QE happened. A set of control variables includes the loan amount, dummies indicating loan facilities' different maturities, a dummy indicating whether loan facilities have collateral and the number of lenders. Fixed effects of time, industry, and loan purpose are considered.

Columns (1) across (4) in Table OA4.1 show the estimation of corporate borrowing costs on the 5-year CDS index in OLS specification of equation OA4.1. Similarly, a 1 basis point increase in the CDS index results in a 4.3 basis point increase in drawdown costs (AISD) and a 0.5 basis point increase in commitment fee (AISU), consistent with the results of short-term debt overhang costs. Moreover, these two numbers are greater than the ones of LIBOR-OIS spreads in Table OA10.1.

Columns (2) and (4) of Table OA4.1 show the estimate of the interaction between long-term debt overhang cost and central banks' QE on drawdown costs and undrawn fees. Using OLS specification in equation OA4.1, the coefficient of the interaction on drawdown cost (AISD) is significant and negative (columns (2)). Regarding the commitment fee (AISU) in column (4), the coefficient on interaction is still significant and negative.

Similarly, we study how debt overhang costs drive firms' comprehensive borrowing costs. We use the usage-weighted spread (UWS) and run the panel regression in equation OA4.1. Columns (1) across (6) in Table OA4.2 show the results of firms' comprehensive borrowing costs (UWS) on the 5-year CDS index, also in OLS specification. Positive coefficients reveal that banks' debt overhang costs increase their overall lending prices to corporate borrowers. Moreover, the comprehensive cost with a 30% drawdown assumption

[16] See Appendix A for more details of variable construction.

has the greatest value, suggesting that a 1 basis point increase in the 5-year CDS index leads to a 1.2 basis point rise in the borrowing cost.

Columns (2), (4), and (6) of Table OA4.2 report the regression results of the interaction term in the OLS specification. Given central bank asset purchase, banks' long-term debt overhang cost, measured by the 5-year CDS index, has less effect on firms' general cost of borrowing credit lines. A 1 basis point increase in the 5-year CDS index merely causes a 0.856 basis points rise in the borrowing cost, compared with the 1.2 basis points before.

To sum up, confronting debt overhang costs in banking systems, US banks moved drawn and undrawn costs in the same direction but to a very different degree. When the central bank intervenes, it reduces these two costs.

Similar to Section OA10.1, we also estimate cross-section regression in the form of equation OA6.1, using CDS spreads as a proxy for funding costs. Table OA4.3 reports the results. Although all coefficients are insignificant, the negative signs still support that central banks intervening in the US financial market via QE mitigated the funding costs and then reduced credit line fees shared by corporate borrowers.

OA4.2 European Market

In Section OA10.2, we find that European banks facing a rising short-term debt overhang cost pass the pressure on firms by increasing drawdown cost and decreasing undrawn fees. Given central bank asset purchase, banks reduce drawdown costs and increase undrawn fees. This section studies whether this situation holds for long-term debt overhang cost.

Using the specification in equation OA4.1, we regress the proxy for banks' long-term debt overhang cost, a CDS index, on borrowing cost of credit line drawdowns (*All In Spread Drawn*) and the fee of retaining undrawn credit lines (*All In Spread Undrawn*). Table OA4.4 reports the estimation. In OLS specification, the CDS index has positive and significant correlations with drawdown cost and negative and significant ones with undrawn fees (columns (1) across (4)), suggesting that European banks transferred long-term debt overhang pressure to borrowers through drawdown fees and mitigated the undrawn fees. Interacted with central bank asset purchase (columns (2) and (4)), banks cut the drawdown cost but inversely increase the undrawn fees.

Next, we use the European sample to investigate banks' long-term debt overhang cost on firms' comprehensive borrowing cost. Substituting LHS of equation OA4.1 with UWS, a measure combining both

Table OA4.1. **Credit Line Prices and Long-Term Funding Costs (US)**

This table estimates corporate borrowing costs on banks' funding costs. The dependent variable is *All In Spread Drawn (AISD)* in columns (1) across (2), and *All In Spread Undrawn (AISU)* in columns (3) across (4). The independent variables include a shock dummy equal to one indicating central bank asset purchase (QE) and an index averaging 12 representative banks' 5-year CDS spreads. The controls contain a logarithm of facility amount, dummies indicating 1-3 years, 3-6 years, and over 6 years maturities, a dummy indicating whether a facility is secured, and a logarithm of lender numbers. All columns include year-month, two-digit SIC industry, and loan purpose fixed effects. Standard errors are in parentheses. *, **, and *** represent significance at the 10%, 5%, and 1% level, respectively. All variables are winsorized at 1% and 99%. Variable definitions can be found in Appendix A.

Sample	Credit Lines			
Dependent Variable	AISD		AISU	
	(1)	(2)	(3)	(4)
CDS Index 5Y	4.287***	4.287***	0.508***	0.508***
	(1.083)	(1.083)	(0.150)	(0.150)
CDS Index 5Y×CB		-1.016***		-0.101***
		(0.261)		(0.036)
ln(Loan Amount)	-39.628***	-39.628***	-3.945***	-3.945***
	(0.582)	(0.582)	(0.092)	(0.092)
Maturity 1-3Y	6.768**	6.768**	8.357***	8.357***
	(2.696)	(2.696)	(0.363)	(0.363)
Maturity 3-6Y	16.206***	16.206***	6.816***	6.816***
	(2.126)	(2.126)	(0.261)	(0.261)
Maturity >6Y	74.968***	74.968***	14.865***	14.865***
	(5.104)	(5.104)	(0.978)	(0.978)
Secured	52.900***	52.900***	10.676***	10.676***
	(1.189)	(1.189)	(0.182)	(0.182)
ln(#Lenders)	-10.687***	-10.687***	-0.360**	-0.360**
	(1.045)	(1.045)	(0.171)	(0.171)
Time FE	yes	yes	yes	yes
Industry FE	yes	yes	yes	yes
Purpose FE	yes	yes	yes	yes
Observations	42880	42880	27314	27314
R^2	0.502	0.502	0.500	0.500

Table OA4.2. **Comprehensive Credit Line Prices on Debt Overhang Cost (US)**

This table estimates comprehensive corporate borrowing costs on banks' long-term debt overhang costs. The dependent variables are usage-weighted spread in different drawdown assumptions, including 30% (columns (1) and (2)), 25% (columns (3) and (4)), and 20% (columns (5) and (6)). The independent variables include a shock dummy equal to one indicating central bank asset purchase (QE) and an index averaging 12 representative banks' 5-year CDS spreads. The controls contain a logarithm of facility amount, dummies indicating 1-3 years, 3-6 years, and over 6 years maturities, a dummy indicating whether a facility is secured, and a logarithm of lender numbers. All columns include year-month, two-digit SIC industry, and loan purpose fixed effects. Standard errors are in parentheses. *, **, and *** represent significance at the 10%, 5%, and 1% level, respectively. All variables are winsorized at 1% and 99%. Variable definitions can be found in Appendix A.

Sample	Credit Lines					
Dependent Variable	UWS 30%		UWS 25%		UWS 20%	
	(1)	(2)	(3)	(4)	(5)	(6)
CDS Index 5Y	1.163***	1.163***	0.933***	0.933***	0.703***	0.703***
	(0.352)	(0.352)	(0.306)	(0.306)	(0.263)	(0.263)
CDS Index 5Y×CB		-0.307***		-0.251***		-0.196***
		(0.085)		(0.073)		(0.063)
ln(Loan Amount)	-13.246***	-13.246***	-11.287***	-11.287***	-9.328***	-9.328***
	(0.185)	(0.185)	(0.161)	(0.161)	(0.138)	(0.138)
Maturity 1-3Y	8.300***	8.300***	7.875***	7.875***	7.450***	7.450***
	(0.852)	(0.852)	(0.740)	(0.740)	(0.638)	(0.638)
Maturity 3-6Y	10.715***	10.715***	9.777***	9.777***	8.838***	8.838***
	(0.654)	(0.654)	(0.569)	(0.569)	(0.490)	(0.490)
Maturity >6Y	27.136***	27.136***	22.904***	22.904***	18.672***	18.672***
	(1.644)	(1.644)	(1.429)	(1.429)	(1.230)	(1.230)
Secured	19.384***	19.384***	16.919***	16.919***	14.453***	14.453***
	(0.385)	(0.385)	(0.335)	(0.335)	(0.288)	(0.288)
ln(#Lenders)	0.769**	0.769**	1.564***	1.564***	2.359***	2.359***
	(0.335)	(0.335)	(0.291)	(0.291)	(0.251)	(0.251)
Time FE	yes	yes	yes	yes	yes	yes
Industry FE	yes	yes	yes	yes	yes	yes
Purpose FE	yes	yes	yes	yes	yes	yes
Observations	43667	43667	43667	43667	43667	43667
R^2	0.488	0.488	0.471	0.471	0.442	0.442

Table OA4.3. **Cross-Sectional Analysis: Credit Line Fees and Funding Costs (US)**

This table estimates credit line fees on funding costs from a specification in equation OA6.1. The dependent variable is credit line fee measured by all-in-spread-drawn (column (1) and usage-weighted spreads in different drawdown assumptions, including 30% (columns (2)), 25% (columns (3)), and 20% (columns (4)). The independent variables include a dummy equal to one indicating the period after central bank asset purchase (QE) and funding costs measured by the cross-sectional average of 12 banks' 5-year CDS spreads. Standard errors are in parentheses. *, **, and *** represent significance at the 10%, 5%, and 1% level, respectively. Variable definitions can be found in Appendix A.

