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Quantitative Easing, Banks’ Funding Costs and Credit Line Prices.

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Quantitative Easing, Banks' Funding Costs, and Credit Line Prices*

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Abstract

Recently, Cooperman et al. (2023) show that the covariance of banks' funding costs and credit lines draw-downs is debt overhang costs for the bank's equity holders. In this paper, we empirically and theoretically study whether this cost can be mitigated by central banks' quantitative easing. We focus on the COVID-19 shock. Based on Cooperman et al. (2023), we empirically find that funding costs generate frictions related to banks' shareholders (debt overhang cost), and banks transfer that cost to the credit lines' fees. However, our econometric analysis, event studies, and theory suggest and formalise why central banks' quantitative easing (QE) can be crucial to mitigating that cost, thereby ensuring a cheaper supply of credit to the economy. Our findings shed further light on the intricate relationship between banks' funding costs and related debt overhang (Andersen et al. 2019), focusing on an important source of credit for firms: credit lines.

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

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

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1 Introduction

Over the past decade, credit lines have channelled a significant amount of credit from banks to US and European enterprises. For example, Cerrato et al. (2023) estimate that European firms (the euro area), during the COVID-19 shock, drew down over €87bn in a short time to stay afloat. This was an unprecedented flight to liquidity on a macroeconomic scale during which the average credit line to total assets ratios rose from 4.72% in 2020:Q1 to 5.15% in 2020:Q2 (average of 7.00% during 2020:Q2-Q3). Acharya & Steffen (2020) show similar results for US firms.

There is extensive literature on firms' liquidity risk management using credit lines (for example, Campello et al. (2011), Acharya et al. (2013), and more). Our paper departs from this literature as it mainly focuses on banks' increasing funding costs post-2008 and its association with credit line prices. We exploit the 2020 COVID-19 shock to study this issue. Recently, Cooperman et al. (2023) made an important contribution, showing that the covariance of banks' funding costs and credit lines draw-downs is debt overhang cost for the banks' equity holders as it introduces a wedge in the (expected) price of lines. We take one step further and ask whether central banks' quantitative easing (QE) can help mitigate debt overhang costs and if the equity holders' beneficial effect from QE (if any) is transferred to final clients (i.e. borrowers). Given the relevance of our topic, our paper speaks to different strands of the literature, for example, post-2008 funding frictions and their effect on asset prices, as well as central banks' intervention to stabilise financial markets and asset prices, and others that we review below.

We make several important contributions. First, our paper is one of the first to suggest that banks' funding costs and related debt overhang costs (see Andersen et al. (2019)) are pervasive and affect the price of credit lines to firms. Cooperman et al. (2023) discuss funding costs and credit lines draw-downs under the switch from LIBOR to SOFR rate). More importantly, we argue empirically and theoretically that central banks' QE can mitigate debt overhang costs for the bank and ensure a (cheap) credit supply to the economy. These are new and important empirical and theoretical results.

Our empirical results and event studies suggest that central banks' quantitative easing (QE) in March 2020 was effective in reducing banks' funding costs (and shareholders' debt overhang costs as indicated in Andersen et al. (2019)), and this contributed to reducing credit lines' fees. We follow Burnside & Cerrato (2023) and use the 5-year CDS spreads for the 12 largest (European and US) dealers. Banks' CDS spread is widely used in the industry as a measure of costs and funding value adjustment (FVA) and, therefore, a good proxy for shareholders' debt overhang costs[1].

Finally, we theoretically discuss the mechanism at work on lines' prices when central banks' QE started in March 2020. We extend the theoretical framework in Cooperman et al. (2023) to show that QE sets an upper bound to banks' funding rates, mitigating debt overhang costs to banks' shareholders. Banks transfer this beneficial effect following QE to borrowers via cheap lines. The framework assumes a risk-neutral bank maximizing equity holders' profit by setting a price for the lines to ensure this is achieved.

What is a credit line? Credit lines are financial contracts enabling firms to draw funds from their bank accounts and have financing available as contingent liquidity provisions to offset shocks (Holmström & Tirole 1998). Hence, they are contingent liquidity lines which can be seen as insurance against unexpected future liquidity shocks. This funding vehicle is crucial in Europe given the high reliance of European firms on bank-based financing, further underscoring its significance relative to alternative capital market-based financing channels in the US.

There is a vast literature for US firms on using credit lines for liquidity risk management (Sufi 2009, Acharya & Steffen 2020, Brown et al. 2021) as well as credit lines' prices (Berg et al. 2016, 2017). While this literature is abundant for the US, it is rather scarce for Europe same literature for Europe (Cerrato et al. 2023). Our paper also speaks to this part of the literature, adding a novel message: Central banks' QE can mitigate liquidity risk and ensure cheaper finance for European and US firms. Additionally, it extends this literature to study cross-country differences in lines' prices as in Berg et al. (2016) and Berg et al. (2017).

Aside from the above literature, our paper is more directly related to the recent literature studying banks' funding frictions and related debt overhang costs to explain some observed empirical facts such as deviations in covered interest rate parity (CIP) post-2008, interest rate future, and more (for example, Du et al. (2018), Du et al. (2023), Andersen et al. (2019), Fleckenstein & Longstaff (2020), Burnside & Cerrato (2023), and Cerrato et al. (2023)). We focus on credit lines and credit lines' fees and introduce a new dimension, central banks' QE.