Sample	Credit Lines			
Specification	ΔAISD	ΔUWS 30%	ΔUWS 25%	ΔUWS 20%
	(1)	(2)	(3)	(4)
ΔCDS Index 5Y	-0.377	-0.069	-0.046	-0.022
	(0.414)	(0.130)	(0.112)	(0.095)
Observations	142	142	142	142
R^2	0.006	0.002	0.001	0.000

drawn and undrawn costs, we run the specification and obtain the results in Table OA4.5. Similar to the US sample (Table OA4.2), columns (1) across (6) show positive and significant coefficients of the CDS index term on UWS. Facing long-term debt overhang costs, European banks pass the pressure to borrowers. Given the interaction between the CDS index and central bank asset purchase, the coefficients of interaction are negative in columns (2), (4), and (6).

Table OA4.4. **Credit Line Prices and Long-Term Funding Costs (Europe)**

This table estimates corporate borrowing costs on banks' long-term funding costs. The dependent variable is *All In Spread Drawn (AISD)* in columns (1) across (2), and *All In Spread Undrawn (AISU)* in columns (3) across (4). The independent variables include a shock dummy equal to one indicating central bank asset purchase (QE) and an index averaging 12 representative banks' 5-year CDS spreads. The controls contain a logarithm of facility amount, dummies indicating 1-3 years, 3-6 years, and over 6 years maturities, a dummy indicating whether a facility is secured, and a logarithm of lender numbers. All columns include year-month, two-digit SIC industry, and loan purpose fixed effects. Standard errors are in parentheses. *, **, and *** represent significance at the 10%, 5%, and 1% level, respectively. All variables are winsorized at 1% and 99%. Variable definitions can be found in Appendix A.

Sample	Credit Lines			
Dependent Variable	AISD		AISU	
	(1)	(2)	(3)	(4)
CDS Index 5Y	7.782***	7.782***	-5.430***	-5.430***
	(1.738)	(1.738)	(0.760)	(0.760)
CDS Index 5Y×CB		-2.076***		1.055***
		(0.450)		(0.213)
ln(Loan Amount)	-15.047***	-15.047***	-8.753***	-8.753***
	(1.071)	(1.071)	(0.956)	(0.956)
Maturity 1-3Y	51.166***	51.166***	0.815	0.815
	(5.060)	(5.060)	(3.699)	(3.699)
Maturity 3-6Y	43.254***	43.254***	6.472**	6.472**
	(4.629)	(4.629)	(3.071)	(3.071)
Maturity >6Y	73.271***	73.271***	9.061**	9.061**
	(5.697)	(5.697)	(4.519)	(4.519)
Secured	69.379***	69.379***	7.631***	7.631***
	(2.478)	(2.478)	(2.009)	(2.009)
ln(#Lenders)	-27.293***	-27.293***	3.627**	3.627**
	(2.010)	(2.010)	(1.564)	(1.564)
Time FE	yes	yes	yes	yes
Industry FE	yes	yes	yes	yes
Purpose FE	yes	yes	yes	yes
Observations	7064	7064	1995	1995
R^2	0.609	0.609	0.774	0.774

Table OA4.5. **Comprehensive Credit Line Prices on Long-Term Debt Overhang Cost (Europe)**

This table estimates comprehensive corporate borrowing costs on banks' long-term debt overhang costs. The dependent variables are usage-weighted spread in different drawdown assumptions, including 30% (columns (1) and (2)), 25% (columns (3) and (4)), and 20% (columns (5) and (6)). The independent variables include a shock dummy equal to one indicating central bank asset purchase (QE) and an index averaging 12 representative banks' 5-year CDS spreads. The controls contain a logarithm of facility amount, dummies indicating 1-3 years, 3-6 years, and over 6 years maturities, a dummy indicating whether a facility is secured, and a logarithm of lender numbers. All columns include year-month, two-digit SIC industry, and loan purpose fixed effects. Standard errors are in parentheses. *, **, and *** represent significance at the 10%, 5%, and 1% level, respectively. All variables are winsorized at 1% and 99%. Variable definitions can be found in Appendix A.

Sample	Credit Lines					
Dependent Variable	UWS 30%		UWS 25%		UWS 20%	
	(1)	(2)	(3)	(4)	(5)	(6)
CDS Index 5Y	1.666**	1.666**	1.227*	1.227*	0.787	0.787
	(0.757)	(0.757)	(0.717)	(0.717)	(0.686)	(0.686)
CDS Index 5Y×CB		-0.545***		-0.434**		-0.324*
		(0.196)		(0.186)		(0.178)
ln(Loan Amount)	-3.874***	-3.874***	-3.066***	-3.066***	-2.258***	-2.258***
	(0.467)	(0.467)	(0.442)	(0.442)	(0.423)	(0.423)
Maturity 1-3Y	13.083***	13.083***	10.316***	10.316***	7.549***	7.549***
	(2.205)	(2.205)	(2.088)	(2.088)	(1.997)	(1.997)
Maturity 3-6Y	11.436***	11.436***	9.172***	9.172***	6.908***	6.908***
	(2.017)	(2.017)	(1.910)	(1.910)	(1.827)	(1.827)
Maturity >6Y	16.149***	16.149***	12.115***	12.115***	8.080***	8.080***
	(2.483)	(2.483)	(2.351)	(2.351)	(2.249)	(2.249)
Secured	22.204***	22.204***	18.800***	18.800***	15.396***	15.396***
	(1.080)	(1.080)	(1.023)	(1.023)	(0.978)	(0.978)
ln(#Lenders)	-10.370***	-10.370***	-9.118***	-9.118***	-7.865***	-7.865***
	(0.876)	(0.876)	(0.829)	(0.829)	(0.794)	(0.794)
Time FE	yes	yes	yes	yes	yes	yes
Industry FE	yes	yes	yes	yes	yes	yes
Purpose FE	yes	yes	yes	yes	yes	yes
Observations	7064	7064	7064	7064	7064	7064
R^2	0.482	0.482	0.443	0.443	0.395	0.395

OA5 Empirical Analysis of Central Bank Asset Purchases

In this section, we explore whether central bank total assets serve as a crucial instrument for reducing funding costs—and, consequently, credit line fee pricing—during periods of financial stress. We extract data from the BIS Central Bank Total Assets dataset, which tracks the evolution of central banks' balance sheets globally. Focusing on the US central bank, we construct the variable *Asset Purchases* as the logarithm of its monthly asset amount.

To address potential endogeneity in funding cost, we implement a two-stage least squares (2SLS) procedure. The strong significance of our instrument is confirmed by the first-stage F-statistic, which is 34.882 for drawn credit lines (AISD), well above the conventional threshold of 10, while for undrawn credit lines (AISU) the F-statistic is only 3.159, indicating potential concerns regarding instrument weakness in that specification. In the second stage, we use the fitted values from the first stage to estimate the effect on *Credit Line Fee*, where *Credit Line Fee* is measured in two forms: drawn (*All In Spread Drawn*) and undrawn (*All In Spread Undrawn*) credit lines. Formally, we estimate the following system of equations:

$$\begin{aligned} CDS\ Index_t &= \beta_0 + \beta_1 \cdot Asset\ Purchases_t + \gamma \cdot Controls_{i,t} + \varepsilon_{i,t} && \text{(OA5.1)} \\ Y_{i,t} &= \alpha_0 + \alpha_1 \cdot \widehat{CDS\ Index}_t + \alpha_2 \cdot \widehat{CDS\ Index}_t \times CB_t && \text{(OA5.2)} \\ &\quad + \lambda \cdot Controls_{i,t} + \eta_{i,t} \end{aligned}$$

where $Y_{i,t}$ represents the second-stage outcome of interest, *Credit Line Fee*, including the drawn and undrawn prices. We control for the loan sizes, different loan maturities, collateral, and lender numbers. We find fixed effects cause collinearity issues in estimations, so we exclude them in two stages.

Columns (1) and (4) of Table OA5.1 report the OLS estimates of credit line prices on funding costs. Without incorporating central bank total assets, funding costs are positively and significantly related to the prices—as lenders demand higher fees to compensate for increased risk. However, the evidence indicates that central bank asset purchase, as captured by the interaction term *CDS Index* × *CB*, substantially mitigates this relationship.

In Table OA5.1 (columns (2) and (5)), the negative second-stage coefficient (-9.763 and -0.191) on instrumented *CDS Index* demonstrates that QE interventions reverse the baseline cost transmission mechanism—a result only identifiable through the 2SLS design. In these specifications, the interaction term between the CDS Index and the QE dummy (denoted by *CB*) captures the baseline effect of funding costs on the prices. Both coefficients are estimated simultaneously within the second-stage regression. Although one might initially expect a positive coefficient on the CDS Index interaction, the negative sign observed here suggests that QE reduces funding costs to such an extent that the sensitivity of credit line prices to these costs is diminished.

Columns (3) and (6) in Table OA5.1 demonstrate that the triple interaction *CDS Index 5Y* × *Asset Purchases* × *CB* is negative and significant, confirming that QE interventions stabilize credit markets by decoupling corporate borrowing costs from bank risk. It matches the interaction results in Columns (2) and (5).

Overall, these results underscore the pivotal role of central bank asset purchases in stabilizing credit markets by reducing the sensitivity of credit line prices to fluctuations in funding costs.

Table OA5.1. **Central Bank Asset Purchase (US)**

This table shows the OLS and 2SLS regression results of credit line prices on funding costs. The dependent variables are *All In Spread Drawn (AISD)* in columns (1) through (3) and *All In Spread Undrawn (AISU)* in columns (4) through (6). The independent variables include a shock dummy (*CB*) equal to one during central bank intervention (QE), an index averaging 12 representative banks' 5-year CDS spreads (*CDS Index 5Y*), and the logarithm of the central bank's monthly asset purchase amount (*Asset Purchases*). The controls include the logarithm of the facility amount, dummies for maturities (1–3 years, 3–6 years, and over 6 years), a dummy for whether a facility is secured, and the logarithm of the number of lenders. Columns (1), (3), (4), and (6) report OLS estimates, while columns (2) and (5) report 2SLS estimates using *Asset Purchases* as an instrument for *CDS Index 5Y*. Fixed effects are included where specified. All variables are winsorized at the 1% and 99% levels. Appendix A contains all variable definitions. Standard errors are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Dependent Variable	AISD			AISU		
	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	2SLS	OLS	OLS	2SLS	OLS
CDS Index 5Y	4.287***	-9.763***	-0.825	0.508***	-0.191**	-0.270**
	(1.083)	(0.611)	(0.836)	(0.150)	(0.084)	(0.115)
CDS Index 5Y × CB	-1.016***	-0.515***	0.000	-0.101***	-0.049***	0.000
	(0.261)	(0.085)	(.)	(0.036)	(0.010)	(.)
Asset Purchases			25.082***			-1.524*
			(6.514)			(0.909)
Asset Purchases × CB			0.000			0.000
			(.)			(.)
CDS Index 5Y × Asset Purchases			0.087			0.033**
			(0.097)			(0.013)
CDS Index 5Y × Asset Purchases × CB			-0.036***			-0.004***
			(0.007)			(0.001)
ln(Loan Amount)	-39.628***	-41.430***	-37.621***	-3.945***	-4.347***	-4.266***
	(0.582)	(0.710)	(0.650)	(0.092)	(0.107)	(0.099)
Maturity 1-3Y	6.768**	-10.787***	11.584***	8.357***	7.676***	8.185***
	(2.696)	(3.274)	(2.968)	(0.363)	(0.433)	(0.386)
Maturity 3-6Y	16.206***	38.452***	45.592***	6.816***	7.209***	7.354***
	(2.126)	(2.233)	(2.218)	(0.261)	(0.263)	(0.260)
Maturity >6Y	74.968***	85.855***	113.674***	14.865***	15.820***	16.386***
	(5.104)	(6.012)	(5.753)	(0.978)	(1.110)	(1.077)
Secured	52.900***	62.037***	84.690***	10.676***	13.209***	13.691***
	(1.189)	(1.807)	(1.278)	(0.182)	(0.260)	(0.185)
ln(#Lenders)	-10.687***	-7.043***	-23.512***	-0.360**	-0.190	-0.536***
	(1.045)	(1.567)	(1.171)	(0.171)	(0.237)	(0.184)
Time FE	yes	no	no	yes	no	no
Industry FE	yes	no	no	yes	no	no
Purpose FE	yes	no	no	yes	no	no
Observations	42880	42880	42880	27314	27314	27314
R^2	0.502	0.324	0.324	0.500	0.353	0.353
First-Stage Results						
Asset Purchases		-3.153***			-3.153***	
		(0.270)			(0.270)	

OA6 Cross-Sectional Analysis

In this section, we complement the results in the main context using an alternative econometric strategy. We estimate a cross-sectional regression with a specification as follows:

$$\Delta \textit{Credit Line Fee}_i = \beta_0 + \beta_1 \Delta \textit{Funding Cost}_i + \varepsilon_i \qquad \text{(OA6.1)}$$

where Δ*Credit Line Fee*$_i$ is the daily change in credit line prices of lender i, measured by all-in-spread-drawn (AISD) and comprehensive fees based on different assumptions of drawn rates (30%, 25%, and 20%). Δ*Funding Cost*$_i$ is the change in funding costs, measured by the 6-month (12-month) LIBOR-OIS spreads. The sampling period contains only one week before and after the first Federal Reserve announcement on March 15, 2020.

Table OA6.1 reports the estimation and confirms our previous results. Central banks' QE is strongly associated with reducing banks' funding costs and credit line prices.

Table OA6.1. **Cross-Sectional Analysis: Credit Line Fees and Funding Costs (US)**

This table estimates credit line fees on funding costs from a specification in equation OA6.1. The dependent variable is credit line fee measured by all-in-spread-drawn (column (1) and usage-weighted spreads in different drawdown assumptions, including 30% (columns (2)), 25% (columns (3)), and 20% (columns (4)). The independent variables include a dummy equal to one indicating the period after central bank intervention (QE) and funding costs measured by 6-month and 12-month LIBOR-OIS spreads. Standard errors are in parentheses. *, **, and *** represent significance at the 10%, 5%, and 1% level, respectively. Variable definitions can be found in Appendix A.

Sample	Credit Lines			
Specification	ΔAISD	ΔUWS 30%	ΔUWS 25%	ΔUWS 20%
Panel A: LIBOR-OIS 6M as Proxy				
	(1)	(2)	(3)	(4)
ΔLIBOR-OIS 6M	-1.612**	-0.518**	-0.439**	-0.359*
	(0.800)	(0.257)	(0.220)	(0.186)
Observations	136	136	136	136
R^2	0.029	0.030	0.029	0.027
Panel B: LIBOR-OIS 12M as Proxy				
	(1)	(2)	(3)	(4)
ΔLIBOR-OIS 12M	-1.862*	-0.484	-0.390	-0.296
	(1.085)	(0.349)	(0.300)	(0.253)
Observations	136	136	136	136
R^2	0.021	0.014	0.012	0.010

OA7 Alternative Test of the QE Impact

We focus on the US sample, including six months before and after March 2020, and estimate cross-sectional specifications as follows:

$$Y_{i,t} = \beta_0 + \beta_1 QE_t + \beta_2 Funding\ Cost_t + \beta_3 Funding\ Cost_t \times QE_t + \gamma_i + \eta_t + \varepsilon_{i,t} \qquad \text{(OA7.1)}$$

where $Y_{i,t}$ is all-in-spread-drawn (AISD) and comprehensive fees based on different assumptions of drawn rates (30%, 25%, and 20%). QE_t is a dummy that takes the value one indicating March 2020 and onward. $Funding\ Cost_t$ is the 6-month (12-month) LIBOR-OIS spreads. γ_i is a set of bank (i.e. lender) fixed effects, and η_t is a set of time fixed effects. Table OA7.1 reports the results. We also find similar results in the European sample reported in Table OA7.2.

Table OA7.1. **Cross-Sectional Analysis: Credit Line Prices and Funding Costs (US)**

This table estimates credit line fees on funding costs from a specification in equation OA7.1. The dependent variable is credit line fee measured by all-in-spread-drawn (column (1) and usage-weighted spreads in different drawdown assumptions, including 30% (columns (2)), 25% (columns (3)), and 20% (columns (4)). The independent variables include a dummy equal to one indicating the period after central bank intervention (QE) and funding costs measured by 6-month and 12-month LIBOR-OIS spreads. All columns include bank and time fixed effects. Standard errors are in parentheses. *, **, and *** represent significance at the 10%, 5%, and 1% level, respectively. All variables are winsorized at 1% and 99%. Variable definitions can be found in Appendix A.

Sample	Credit Lines			
Specification	AISD	UWS 30%	UWS 25%	UWS 20%
Panel A: LIBOR-OIS 6M as Proxy				
	(1)	(2)	(3)	(4)
QE	378.036***	112.410***	96.432***	80.454***
	(62.771)	(21.557)	(18.846)	(16.273)
LIBOR-OIS 6M	5.096***	0.989***	0.800***	0.611***
	(0.914)	(0.310)	(0.271)	(0.234)
LIBOR-OIS 6M×QE	-13.235***	-4.106***	-3.537***	-2.968***
	(2.576)	(0.886)	(0.775)	(0.669)
Bank FE	yes	yes	yes	yes
Time FE	yes	yes	yes	yes
Observations	4772	4930	4930	4930
R^2	0.507	0.436	0.411	0.373
Panel B: LIBOR-OIS 12M as Proxy				
	(1)	(2)	(3)	(4)
QE	650.505***	160.397***	134.564***	108.731***
	(98.258)	(33.460)	(29.252)	(25.258)
LIBOR-OIS 12M	9.662***	1.876***	1.518***	1.159***
	(1.733)	(0.587)	(0.513)	(0.443)
LIBOR-OIS 12M×QE	-14.085***	-3.570***	-3.005***	-2.440***
	(2.173)	(0.741)	(0.648)	(0.560)
Bank FE	yes	yes	yes	yes
Time FE	yes	yes	yes	yes
Observations	4772	4930	4930	4930
R^2	0.507	0.436	0.411	0.373

Table OA7.2. **Cross-Sectional Analysis: Credit Line Prices and Funding Costs (Europe)**

This table estimates credit line fees on funding costs from a specification in equation OA7.1. The dependent variable is credit line fee measured by all-in-spread-drawn (column (1) and usage-weighted spreads in different drawdown assumptions, including 30% (columns (2)), 25% (columns (3)), and 20% (columns (4)). The independent variables include a dummy equal to one indicating the period after central bank intervention (QE) and funding costs measured by 6-month and 12-month LIBOR-OIS spreads. All columns include bank and time fixed effects. Standard errors are in parentheses. *, **, and *** represent significance at the 10%, 5%, and 1% level, respectively. All variables are winsorized at 1% and 99%. Variable definitions can be found in Appendix A.