The closest paper to ours is Cooperman et al. (2023) who show that credit lines' drawdowns increase when banks' funding costs are high. This correlation between banks' funding costs and credit line drawdowns poses a significant cost for banks' shareholders (debt overhang costs). While that paper mainly focused on important friction (funding costs following the switch from LIBOR

[1]For the banks, see also discussion in Burnside & Cerrato (2023). They have also used other proxies for FVA, such as banks' asset swaps and others, and their empirical results are unchanged. We first show that when the FED started quantitative easing (QE) in March 2020, credit spreads dropped quickly, and credit line prices followed. This suggests that lower funding costs associated with lower debt overhang costs to equity holders benefit firms.

to SOFR) but did not discuss ways (if any) to mitigate the covariance cost (debt overhang) of the bank, we introduced and studied this new dimension. Additionally, from an empirical viewpoint, our paper complements the empirical analysis in Cooperman et al. (2023) by studying the association of banks' funding costs (as shareholders' debt overhang costs) and credit lines prices, in two critical markets, the European and US markets. In so doing, it also studies cross-country differences in fees. This is in the spirit of Berg et al. (2016) and Berg et al. (2017) who studied cross-country divergences in credit lines' fees.

We find that banks' funding costs are indeed strongly associated with credit lines' (drawn but also undrawn) fees. For example, one basis point increase in funding costs (proxied by the difference between the LIBOR minus OIS spread) leads to a 2-3bp basis point increase in All In Spread Drawn (AISD) spread for US firms and a 3-6 basis point increase for European firms—the opposite is true for the All In Spread Undrawn (AISU).

In the second part of the paper, given our empirical results, we ask ourselves whether central banks' QE can help mitigate shareholders' debt overhang costs to banks. So far, we have yet to be aware of papers that have addressed this critical issue for the credit line market and from the viewpoint of banks' shareholders. One would expect that following QE, banks' funding costs would fall, and consequently, debt overhang costs would be mitigated. The main issue is that we are not aware of papers which have formally tested this. No empirical evidence suggests that central banks' QE can benefit banks' shareholders. Also, it is not evident whether this beneficial effect for shareholders will be transferred to borrowers. This paper addresses these critical issues.

In sum, higher banks' funding costs, especially during adverse shocks, may introduce significant frictions that impact credit lines' prices across Europe and the US. However, central banks' QE can mitigate this cost. The message is that central banks' asset purchase programs can mitigate banks' debt overhang costs with beneficial effects on lines' fees and the economy. Of course, there is a political economy discussion related to our results about whether QE is beneficial for financial markets in the long run (for example, Acharya et al. (2023), Acharya & Rajan (2022), and Greenwood et al. (2016)). Although this is an important issue, it is left on the agenda for future research, but our paper clearly points in the direction that borrowers can benefit from QE. This is a new and important result.

The rest of the paper is as follows. Section 2 introduces the data we employ in our analyses and an event study. Section 3 presents panel regression analyses linking central bank intervention with credit spread and credit line drawdown costs using the US sample. Section 4 then further analyzes these patterns using the European sample. Section 5 introduces a simple theoretical model to explore the mechanism of how central bank intervention affects borrowers' drawdown cost through bank equity holders' debt overhang cost. 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-U.S. firms. In this paper, we focus on loans to European and US corporations. We define European and US loans based on the borrowers' countries[2]. Following Acharya et al. (2013), we do not consider utilities, quasi-public, and financial firms with SIC codes greater than 5999 and lower than 7000, greater than 4899 and lower than 5000, and greater than 8999 from our sample. Our sample covers the period from the beginning of January 2015 to the end of December 2022, including the COVID-19 pandemic crisis. We focus on the COVID-19 shock.

We also collect information on 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. 2023). Following Burnside & Cerrato (2023), we also collect from Bloomberg 5-year credit default swap (CDS) spreads of the 12 representative banks across the two markets. Appendix A provides details of these 12 banks. Our study uses monthly data unless specified otherwise.

Following the the literature on credit lines' prices we use the *All In Spread Drawn* or AISD as the key proxy for the loan price, Berg et al. (2016), and Berg et al. (2017). This is the spread over benchmark interest rates, in our case, the LIBOR, and the facility fee. This is the borrowers' cost of drawing down the credit line. We collect information such as loan size, maturity, loan purpose, and creditor number from the DealScan database to capture the loan characteristics across the European and the US loan markets. These variables are widely used in the literature studying the US and European loan markets (see Carey & Nini (2007), Berg et al. (2016), and Berg et al. (2017)). In addition, we construct several indicators, *Maturity 1-3Y*, *Maturity 3-6Y*, and *Maturity >6Y*, denoting different maturities of loan facilities. The rest are loans with maturities within one year.

[2] In DealScan, we use a variable *Country* which describes borrowers' motherlands to define the US and European countries. Our sample includes European Union (EU) and the United Kingdom (UK) firms. Figure D1 in Appendix E shows that European banks mainly lend to European firms and US banks mainly lend to US firms.