Sample	Credit Lines			
Specification	AISD	UWS 30%	UWS 25%	UWS 20%
Panel A: LIBOR-OIS 6M as Proxy				
	(1)	(2)	(3)	(4)
QE	331.899	306.786***	304.992***	303.198***
	(201.437)	(79.554)	(72.772)	(66.716)
LIBOR-OIS 6M	4.606**	2.196**	2.024**	1.851**
	(2.203)	(0.870)	(0.796)	(0.730)
LIBOR-OIS 6M×QE	-13.987	-12.644***	-12.548***	-12.452***
	(8.906)	(3.517)	(3.217)	(2.950)
Bank FE	yes	yes	yes	yes
Time FE	yes	yes	yes	yes
Observations	594	594	594	594
R^2	0.464	0.491	0.499	0.509
Panel B: LIBOR-OIS 12M as Proxy				
	(1)	(2)	(3)	(4)
QE	571.734**	401.967***	389.841***	377.715***
	(264.462)	(104.444)	(95.540)	(87.590)
LIBOR-OIS 12M	8.735**	4.164**	3.837**	3.510**
	(4.178)	(1.650)	(1.509)	(1.384)
LIBOR-OIS 12M×QE	-13.832**	-9.841***	-9.556***	-9.271***
	(6.375)	(2.518)	(2.303)	(2.111)
Bank FE	yes	yes	yes	yes
Time FE	yes	yes	yes	yes
Observations	594	594	594	594
R^2	0.464	0.491	0.499	0.509

OA8 Alternative Test of Funding Cost: 12 Banks CDS Spreads

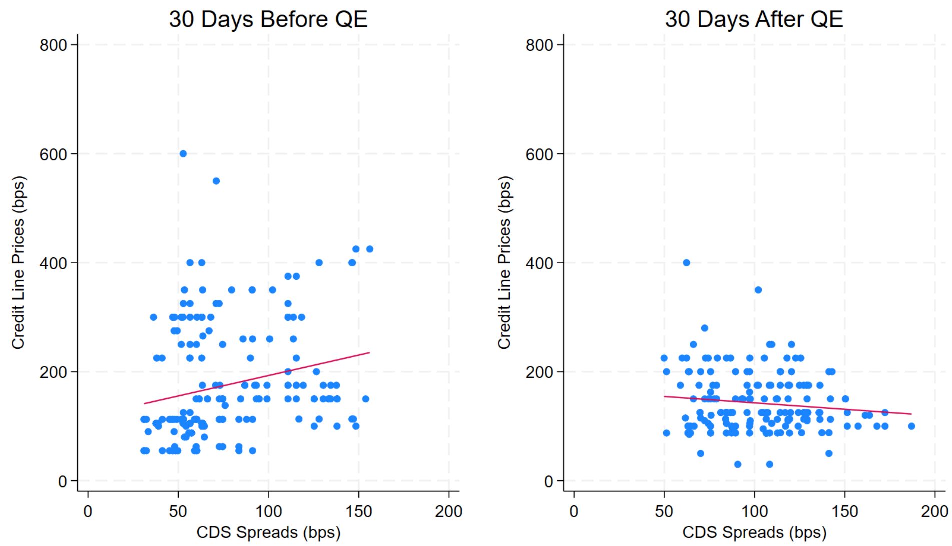

Figure OA8.1. Event Study: 12 Banks. This figure plots the credit line prices against 5-year CDS spreads within the 12 selected banks. The left plot shows 30 days before the QE. The right plot shows 30 days after the QE.

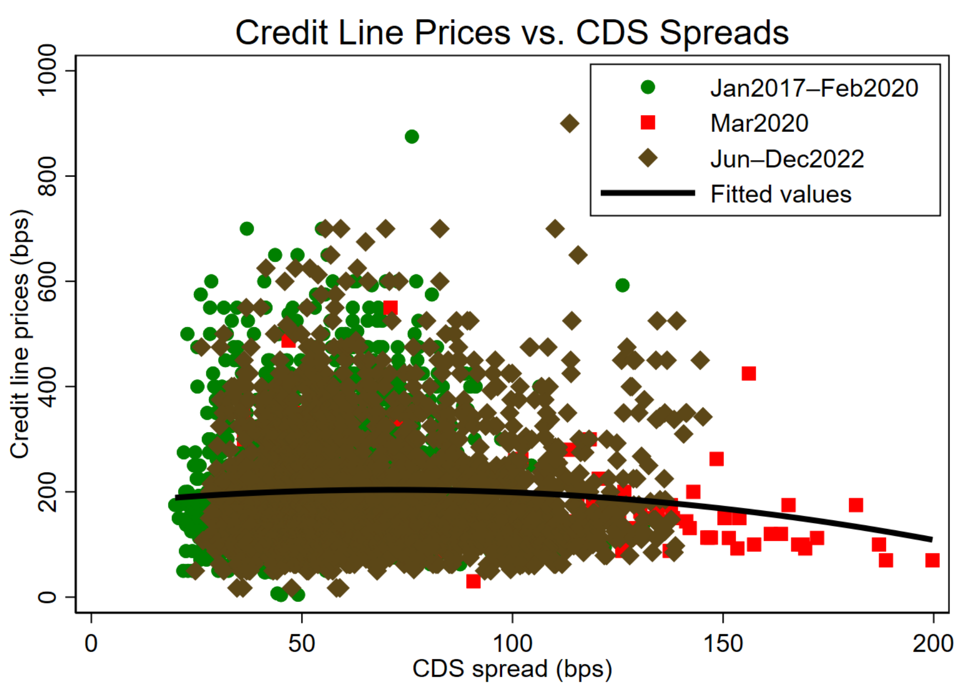

Figure OA8.2. Credit Line Prices versus CDS Spreads. This figure plots the credit line prices against the CDS spreads within the 12 selected banks. The green cycles indicate the period before the QE happening in March 2020. The red squares indicate the shock of QE in March 2020. The brown diamonds indicate the period after the shock.

Table OA8.1. **Comprehensive Credit Line Prices on Debt Overhang Cost (12 Banks)**

This table estimates corporate borrowing costs on banks' funding costs. The dependent variable is *All In Spread Drawn (AISD)* in columns (1) across (2), and *All In Spread Undrawn (AISU)* in columns (3) across (4). The independent variables include 5-year CDS spreads of the 12 banks and a shock dummy equal to one indicating central bank intervention (QE). The controls contain a logarithm of facility amount, dummies indicating 1-3 years, 3-6 years, and over 6 years maturities, a dummy indicating whether a facility is secured, and a logarithm of lender numbers. All columns include year-month, two-digit SIC industry, and loan purpose fixed effects. Standard errors are in parentheses. *, **, and *** represent significance at the 10%, 5%, and 1% level, respectively. All variables are winsorized at 1% and 99%. Variable definitions can be found in Appendix A.

	(1)	(2)	(3)	(4)
	AISD	AISU	AISD	AISU
CDS Spread 5Y	0.295***	0.331***	0.033***	0.035***
	(0.050)	(0.053)	(0.011)	(0.012)
CDS Spread 5Y×CB		-0.402**		-0.015
		(0.176)		(0.035)
ln(Loan Amount)	-15.675***	-15.655***	-4.375***	-4.375***
	(0.793)	(0.792)	(0.193)	(0.193)
Maturity 1-3Y	34.700***	34.638***	12.470***	12.464***
	(3.146)	(3.146)	(0.722)	(0.722)
Maturity 3-6Y	24.735***	24.734***	8.417***	8.418***
	(2.454)	(2.454)	(0.510)	(0.510)
Maturity >6Y	69.817***	69.737***	26.261***	26.257***
	(4.950)	(4.949)	(1.646)	(1.646)
Secured	56.935***	56.925***	11.660***	11.661***
	(1.623)	(1.623)	(0.393)	(0.393)
ln(#Lenders)	-19.929***	-20.016***	0.840**	0.836**
	(1.358)	(1.359)	(0.345)	(0.345)
Time FE	yes	yes	yes	yes
Purpose FE	yes	yes	yes	yes
Observations	17366	17366	10660	10660
R^2	0.372	0.372	0.362	0.362

OA9 Alternative Test of the QE Impact: 2008 Financial Crisis

Table OA9.1. **Credit Line Prices and Funding Costs in the 2008 Crisis (US)**

This table estimates corporate borrowing fees and banks' short-term funding costs during the 2008 Global Finance Crisis (GFC). The sampling period is 2005-2012. The dependent variable is *All In Spread Drawn (AISD)* in columns (1) across (4), and *All In Spread Undrawn (AISU)* in columns (5) across (8). The independent variables include a shock dummy equal to one indicating the Federal Reserve started to intervene in the market (that is, quantitative easing) in September and October 2008, 6-month and 12-month LIBOR-OIS spreads. The controls contain a logarithm of facility amount, dummies indicating 1-3 years, 3-6 years, and over 6 years maturities, a dummy indicating whether a facility is secured, and a logarithm of lender numbers. All columns include year-month, two-digit SIC industry, and loan purpose fixed effects. Standard errors are in parentheses. *, **, and *** represent significance at the 10%, 5%, and 1% level, respectively. All variables are winsorized at 1% and 99%. Variable definitions can be found in Appendix A.