[3] To save space, we only report results using six and one-year LIBOR, results using three-month LIBOR are similar and available upon request

Table 1 presents the summary statistics of all variables. Panel A shows 6-month and 12-month LIBOR-OIS spreads. These are measure of short-term funding costs. During the sampling period we cover, funding costs were, on average, about 34.507 bps (6-month) and 49.852 bps (1-year), We also use banks' CDS spreads as in Burnside & Cerrato (2023) and average them to form an Index. Burnside and Cerrato et al (2023) show that this is also a good funding costs' proxy based on dealers' rather than market spreads. CDS spread is, on average, 66.027 bps over the same sample period. Panels B and C show a summary statistics of the variables employed in this study. The spread of *All In Spread Drawn* is nearly 20 bps lower for European loans than US ones, close to 35 bps in Berg et al. (2017). However, the spread of *All In Spread Undrawn* is 38 bps higher for European loans. The US market has a higher fraction of credit lines (47%) than the European market (35%). Meanwhile, the loan size is also larger in the US market (1,626 million USD) than in the European market (1,270 million USD). Loans to European firms have longer maturity than the ones to US firms (5.3 years compared to 4.8 years). These results are, overall, consistent with Berg et al. (2017).

2.2 Preliminary Statistics

In this section, we fit the average credit lines' prices across the US and European markets. We focus on the COVID-19 shock and fit the lines' prices over two periods. The period before and after the European Central Bank, and Federal Reserve, started the quantitative easying (QE) (we select 20 March as the FED started QE on 23 March 2020) Figure 1 shows the results. There is an impressive change of slope soon after the QE was implemented. The change in slope suggests that line of credits became cheaper following QE. In the next sections, we shall investigate this issue further and we also study empirically and theoretically the mechanism driving it.

Cooperman et al. (2023) show that lines' prices are largely affected by the covariance between credit lines draw-downs and banks' funding costs. They show that this covariance introduces a wedge in the price of lines which represents a compensation for the equity holder of the bank after raising funding to provide a new line to the client. We plot banks' funding costs over our (full) sample period. Figure 2 shows funding spreads at 6-month and 1-year maturity (following Cooperman et al. (2023), we use 6-month and 12-month LIBOR-OIS spreads). We can see that at the time when the WHO declared the outbreak of COVID-19 (March 2020), the 6-month LIBOR-OIS spreads (solid blue line) reached a peak at 100bps, while 12-month spreads (dashed red line)

Table 1. **Summary Statistics**

This table shows the summary statistics for our sample. Panel A shows the 6-month LIBOR-OIS spread, 12-month LIBOR-OIS spread, and the CDS index measured from the average of 12 banks' 5-year CDS spreads. Panel B shows the European sample of 92,899 facilities-month with loan characteristics. Panel C shows the US sample of 111,104 facilities-month with loan characteristics. The period covers 2015-2022. All variables are winsorized at 1% and 99%. Appendix A contains all variable definitions.

Variable	N	Mean	Std. Dev.	Min	0.25	Median	0.75	Max
Panel A: Bank Funding Risk								
LIBOR-OIS 6M (bps)	102,944	34.507	17.898	6.773	23.990	29.800	44.265	101.000
LIBOR-OIS 12M (bps)	102,944	49.852	20.109	13.553	39.715	47.363	61.399	99.218
CDS Index 5Y (bps)	102,944	66.027	19.688	36.198	47.985	62.715	81.224	115.142
Panel B: Europe								
All In Spread Drawn (bps)	22,774	280.374	149.216	2.500	165.000	275.000	375.000	1,450.000
All in Spread Undrawn (bps)	2,185	64.790	56.469	0.350	25.000	50.000	90.000	400.000
Revolver	92,899	0.354	0.478	0.000	0.000	0.000	1.000	1.000
Facility Amount (million USD)	92,653	1,269.504	3,816.877	0.000	141.290	400.000	1,128.800	75,000.000
Maturity	89,145	5.319	3.066	0.083	4.000	5.000	6.000	40.000
Maturity 1-3Y	92,899	0.135	0.342	0.000	0.000	0.000	0.000	1.000
Maturity 3-6Y	92,899	0.518	0.500	0.000	0.000	1.000	1.000	1.000
Maturity >6Y	92,899	0.279	0.449	0.000	0.000	0.000	1.000	1.000
Secured	92,899	0.382	0.486	0.000	0.000	0.000	1.000	1.000
Number of Lenders	92,899	9.332	7.656	1.000	4.000	7.000	12.000	55.000
Panel C: US								
All In Spread Drawn (bps)	90,938	301.379	185.981	30.000	150.000	250.000	410.000	1,100.000
All In Spread Undrawn (bps)	30,028	26.538	19.510	1.750	12.500	25.000	37.500	225.000
Revolver	111,104	0.472	0.499	0.000	0.000	0.000	1.000	1.000
Facility Amount (million USD)	111,031	1,625.904	3,164.691	7.200	185.500	600.000	1,790.000	38,000.000
Maturity	108,775	4.772	1.726	0.167	4.917	5.000	5.000	13.500
Maturity 1-3Y	111,104	0.101	0.301	0.000	0.000	0.000	0.000	1.000
Maturity 3-6Y	111,104	0.644	0.479	0.000	0.000	1.000	1.000	1.000
Maturity >6Y	111,104	0.174	0.379	0.000	0.000	0.000	0.000	1.000
Secured	111,104	0.426	0.494	0.000	0.000	0.000	1.000	1.000
Number of Lenders	111,104	9.466	7.444	1.000	4.000	7.000	13.000	44.000