Sample	Credit Lines							
Dependent Variable	AISD				AISU			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
LIBOR-OIS 6M	3.736***	3.736***			0.003	0.003		
	(0.158)	(0.158)			(0.035)	(0.035)		
LIBOR-OIS 6M×QE		-3.252***				0.024		
		(0.144)				(0.033)		
LIBOR-OIS 12M			1.648***	1.648***			0.001	0.001
			(0.070)	(0.070)			(0.016)	(0.016)
LIBOR-OIS 12M×QE				-1.208***				0.029**
				(0.061)				(0.014)
ln(Loan Amount)	-24.216***	-24.216***	-24.216***	-24.216***	-3.221***	-3.221***	-3.221***	-3.221***
	(0.358)	(0.358)	(0.358)	(0.358)	(0.077)	(0.077)	(0.077)	(0.077)
Maturity 1-3Y	16.274***	16.274***	16.274***	16.274***	5.166***	5.166***	5.166***	5.166***
	(1.508)	(1.508)	(1.508)	(1.508)	(0.306)	(0.306)	(0.306)	(0.306)
Maturity 3-6Y	25.881***	25.881***	25.881***	25.881***	5.753***	5.753***	5.753***	5.753***
	(1.320)	(1.320)	(1.320)	(1.320)	(0.264)	(0.264)	(0.264)	(0.264)
Maturity >6Y	30.240***	30.240***	30.240***	30.240***	9.374***	9.374***	9.374***	9.374***
	(2.455)	(2.455)	(2.455)	(2.455)	(0.593)	(0.593)	(0.593)	(0.593)
Secured	60.537***	60.537***	60.537***	60.537***	15.582***	15.582***	15.582***	15.582***
	(0.673)	(0.673)	(0.673)	(0.673)	(0.145)	(0.145)	(0.145)	(0.145)
ln(#Lenders)	-28.528***	-28.528***	-28.528***	-28.528***	-0.932***	-0.932***	-0.932***	-0.932***
	(0.567)	(0.567)	(0.567)	(0.567)	(0.123)	(0.123)	(0.123)	(0.123)
Time FE	yes	yes	yes	yes	yes	yes	yes	yes
Industry FE	yes	yes	yes	yes	yes	yes	yes	yes
Purpose FE	yes	yes	yes	yes	yes	yes	yes	yes
Observations	83302	83302	83302	83302	66601	66601	66601	66601
R^2	0.584	0.584	0.584	0.584	0.454	0.454	0.454	0.454

Table OA9.2. **Credit Line Prices and Long-Term Funding Costs in the 2008 Crisis (US)**

This table estimates corporate borrowing costs on banks' funding costs during the 2008 Global Finance Crisis (GFC). The sampling period is 2005-2012. The dependent variable is *All In Spread Drawn (AISD)* in columns (1) across (2), and *All In Spread Undrawn (AISU)* in columns (3) across (4). The independent variables include a shock dummy equal to one indicating the Federal Reserve started to intervene in the market (that is, quantitative easing) in September and October 2008, and an index averaging 12 representative banks' 5-year CDS spreads. The controls contain a logarithm of facility amount, dummies indicating 1-3 years, 3-6 years, and over 6 years maturities, a dummy indicating whether a facility is secured, and a logarithm of lender numbers. All columns include year-month, two-digit SIC industry, and loan purpose fixed effects. Standard errors are in parentheses. *, **, and *** represent significance at the 10%, 5%, and 1% level, respectively. All variables are winsorized at 1% and 99%. Variable definitions can be found in Appendix A.

Sample	Credit Lines			
Dependent Variable	AISD		AISU	
	(1)	(2)	(3)	(4)
CDS Index 5Y	0.682***	0.682***	0.001	0.001
	(0.029)	(0.029)	(0.006)	(0.006)
CDS Index 5Y×CB		-0.138***		0.043***
		(0.035)		(0.008)
ln(Loan Amount)	-24.216***	-24.216***	-3.221***	-3.221***
	(0.358)	(0.358)	(0.077)	(0.077)
Maturity 1-3Y	16.274***	16.274***	5.166***	5.166***
	(1.508)	(1.508)	(0.306)	(0.306)
Maturity 3-6Y	25.881***	25.881***	5.753***	5.753***
	(1.320)	(1.320)	(0.264)	(0.264)
Maturity >6Y	30.240***	30.240***	9.374***	9.374***
	(2.455)	(2.455)	(0.593)	(0.593)
Secured	60.537***	60.537***	15.582***	15.582***
	(0.673)	(0.673)	(0.145)	(0.145)
ln(#Lenders)	-28.528***	-28.528***	-0.932***	-0.932***
	(0.567)	(0.567)	(0.123)	(0.123)
Time FE	yes	yes	yes	yes
Industry FE	yes	yes	yes	yes
Purpose FE	yes	yes	yes	yes
Observations	83302	83302	66601	66601
R^2	0.584	0.584	0.454	0.454

OA10 Additional Analyses

We now test whether pricing of contingent credit embeds funding-risk exposure, and whether APP attenuates that pricing sensitivity in the contract segments predicted by the covariance mechanism. Our model formalizes this mechanism in Equation 13, which contains the covariance structure discussed earlier. Equation 13 implies that APP, by lowering credit spreads (i.e., reducing funding costs), mitigates the covariance effect.

Does the central bank's APP mitigate the covariance between funding costs and credit line drawdowns? One might conjecture so based on the theoretical results in Cooperman et al. (2025). However, this would implicitly assume symmetry (i.e., that increases and decreases in funding costs have equal and symmetric effects on credit line prices). Our empirical question is therefore important and deserves further analysis.

Although in this section we focus on the US and the Fed, we also present correlation results for the ECB's QE in Europe (see the online appendix) to strengthen the case that APP affects credit line pricing by mitigating balance-sheet frictions. By considering two jurisdictions and different approaches to QE, we can better account for factors specific to a given geographic area or QE implementation.

OA10.1 US Market

We study whether banks' funding costs are associated with credit line prices.[17] We employ the following regression:

$$\begin{aligned} Y_{i,t} \quad = \quad & \beta_0 + \beta_1 \mathit{LIBOR\text{–}OIS}_t + \beta_2 \mathit{LIBOR\text{–}OIS}_t \times CB_t + \beta_3 \mathit{ln(Loan\ Amount)}_{i,t} \\ & + \beta_4 \mathit{Maturity\ 1\text{–}3yr}_{i,t} + \beta_5 \mathit{Maturity\ 3\text{–}6yr}_{i,t} + \beta_6 \mathit{Maturity\ {>}6yr}_{i,t} + \beta_7 \mathit{Secured}_{i,t} \\ & + \beta_8 \mathit{ln(\#Lenders)}_{i,t} + \gamma X_{i,t} + \varepsilon_{i,t} \end{aligned} \tag{OA10.1}$$

where $Y_{i,t}$ denotes corporate borrowing fees, and $\mathit{LIBOR\text{–}OIS}_t$ is the LIBOR–OIS spread, which proxies for funding costs. CB_t is a time dummy equal to one after March 2020, when central banks implemented QE. $\mathit{ln(Loan\ Amount)}_{i,t}$ denotes the natural logarithm of the facility amount, which for revolving credit facilities corresponds to the total committed amount. A set of dummies, $\mathit{Maturity\ 1\text{–}3yr}_{i,t}$, $\mathit{Maturity\ 3\text{–}6yr}_{i,t}$,

[17] Following Burnside & Cerrato (2023), we use LIBOR–OIS spreads to proxy for funding costs. In the online appendix, we also report results using banks' CDS spreads and alternative methodologies. This correlation analysis provides a benchmark for the remainder of the empirical results. Table OA4.1 in Appendix OA4.1 shows the results.

and $Maturity > 6yr_{i,t}$, control for facility maturity. $Secured_{i,t}$ is a dummy indicating that the facility is collateralized, and $ln(\#Lenders)_{i,t}$ denotes the natural logarithm of the number of lenders. $X_{i,t}$ denotes fixed effects, including time, industry, and loan purpose.

Columns (1) through (8) in Table OA10.1 report the OLS results from Equation OA10.1. We begin with credit line prices (columns (1) to (4)). The coefficients on the LIBOR–OIS spread are positive and statistically significant, suggesting that US banks pass higher funding costs on to borrowers by increasing credit line prices. For example, a 1-basis-point increase in 6-month (12-month) LIBOR–OIS spreads is associated with a 3.2-basis-point (1.8-basis-point) increase in drawdown fees. This result is consistent with the theoretical model in Cooperman et al. (2025).

The positive coefficient on the LIBOR–OIS spread in columns (5) through (8) indicates that higher funding costs also raise the price of undrawn credit lines. The undrawn price increases by 0.4 basis points (0.2 basis points) following a 1-basis-point increase in 6-month (12-month) LIBOR–OIS spreads. Note that the impact of funding costs on undrawn prices is much smaller (and sometimes insignificant) relative to drawdown prices. This is plausible because undrawn credit lines are off-balance-sheet items and therefore are less sensitive to increases in funding (and regulatory) costs.

Based on Section 2.4, we include an interaction between funding costs and a post-APP dummy to capture the effect of central bank asset purchases. We set the dummy equal to one in March 2020. Cooperman et al. (2025) and our theory in Section 5 imply a covariance-based mechanism between banks' funding costs and drawdown size.

Columns (2), (4), (6), and (8) of Table OA10.1 report the estimated coefficients on the interaction term in Equation OA10.1. The combined coefficients on the LIBOR–OIS spread and the interaction term capture how the relationship between funding costs and prices changes after APP. The results suggest that APP mitigates the pass-through of funding costs to credit line prices.

Our results reinforce the conjecture that the Fed's Asset Purchase Program can mitigate the wedge by easing banks' balance-sheet constraint[18]

In Online Appendix OA9, we consider the period around the 2008 financial crisis. Although this shock differs from the COVID-19 episode, the APP launched during the financial crisis was also intended to stabilize financial markets. We therefore expect similar effects because the underlying balance-sheet mechanism is comparable in 2008 and 2020. Table OA9.1 (using LIBOR-based measures) and Table OA9.2 (using

[18] We also report complementary results in Table OA4.1 of Online Appendix OA4.1.

CDS spreads) confirm that APP also mitigated debt-overhang costs embedded in credit line prices during the financial crisis. Overall, our results are robust.