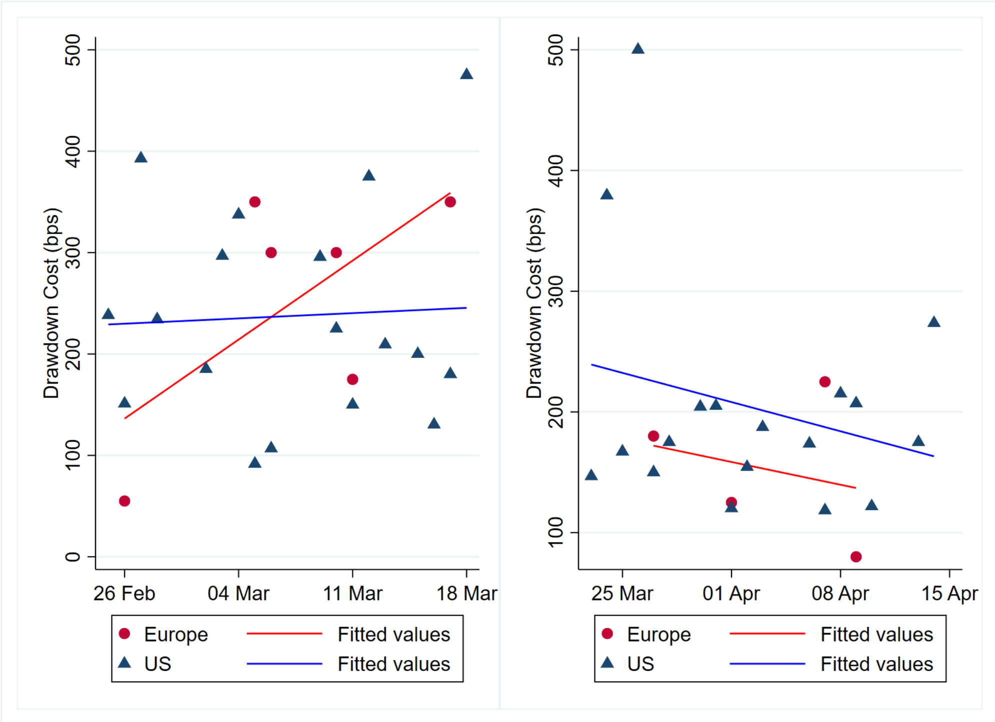


Figure 1. Drawdown Cost. This figure plots the daily average drawdown fee (*All In Spread Drawn*). The red solid line indicates the AISD fees in the European market. The blue solid line indicates the AISD fee in the US market.

also approached 90bps. Spreads dropped quickly soon after central banks' QE [4].

To shed further light on the dynamics behind the LIBOR and OIS rates after the QE, we also show the 6-month (12-month) LIBOR and related OIS rates. Figure 3 shows the 6-month LIBOR (solid blue line) and the OIS rates (dashed red line). We note, indeed, a sharp fall in the OIS rate, which is consistent with investors moving to safe assets like Treasury Bills (He et al. 2022).

We complement the results above using an alternative measure of banks' funding costs, the 5-year CDS spread of the largest US and European banks. This data is collected from Bloomberg for the 12 primary US and European dealers across Europe and US[5]. Figure 4 plots the CDS spread against the sampling period. Similar to Figure 2, we find a peak in March 2020, followed by a significant drop. The evidence points into the direction that QE was effective in reducing banks' funding costs following the COVID-19 shock.

Did central banks' QE help to reduce banks' funding costs? We do a simple event study to shed light on this, reporting the average funding spreads (and lines' prices) between March and May 2020. Table 2 shows a decline in banks' funding costs between March and May 2020. In line with this trend, lines' fees, on average, decreased from March 2020 to April 2020 and remained

[4] According to ECB (2020, Mar 18) and Federal Reserve (2020, Mar 23), European and US central banks announced a vast asset purchase programme to support financial markets. Particularly, the FED started a large QE on 23 March 2020

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

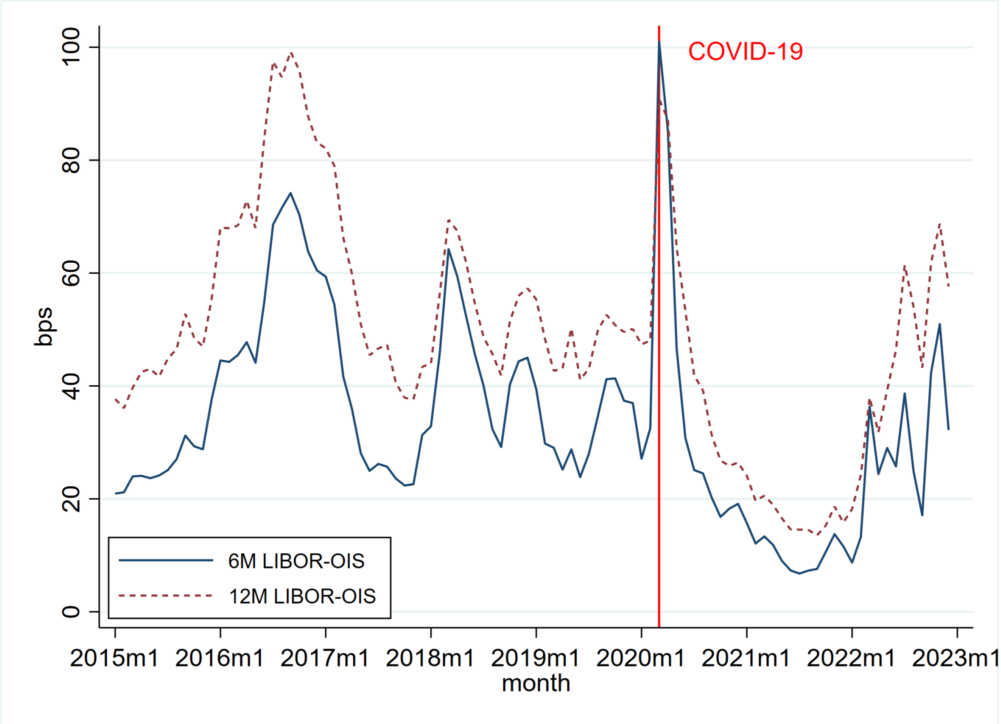


Figure 2. LIBOR-OIS Spread. This figure plots the monthly LIBOR-OIS spread. The blue solid line represents the spread between the 6-month LIBOR-OIS rate. The red dashed line represents the spread 12-month LIBOR-OIS rate. The solid red line represents when the WHO announced the COVID-19 pandemic.

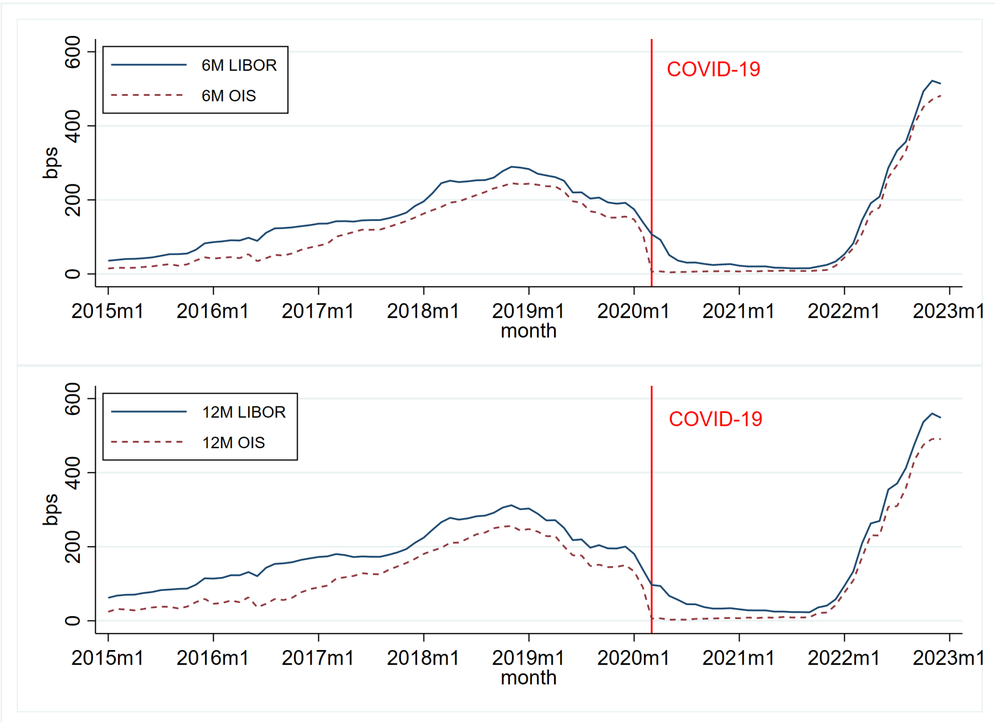


Figure 3. LIBOR and OIS Rates. This figure plots monthly LIBOR and OIS rates. The upper plot shows the rates of 6-month LIBOR (blue solid line) and OIS (red dashed line). The lower plot shows the rates of 12-month LIBOR (blue solid line) and OIS (red dashed line). The solid red line refers to the period when the WHO announced the COVID-19 pandemic.