Finally, we use a counterfactual exercise in Appendix OA1 to corroborate our intuition. We examine QE episodes launched by the Fed during 2012–2014 and by the ECB during 2013–2017. Because these programs were designed primarily as monetary policy tools—rather than to address acute funding pressure or balance-sheet frictions—we expect either no significant effects or mixed results. Consistent with this view, Appendix OA1 shows that in the US (Table OA1.1) credit line prices increased (rather than decreased), while in Europe (Table OA1.2) QE had no significant effect on prices. The online appendix presents alternative empirical approaches to test the relationship between QE, bank funding costs, and credit line prices, yielding similar conclusions to those in this section.

Table OA10.1. **Credit Line Prices and Funding Costs (US)**

This table estimates corporate borrowing fees and banks' short-term funding costs. The dependent variable is *All In Spread Drawn (AISD)* in columns (1) across (4), and *All In Spread Undrawn (AISU)* in columns (5) across (8). The independent variables include a shock dummy equal to one indicating central bank asset purchases (QE), 6-month and 12-month LIBOR-OIS spreads. The controls contain a logarithm of facility amount, dummies indicating 1-3 years, 3-6 years, and over 6 years maturities, a dummy indicating whether a facility is secured, and a logarithm of lender numbers. All columns include year-month, two-digit SIC industry, and loan purpose fixed effects. Standard errors are in parentheses. *, **, and *** represent significance at the 10%, 5%, and 1% level, respectively. All variables are winsorized at 1% and 99%. Variable definitions can be found in Appendix A.

Dependent Variable:	AISD (Drawn)				AISU (Undrawn)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
LIBOR-OIS 6M	3.211***	3.211***			0.380***	0.380***		
	(0.811)	(0.811)			(0.113)	(0.113)		
LIBOR-OIS 6M × CB		-1.801***				-0.070		
		(0.563)				(0.079)		
LIBOR-OIS 12M			1.812***	1.812***			0.215***	0.215***
			(0.458)	(0.458)			(0.064)	(0.064)
LIBOR-OIS 12M × CB				-0.424*				0.089***
				(0.221)				(0.031)
Loan Controls:								
ln(Loan Amount)	-39.63***	-39.63***	-39.63***	-39.63***	-3.95***	-3.95***	-3.95***	-3.95***
Secured	52.90***	52.90***	52.90***	52.90***	10.68***	10.68***	10.68***	10.68***
ln(#Lenders)	-10.69***	-10.69***	-10.69***	-10.69***	-0.36**	-0.36**	-0.36**	-0.36**
Maturity Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	42,880	42,880	42,880	42,880	27,314	27,314	27,314	27,314
R^2	0.502	0.502	0.502	0.502	0.500	0.500	0.500	0.500

OA10.2 European Market

In this section, we focus on the European market to strengthen our case that APP can affect credit lines' prices by reducing funding costs. By considering two different countries, different banking systems and different ways of conducting APP, we can mitigate the effect of factors specific to a geographic area, banking system or APP implementation. Furthermore, this will help us to understand credit line price dynamics in the US and Europe, following APP.

We use the same econometric framework as before. We regress LIBOR-OIS spreads on credit line drawdown prices and undrawn prices by using equation OA10.1 specification.[19] Table OA10.2 shows the empirical results.

In line with the US market, we note positive and significant coefficients on LIBOR-OIS spreads versus drawdown prices (columns (1) across (4)) using the OLS specification. Credit lines' prices in Europe are more sensitive to banks' funding costs (see columns 1 and 3) if compared with the US. Furthermore, the impact of QE on funding costs is larger in Europe (see columns (2) and (4)).

The results in Table OA10.2 suggest that the ECB Asset Purchase Programs also contributed to mitigating banks' funding costs with a beneficial effect on credit lines' prices. Banks raise the price on undrawn credit lines (columns (6) and (8)).[20]

OA10.3 Does APP Increase the Transatlantic Credit Line Price Gap?

As shown in Table OA10.2, APP increases undrawn fees in Europe (2.960) while reducing drawdown prices (-4.460). This contrasts with the US, where undrawn fees remain neutral in the COVID-19 pandemic (Table OA10.1) or marginally responsive in the GFC (Table OA9.1). It reveals a strategic repricing mechanism unique to bank-dominated systems: European banks compensate for QE-induced drawn spread compression by raising undrawn fees—effectively transferring liquidity costs from crisis borrowers to precautionary users.

Our findings build on and extend the insights of Berg et al. (2017) who document structural differences in credit line pricing between the US and Europe—specifically, that European banks tend to charge higher undrawn fees (AISU) and lower drawdown spreads (AISD) relative to their US counterparts. While their analysis focuses on long-run institutional patterns and only covers the GFC and the European sovereign

[19] In Table OA4.4 of Appendix OA4.2, we regress corporate borrowing prices of credit lines on bank funding costs.
[20] Table OA4.4 in Appendix OA4.2 reports the results by using banks' CDS spreads.

Table OA10.2. **Credit Line Prices and Funding Costs (Europe)**

This table estimates corporate borrowing prices on banks' funding costs. The dependent variable is *All In Spread Drawn (AISD)* in columns (1) across (4), and *All In Spread Undrawn (AISU)* in columns (5) across (8). The independent variables include a shock dummy equal to one indicating central bank intervention (QE), 6-month and 12-month LIBOR-OIS spreads. The controls contain a logarithm of facility amount, dummies indicating 1-3 years, 3-6 years, and over 6 years maturities, a dummy indicating whether a facility is secured, and a logarithm of lender numbers. All columns include year-month, two-digit SIC industry, and loan purpose fixed effects. Standard errors are in parentheses. *, **, and *** represent significance at the 10%, 5%, and 1% level, respectively. All variables are winsorized at 1% and 99%. Variable definitions can be found in Appendix A.

Sample	Credit Lines							
Dependent Variable	AISD				AISU			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
LIBOR-OIS 6M	5.828***	5.828***			-4.067***	-4.067***		
	(1.301)	(1.301)			(0.569)	(0.569)		
LIBOR-OIS 6M×CB		-4.460***				2.960***		
		(0.934)				(0.401)		
LIBOR-OIS 12M			3.289***	3.289***			-2.295***	-2.295***
			(0.735)	(0.735)			(0.321)	(0.321)
LIBOR-OIS 12M×CB				-1.932***				1.200***
				(0.387)				(0.162)
ln(Loan Amount)	-15.047***	-15.047***	-15.047***	-15.047***	-8.753***	-8.753***	-8.753***	-8.753***
	(1.071)	(1.071)	(1.071)	(1.071)	(0.956)	(0.956)	(0.956)	(0.956)
Maturity 1-3Y	51.166***	51.166***	51.166***	51.166***	0.815	0.815	0.815	0.815
	(5.060)	(5.060)	(5.060)	(5.060)	(3.699)	(3.699)	(3.699)	(3.699)
Maturity 3-6Y	43.254***	43.254***	43.254***	43.254***	6.472**	6.472**	6.472**	6.472**
	(4.629)	(4.629)	(4.629)	(4.629)	(3.071)	(3.071)	(3.071)	(3.071)
Maturity >6Y	73.271***	73.271***	73.271***	73.271***	9.061**	9.061**	9.061**	9.061**
	(5.697)	(5.697)	(5.697)	(5.697)	(4.519)	(4.519)	(4.519)	(4.519)
Secured	69.379***	69.379***	69.379***	69.379***	7.631***	7.631***	7.631***	7.631***
	(2.478)	(2.478)	(2.478)	(2.478)	(2.009)	(2.009)	(2.009)	(2.009)
ln(#Lenders)	-27.293***	-27.293***	-27.293***	-27.293***	3.627**	3.627**	3.627**	3.627**
	(2.010)	(2.010)	(2.010)	(2.010)	(1.564)	(1.564)	(1.564)	(1.564)
Time FE	yes	yes	yes	yes	yes	yes	yes	yes
Industry FE	yes	yes	yes	yes	yes	yes	yes	yes
Purpose FE	yes	yes	yes	yes	yes	yes	yes	yes
Observations	7064	7064	7064	7064	1995	1995	1995	1995
R^2	0.609	0.609	0.609	0.609	0.774	0.774	0.774	0.774

debt crisis, we provide new evidence that APP amplifies this transatlantic pricing gap during crisis periods. In particular, we show that during the COVID-19 shock, European banks increased undrawn fees even as drawdown spreads declined (Tables OA10.2 & OA4.4), suggesting an active policy-induced repricing by banks under central bank interventions. This pattern contrasts with the US market, where undrawn fees remained largely unchanged, and drawdown spreads fell more directly in response to APP (Tables OA10.1 & OA4.1). Our results highlight a previously undocumented policy-induced divergence in credit line pricing structures, adding a novel, dynamic dimension to the literature on liquidity risk management and the cross-market transmission of monetary policy.

Although the literature on loan facilities' fees uses All In Spread Drawn as a crucial proxy for the loan price, following Berg et al. (2017), we also employ a comprehensive measure of borrowing fee, which is "usage-weighted spread (UWS)." UWS consists of two parts: 1) All In Spread Drawn, measuring borrowers' cost of drawing down credit lines, and 2) All In Spread Undrawn, measuring borrowers' cost of keeping the undrawn amount of credit lines. This is defined as follows:

$$UWS(p) \quad = \quad p \cdot \textit{All In Spread Drawn} + (1-p) \cdot \textit{All In Spread Undrawn} \qquad \text{(OA10.2)}$$

where p represents the probability of a firm drawing down credit lines, and $1-p$ represents the probability that this firm withdraws nothing from credit facilities. As Berg et al. (2016) and Berg et al. (2017) measure the average credit line drawdown rate (or credit line usage) is around 20%-30% across European and US firms, we apply this range and approximate the drawdown probability p as 30%, 25%, and 20%, respectively. We construct a comprehensive borrowing cost, UWS, based on the following assumptions: *UWS 30%*, *UWS 25%*, and *UWS 20%*. Substituting $Y_{i,t}$ in equation OA10.1 with UWSs, we report the results in Table OA10.3 (for the US market) and OA10.4 (for the European market).