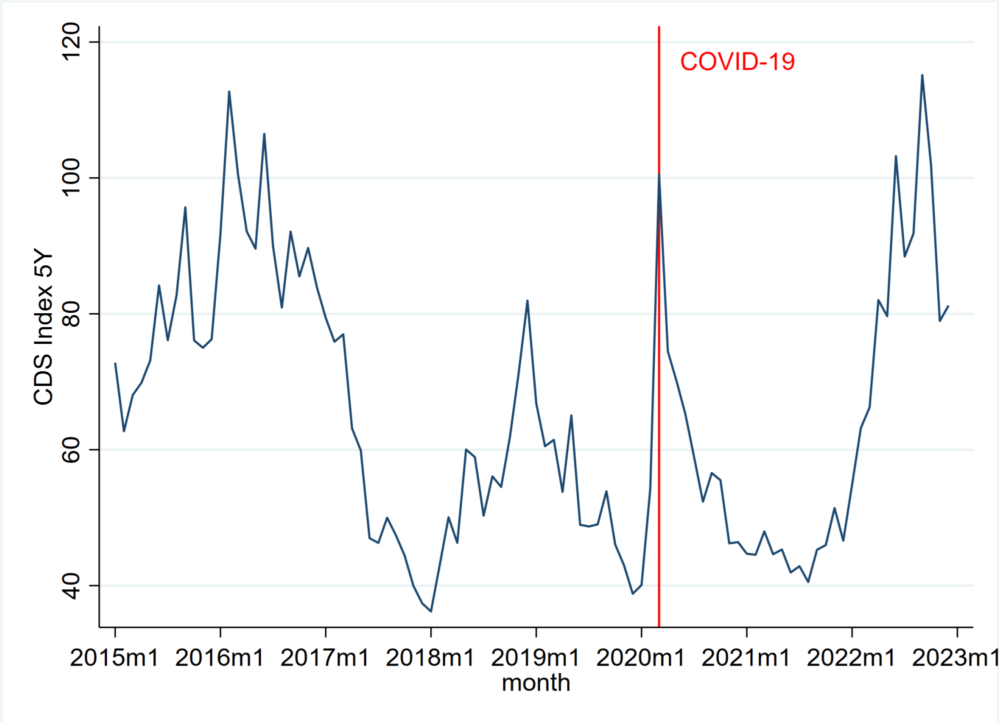


Figure 4. CDS Index. This figure plots the monthly 5-year CDS index. The index is a monthly average of 12 representative banks' 5-year CDS spread. The solid red line represents when the WHO announced the COVID-19 pandemic.

stable in May, with a small difference for the US market. As for commitment fees, both markets had a bounce-back trend within months, but the change in the US market was more pronounced than the European market. Total loan size increased. The European loans were almost three times larger than before [6]. To shed further light on banks' funding costs during the COVID-19 shock, we employ high-frequency data and conduct an additional event study in the next section.

2.3 Time Series Event Study

We consider high frequency CDS spreads and a narrow window around the ECB and the FED QE (17 March to 26 March) to account for the possibility of confunding factors affecting our results. We collect hourly banks' CDS data from Bloomberg [7].

Figure 5 shows the intraday CDS index scatter plot and fitted line around the window. Consistent with the previous results, banks' funding costs increased during the COVID-19 shock and quickly reversed after central banks' QE. The slope coefficients before 23 March are 6.42 bps with a t-statistic of 1.8 for the European market and 13.34 bps with a t-statistic of 11.40 for the US market. After QE, the slope coefficients are -22.79 bps with t-statistic of -9.46 in Europe and -23.30 bps with t-statistic of -17.77 for the US. These results point further into the effectiveness of QE in

[6] The percentage increment in the US market is 119.82% (=(1647.63-749.545)/749.545), while the increment in the European market is 196.58% (=(1184.66-399.44)/399.44).

[7] The ECB announced the Pandemic Emergency Purchase Programme (PEPP) around the 20 March (ECB 2020, Mar 18), and the Federal Reserve announced the policy rate cut on 23 March Federal Reserve (2020, Mar 16).

Table 2. **Basic Statistics**

This table reports monthly statistics of LIBOR rates, OIS rates, LIBOR-OIS spreads, drawdown costs (*All In Spread Drawn*), undrawn fees (*All In Spread Undrawn*), and the sum of loan size (*Total Facility Amount*) from January 2020 to May 2020. The period covers the announcement or the launch of central banks' monetary policies across Europe. All variables have winsorization at 1% and 99%.

	Mar-20	Apr-20	May-20
LIBOR-OIS 6M (bps)	101	85.175	46.675
LIBOR-OIS 12M (bps)	90.79	87.25	64.55
CDS Index 5Y (bps)	100.496	74.459	70.066
Europe			
All In Spread Drawn (bps)	214.595	164.818	215.409
All In Spread Undrawn (bps)	50	54.763	40.25
Total Facility Amount (billion USD)	1,184.66	1,161.20	488.161
US			
All In Spread Drawn (bps)	196.042	176.372	206.812
All In Spread Undrawn (bps)	17.086	28.722	30.036
Total Facility Amount (billion USD)	1,647.63	1,238.65	362.365

reducing banks' funding costs.

2.4 The Effect of Central Bank Intervention

We now support the previous results using simple regression analysis and daily data. We regress the changes in LIBOR-OIS (CDS) spreads over a dummy equal to one representing the period associated with QE between March 2020 and May 2020. Equation 1 details the specification.

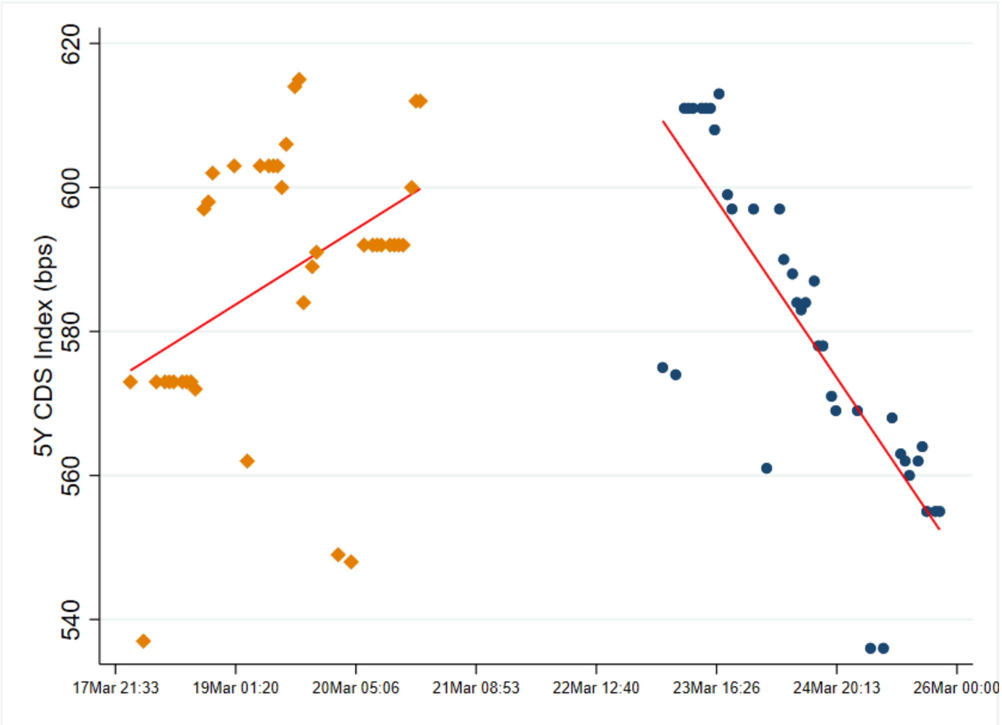
$$\Delta \mathit{LIBOR\text{-}OIS}_t \quad = \quad \alpha_0 + \alpha_0 CB_t + \epsilon_t \tag{1}$$

where $Spread_t$ denotes different measures of banks' funding costs, including 6-month LIBOR-OIS spread, 12-month LIBOR-OIS spreads, and the CDS index at time t[8]. CB_t is a dummy equal to one indicating the period after central banks' QE.

Table 3 shows the results. The significant and negative coefficients in columns (1) and (2) suggest that central bank intervention effectively reduced funding costs during the pandemic. For example, we note a 13 bps decrease in the 6-month LIBOR-OIS spread, and a 20 bps decrease in the 12-month LIBOR-OIS spread. In sum, our results strongly suggest that during the COVID-19 pandemic and following the QE, banks' wholesale funding costs decreased.

[8]CDS index is a monthly average of 12 representative banks' 5-year CDS spreads.

Panel A: Europe



Panel B: US

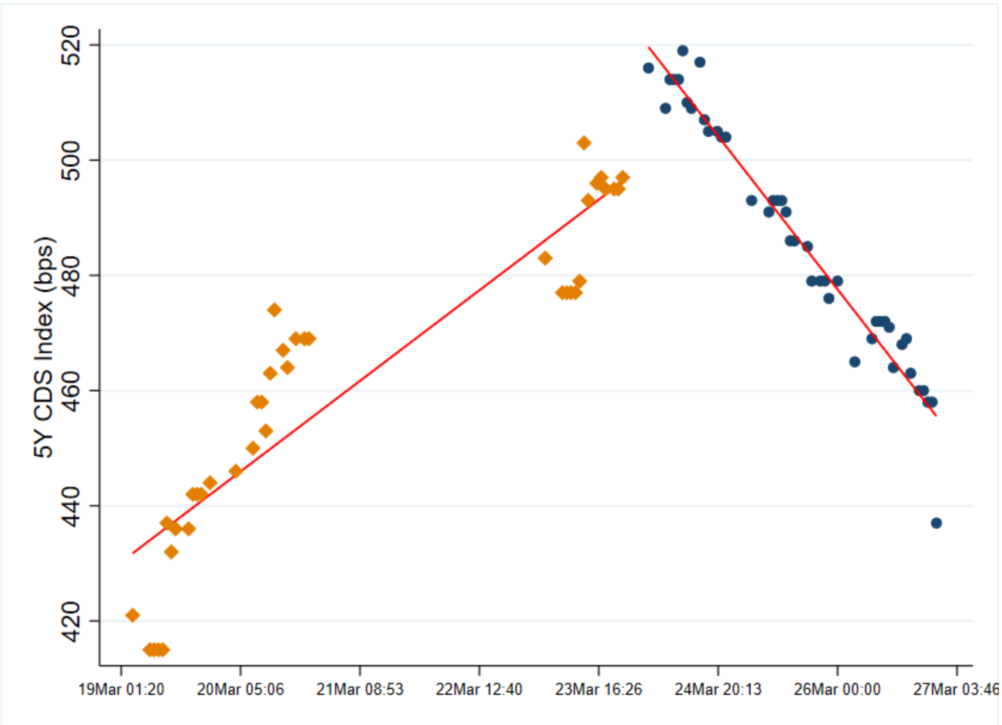


Figure 5. Intraday CDS Index. This figure plots the intraday 5-year CDS index in a narrow window during the ECB and the Federal Reserve QE. Panel A plots the intraday data for European banks, while Panel B plots the data for US banks. The diamond-yellow scatter represents the CDS spread before central bank intervention. The circle blue scatter represents the CDS spread after the intervention. The red solid lines are fitted lines.

We now consider long term funding costs using the equation 1:

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

The results are reported in column (3) of Table 3. Central banks' QE reduced long-term funding costs.