Regarding the US market, Table OA10.3 shows that the coefficients on LIBOR-OIS spread for UWS are similar to those in Table OA10.1. Columns (1) to (12) are based on OLS specifications as in equation OA10.1, holding positive coefficients and suggesting that, without central banks' Asset Purchase Programs, banks would have increased lines' fees. The drawdown assumption of 30% leads to the largest coefficients in which a 1 basis point increase in 6-month (12-month) LIBOR-OIS spreads leads to a 0.9 basis points (0.5 basis points) increase in borrowing fees.

Columns (2), (4), (6), (8), (10), and (12) in Table OA10.3 show the estimation of the interaction term in equation OA10.1. In line with the results presented earlier, APP does help to mitigate banks' funding costs and this benefit was transferred, in part, to borrowers [21]. Nonetheless, this mitigation effect is significant for shorter-term funding spreads (6M LIBOR-OIS spreads) rather than longer-term ones (12M LIBOR-OIS spreads).

When it comes to the European market, we show the results in Table OA10.4. We find similar results as for the US market (Table OA10.3) on funding costs and their interaction with the COVID-19 shock.[22]

[21] In Table OA4.2 of Appendix OA4.1, we also show similar results when banks' CDS spread is considered.

[22] In Table OA4.5 of Appendix OA4.2, we support these results using banks' CDS spreads.

Table OA10.3. **Credit Line Fees and Funding Costs (US)**

This table estimates corporate borrowing fees on banks' short-term funding costs. The dependent variable is usage-weighted spreads in different drawdown assumptions, including 30% (columns (1) across (4)), 25% (columns (5) across (8)), and 20% (columns (9) across (12)). The independent variables include a shock dummy equal to one indicating central bank intervention (QE), 6-month and 12-month LIBOR-OIS spreads. The controls are the logarithm of facility amount, dummies indicating 1-3 years, 3-6 years, and over 6 years maturities, a dummy indicating whether a facility is secured, and a logarithm of lender numbers. All columns include year-month, two-digit SIC industry, and loan purpose fixed effects. Standard errors are in parentheses. *, **, and *** represent significance at the 10%, 5%, and 1% level, respectively. All variables are winsorized at 1% and 99%. Variable definitions can be found in Appendix A.

Sample	Credit Lines											
Specification	UWS 30%				UWS 25%				UWS 20%			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
LIBOR-OIS 6M	0.874***	0.874***			0.701***	0.701***			0.528***	0.528***		
	(0.261)	(0.261)			(0.227)	(0.227)			(0.196)	(0.196)		
LIBOR-OIS 6M×CB		-0.365**				-0.263*				-0.161		
		(0.181)				(0.158)				(0.136)		
LIBOR-OIS 12M			0.493***	0.493***			0.396***	0.396***			0.298***	0.298***
			(0.148)	(0.148)			(0.128)	(0.128)			(0.111)	(0.111)
LIBOR-OIS 12M×CB				0.007				0.034				0.062
				(0.071)				(0.062)				(0.053)
ln(Loan Amount)	-13.239***	-13.239***	-13.239***	-13.239***	-11.274***	-11.274***	-11.274***	-11.274***	-9.311***	-9.311***	-9.311***	-9.311***
	(0.183)	(0.183)	(0.183)	(0.183)	(0.159)	(0.159)	(0.159)	(0.159)	(0.137)	(0.137)	(0.137)	(0.137)
Maturity 1-3Y	8.440***	8.440***	8.440***	8.440***	8.027***	8.027***	8.027***	8.027***	7.589***	7.589***	7.589***	7.589***
	(0.845)	(0.845)	(0.845)	(0.845)	(0.734)	(0.734)	(0.734)	(0.734)	(0.633)	(0.633)	(0.633)	(0.633)
Maturity 3-6Y	10.865***	10.865***	10.865***	10.865***	9.930***	9.930***	9.930***	9.930***	8.970***	8.970***	8.970***	8.970***
	(0.649)	(0.649)	(0.649)	(0.649)	(0.564)	(0.564)	(0.564)	(0.564)	(0.486)	(0.486)	(0.486)	(0.486)
Maturity >6Y	26.331***	26.331***	26.331***	26.331***	22.409***	22.409***	22.409***	22.409***	18.596***	18.596***	18.596***	18.596***
	(1.630)	(1.630)	(1.630)	(1.630)	(1.416)	(1.416)	(1.416)	(1.416)	(1.221)	(1.221)	(1.221)	(1.221)
Secured	19.449***	19.449***	19.449***	19.449***	16.968***	16.968***	16.968***	16.968***	14.477***	14.477***	14.477***	14.477***
	(0.382)	(0.382)	(0.382)	(0.382)	(0.332)	(0.332)	(0.332)	(0.332)	(0.286)	(0.286)	(0.286)	(0.286)
ln(#Lenders)	0.804**	0.804**	0.804**	0.804**	1.598***	1.598***	1.598***	1.598***	2.385***	2.385***	2.385***	2.385***
	(0.332)	(0.332)	(0.332)	(0.332)	(0.289)	(0.289)	(0.289)	(0.289)	(0.249)	(0.249)	(0.249)	(0.249)
Time FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Industry FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Purpose FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	43667	43667	43667	43667	43667	43667	43667	43667	43667	43667	43667	43667
R^2	0.492	0.492	0.492	0.492	0.475	0.475	0.475	0.475	0.445	0.445	0.445	0.445

Table OA10.4. **Credit Line Prices and Funding Costs (Europe)**

This table estimates corporate borrowing prices on banks' funding costs. The dependent variable is usage-weighted spreads in different drawdown assumptions, including 30% (columns (1) across (4)), 25% (columns (5) across (8)), and 20% (columns (9) across (12)). The independent variables include a shock dummy equal to one indicating central bank intervention (QE), 6-month and 12-month LIBOR-OIS spreads. The controls contain a logarithm of facility amount, dummies indicating 1-3 years, 3-6 years, and over 6 years maturities, a dummy indicating whether a facility is secured, and a logarithm of lender numbers. All columns include year-month, two-digit SIC industry, and loan purpose fixed effects. Standard errors are in parentheses. *, **, and *** represent significance at the 10%, 5%, and 1% level, respectively. All variables are winsorized at 1% and 99%. Variable definitions can be found in Appendix A.

Sample	Credit Lines											
Specification	UWS 30%				UWS 25%				UWS 20%			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
LIBOR-OIS 6M	1.248**	1.248**			0.919*	0.919*			0.590	0.590		
	(0.567)	(0.567)			(0.537)	(0.537)			(0.514)	(0.514)		
LIBOR-OIS 6M×CB		-0.808**				-0.546				-0.283		
		(0.407)				(0.385)				(0.369)		
LIBOR-OIS 12M			0.705**	0.705**			0.519*	0.519*			0.333	0.333
			(0.320)	(0.320)			(0.303)	(0.303)			(0.290)	(0.290)
LIBOR-OIS 12M×CB				-0.270				-0.151				-0.031
				(0.169)				(0.160)				(0.153)
ln(Loan Amount)	-3.873***	-3.873***	-3.873***	-3.873***	-3.066***	-3.066***	-3.066***	-3.066***	-2.258***	-2.258***	-2.258***	-2.258***
	(0.467)	(0.467)	(0.467)	(0.467)	(0.442)	(0.442)	(0.442)	(0.442)	(0.423)	(0.423)	(0.423)	(0.423)
Maturity 1-3Y	13.091***	13.091***	13.091***	13.091***	10.323***	10.323***	10.323***	10.323***	7.554***	7.554***	7.554***	7.554***
	(2.205)	(2.205)	(2.205)	(2.205)	(2.087)	(2.087)	(2.087)	(2.087)	(1.997)	(1.997)	(1.997)	(1.997)
Maturity 3-6Y	11.450***	11.450***	11.450***	11.450***	9.183***	9.183***	9.183***	9.183***	6.917***	6.917***	6.917***	6.917***
	(2.017)	(2.017)	(2.017)	(2.017)	(1.910)	(1.910)	(1.910)	(1.910)	(1.827)	(1.827)	(1.827)	(1.827)
Maturity >6Y	16.150***	16.150***	16.150***	16.150***	12.115***	12.115***	12.115***	12.115***	8.081***	8.081***	8.081***	8.081***
	(2.483)	(2.483)	(2.483)	(2.483)	(2.350)	(2.350)	(2.350)	(2.350)	(2.249)	(2.249)	(2.249)	(2.249)
Secured	22.202***	22.202***	22.202***	22.202***	18.798***	18.798***	18.798***	18.798***	15.395***	15.395***	15.395***	15.395***
	(1.080)	(1.080)	(1.080)	(1.080)	(1.022)	(1.022)	(1.022)	(1.022)	(0.978)	(0.978)	(0.978)	(0.978)
ln(#Lenders)	-10.364***	-10.364***	-10.364***	-10.364***	-9.113***	-9.113***	-9.113***	-9.113***	-7.861***	-7.861***	-7.861***	-7.861***
	(0.876)	(0.876)	(0.876)	(0.876)	(0.829)	(0.829)	(0.829)	(0.829)	(0.793)	(0.793)	(0.793)	(0.793)
Time FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Industry FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Purpose FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	7064	7064	7064	7064	7064	7064	7064	7064	7064	7064	7064	7064
R^2	0.482	0.482	0.482	0.482	0.443	0.443	0.443	0.443	0.395	0.395	0.395	0.395

OA11 Alternative Test of the QE Impact: WHO Announcement of the COVID-19 Pandemic (March 11, 2020)

Table OA11.1. **DID Analysis (US)**

This table shows differences-in-differences estimates. The sampling period contains six months before the central bank's QE in March 2020 and six months after. The dependent variable is loan price. The time dummy is equal to one, indicating the period after March 11, 2020 when the WHO announced the COVID-19 pandemic and zero otherwise. The treatment dummy is equal to one indicating the treatment group and drawdown price across all columns, and zero indicating the control group, which is the undrawn fee in columns (1) - (4) and the term loan price in the rest columns. The control variables contain a logarithm of facility amount, dummies indicating 1-3 years, 3-6 years, and over 6 years maturities, a dummy indicating whether a facility is secured, and a logarithm of lender numbers. Columns (2), (4), (6), and (8) include year-month, two-digit SIC industry, and loan purpose fixed effects. Standard errors are in parentheses. *, **, and *** represent significance at the 10%, 5%, and 1% level, respectively. All variables are winsorized at 1% and 99%. Variable definitions can be found in Appendix A.

Treatment Group	Drawdown Price							
Control Group	Undrawn Fee				Term Loan Price			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Post WHO	2.272***	13.319**	11.880***	2.922	-0.294	6.451	24.649***	9.692
	(0.593)	(6.067)	(2.155)	(6.002)	(7.227)	(9.928)	(5.909)	(7.868)
Treatment	218.729***	190.171***	190.914***	178.215***	-106.111***	-59.536***	-65.907***	-39.371***
	(3.085)	(2.508)	(2.600)	(2.374)	(5.082)	(4.451)	(4.623)	(4.369)
Post WHO×Treatment	-34.962***	-19.761***	-27.332***	-15.892***	-32.396***	-34.889***	-22.271***	-29.058***
	(4.358)	(3.759)	(3.921)	(3.543)	(8.419)	(7.292)	(6.866)	(6.369)
ln(Loan Amount)			-22.963***	-19.324***			-26.787***	-25.199***
			(1.589)	(1.513)			(1.969)	(1.949)
Maturity 1-3Y			-7.346**	-13.468***			-39.765***	-46.898***
			(3.406)	(3.388)			(5.446)	(5.388)
Maturity 3-6Y			10.992***	-13.638***			14.374***	-16.096***
			(2.885)	(2.789)			(5.099)	(5.136)
Maturity >6Y			92.370***	90.198***			22.955***	16.518**
			(24.734)	(25.256)			(8.669)	(8.286)
Secured			60.445***	35.567***			135.918***	92.213***
			(3.185)	(3.589)			(4.184)	(4.316)
ln(#Lenders)			-21.269***	-15.004***			-51.239***	-46.776***
			(2.938)	(2.827)			(3.870)	(3.805)
Constant	23.005***	3.167	212.478***	184.910***	347.845***	326.916***	528.821***	550.843***
	(0.393)	(15.504)	(7.117)	(17.117)	(4.058)	(23.480)	(9.776)	(22.140)
Time FE	no	yes	no	yes	no	yes	no	yes
Industry FE	no	yes	no	yes	no	yes	no	yes
Purpose FE	no	yes	no	yes	no	yes	no	yes
Observations	7616	7616	7615	7615	8261	8261	8258	8258
R^2	0.445	0.647	0.585	0.695	0.104	0.417	0.422	0.568

OA12 Alternative Test of the QE Impact: Functioning Market

Table OA12.1. **DID Analysis: Functioning Market (US)**

This table shows differences-in-differences estimates. The sampling period contains twelve months before the central bank's QE in September 2012 and twelve months after. The dependent variable is loan price. The time dummy is equal to one, indicating the period after September, 2012 when the Federal Reserve announced the QE3 and zero otherwise. The treatment dummy is equal to one indicating the treatment group and drawdown price across all columns, and zero indicating the control group, which is the undrawn fee in columns (1) - (4) and the term loan price in the rest columns. The control variables contain a logarithm of facility amount, dummies indicating 1-3 years, 3-6 years, and over 6 years maturities, a dummy indicating whether a facility is secured, and a logarithm of lender numbers. Columns (2), (4), (6), and (8) include year-month, two-digit SIC industry, and loan purpose fixed effects. Standard errors are in parentheses. *, **, and *** represent significance at the 10%, 5%, and 1% level, respectively. All variables are winsorized at 1% and 99%. Variable definitions can be found in Appendix A.

Treatment Group	Drawdown Price							
Control Group	Undrawn Fee				Term Loan Price			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Post QE	3.571***	-28.490***	0.270	-44.240***	-4.936	-46.433***	-17.289***	-50.486***
	(0.356)	(4.157)	(0.837)	(3.716)	(3.552)	(7.522)	(2.852)	(6.088)
Treatment	210.547***	200.764***	197.368***	189.923***	-135.066***	-98.240***	-89.703***	-67.437***
	(1.640)	(1.452)	(1.413)	(1.298)	(3.195)	(3.022)	(2.554)	(2.484)
Post QE×Treatment	11.331***	9.059***	7.531***	7.732***	19.838***	13.640***	16.858***	9.629***
	(2.207)	(2.012)	(2.041)	(1.880)	(4.167)	(3.806)	(3.393)	(3.197)
ln(Loan Amount)			-14.539***	-19.322***			-17.335***	-21.526***
			(0.689)	(0.717)			(0.967)	(0.957)
Maturity 1-3Y			16.678***	18.157***			4.452	11.500*
			(3.385)	(3.459)			(6.840)	(6.161)
Maturity 3-6Y			25.480***	17.550***			30.052***	24.222***
			(2.530)	(2.635)			(6.197)	(5.472)
Maturity >6Y			22.577**	7.646			87.867***	72.586***
			(9.806)	(8.626)			(7.587)	(6.772)
Secured			42.484***	29.182***			86.017***	68.188***
			(1.214)	(1.194)			(1.736)	(1.648)
ln(#Lenders)			-33.207***	-23.175***			-75.520***	-64.929***
			(1.160)	(1.180)			(1.558)	(1.596)
Constant	29.257***	-40.056***	166.040***	178.484***	374.870***	222.513***	542.725***	557.997***
	(0.216)	(11.036)	(4.338)	(8.401)	(2.751)	(18.788)	(7.979)	(14.581)
Time FE	no	yes	no	yes	no	yes	no	yes
Industry FE	no	yes	no	yes	no	yes	no	yes
Purpose FE	no	yes	no	yes	no	yes	no	yes
Observations	28723	28723	28723	28723	29197	29197	29197	29197
R^2	0.493	0.605	0.598	0.677	0.122	0.312	0.406	0.507

Table OA12.2. **DID Analysis: Functioning Market (Europe)**

This table shows differences-in-differences estimates. The sampling period contains twelve months before the central bank's QE in March 2015 and twelve months after. The dependent variable is loan price. The time dummy is equal to one, indicating the period after March, 2015 when the European Central Bank launched the Asset Purchase Program (APP) and zero otherwise. The treatment dummy is equal to one indicating the treatment group and drawdown price across all columns, and zero indicating the control group, which is the undrawn fee in columns (1) - (4) and the term loan price in the rest columns. The control variables contain a logarithm of facility amount, dummies indicating 1-3 years, 3-6 years, and over 6 years maturities, a dummy indicating whether a facility is secured, and a logarithm of lender numbers. Columns (2), (4), (6), and (8) include year-month, two-digit SIC industry, and loan purpose fixed effects. Standard errors are in parentheses. *, **, and *** represent significance at the 10%, 5%, and 1% level, respectively. All variables are winsorized at 1% and 99%. Variable definitions can be found in Appendix A.

Treatment Group	Drawdown Price							
Control Group	Undrawn Fee				Term Loan Price			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Post QE	13.650***	31.365***	-35.633***	11.378	-25.988***	24.057	-30.295***	27.657*
	(2.510)	(11.153)	(3.890)	(11.195)	(4.592)	(15.914)	(3.808)	(14.472)
Treatment	139.127***	126.237***	121.395***	113.874***	-145.496***	-98.904***	-70.990***	-56.159***
	(2.823)	(2.972)	(2.691)	(2.837)	(3.719)	(3.424)	(3.076)	(2.930)
Post QE×Treatment	12.580***	29.196***	37.467***	43.592***	52.218***	31.266***	27.939***	19.994***
	(4.389)	(4.676)	(4.748)	(4.674)	(5.835)	(4.984)	(4.911)	(4.404)
ln(Loan Amount)			-12.659***	-16.667***			-11.340***	-18.873***
			(1.381)	(1.502)			(1.163)	(1.255)
Maturity 1-3Y			40.565***	45.199***			42.504***	46.325***
			(4.677)	(4.981)			(4.798)	(4.663)
Maturity 3-6Y			23.752***	25.161***			30.209***	37.836***
			(3.344)	(3.976)			(3.980)	(4.252)
Maturity >6Y			24.126***	34.081***			98.023***	105.006***
			(7.035)	(6.735)			(5.705)	(5.491)
Secured			83.966***	67.582***			84.805***	77.345***
			(3.312)	(3.462)			(2.913)	(3.016)
ln(#Lenders)			-37.963***	-22.450***			-46.350***	-30.265***
			(2.994)	(3.126)			(2.742)	(2.953)
Constant	50.692***	55.618***	206.485***	204.300***	335.314***	274.251***	402.952***	386.003***
	(1.628)	(14.772)	(9.201)	(14.756)	(2.917)	(13.738)	(9.057)	(14.646)
Time FE	no	yes	no	yes	no	yes	no	yes
Industry FE	no	yes	no	yes	no	yes	no	yes
Purpose FE	no	yes	no	yes	no	yes	no	yes
Observations	6009	6009	6009	6009	9890	9890	9890	9890
R^2	0.212	0.545	0.462	0.644	0.162	0.435	0.426	0.588