Table 3. **Funding Costs and Central banks' QE**

This table estimates banks' debt overhang costs on central banks' monetary policy announcements or launches. The dependent variables are the 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' short- and long-term debt overhang costs. The independent variable is a dummy equal to one, indicating the period after the central banks' intervention 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 US Market

The results in Section 2 suggest that QE effectively reduced banks' funding costs and that lines' prices were lower after QE. In the following sections, we provide further empirical evidence supporting our results. In so doing, we add to Cooperman et al. (2023) as we empirically study the effect of debt overhang costs on prices.

Additionally, we extend our analysis to cross-country (US and Europe) and undrawn fees. Therefore, our results should also help us to understand credit line fee dynamics in the US and Europe. In this sense, our results extend Berg et al. (2016) and Berg et al. (2017) when QE is considered.

3.1 Baseline specification

We start with the US market and use pooled OLS. We study if banks' funding costs are associated with credit lines' fees[9]. We employ the following regression:

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

where $Y_{i,t}$ denotes corporate borrowing fees, and $\textit{LIBOR-OIS}_t$ is LIBOR-OIS spread, proxying for short-term borrowing costs. CB_t is a time dummy equal to one indicating March 2020, when central banks' QE was implemented. $\textit{ln(Loan Amount)}_{i,t}$ denotes the natural logarithm of facility amount. Under the context of revolving credit facilities, this facility amount represents the total committed amount of credit lines. A set of dummies, $\textit{Maturity 1-3yr}_{i,t}$, $\textit{Maturity 3-6yr}_{i,t}$, and $\textit{Maturity} > \textit{6yr}_{i,t}$, control for different maturities of the loan facility. $\textit{Secured}_{i,t}$ is a dummy indicating the facility has collateral, and $\textit{ln(\#Lenders)}_{i,t}$ denotes the natural logarithm of the number of lenders. $X_{i,t}$ indicates fixed effects, including time, industry, and loan purpose.

Columns (1) across (8) in Table 4 show the empirical results using OLS regressions 3. We start with credit lines' fees (columns (1) to (4)). The coefficients on the LIBOR-OIS spread are significant and positive, suggesting that US banks transfer the increasing funding costs to borrowers (i.e. firms) by increasing the prices of credit lines. For example, a 1 bps increase in 6-month (12-month) LIBOR-OIS spreads leads to a 3.2 bps (1.8 bps) increase in drawdown fees. This result

[9] Following Burnside & Cerrato (2023), we use LIBOR minus OIS spreads to proxy for funding costs, and in the Appendix, we also report results when using banks' CDS spreads. Table B1 in Appendix B.1 shows the results.

is in line with Cooperman et al. (2023)'s theoretical model. The positive coefficient of LIBOR-OIS spread (columns (5) across (8)) on the cost of undrawn credit lines is also consistent with an increase in funding costs having a positive impact on undrawn fees. The undrawn fee increases by 0.4 bps (0.2 bps), given a 1 bps increase in 6-month (12-month) LIBOR-OIS spreads.

Following the results in Section 2.4, we include an interaction term of funding costs with a dummy to capture the effect of central bank intervention. We set the dummy equal to one in March 2020. As pointed out in Cooperman et al. (2023), higher funding costs are debt overhang costs for banks' shareholders, and this friction introduces a wedge in the lines' fees equal to the covariance between borrowing costs and the amount of drawdown. Banks will price this cost in the lines' fees proportionally to the wedge. We confirm this prediction and extend it to capture central banks' QE.

Columns (2), (4), (6), and (8) of Table 4 show the estimated coefficients of the interaction in equation 3. The combined coefficients on LIBOR-OIS spread and the interaction term can capture the effect of the central banks' QE. The results suggest that QE does help mitigate banks' funding costs, and this benefit is, in part, transferred to lines' prices. These results further suggest that during the pandemic shock, the FED asset purchase program may have contributed to the supply of credit to the real economy [10]. Our results are new and very important as they suggest that 1) the QE is strongly associated with a reduction of banks' funding costs and, therefore, the covariance between funding costs and credit lines drawdowns; and 2) central banks' QE may not only be effective to stabilise financial markets, but it can also help an important, credit market, and help to convey credit to the real economy. In Section 5, we provide a simple theoretical framework to explain the mechanism.

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:

$$UWS(p) \quad = \quad p \cdot \textit{All In Spread Drawn} + (1-p) \cdot \textit{All In Spread Undrawn} \tag{4}$$

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

[10] Similarly, we complement these results in Table B1 of Appendix B.1.

Table 4. **Credit Line Fees and Short-Term 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 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	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)
ln(Loan Amount)	-39.628***	-39.628***	-39.628***	-39.628***	-3.945***	-3.945***	-3.945***	-3.945***
	(0.582)	(0.582)	(0.582)	(0.582)	(0.092)	(0.092)	(0.092)	(0.092)
Maturity 1-3Y	6.768**	6.768**	6.768**	6.768**	8.357***	8.357***	8.357***	8.357***
	(2.696)	(2.696)	(2.696)	(2.696)	(0.363)	(0.363)	(0.363)	(0.363)
Maturity 3-6Y	16.206***	16.206***	16.206***	16.206***	6.816***	6.816***	6.816***	6.816***
	(2.126)	(2.126)	(2.126)	(2.126)	(0.261)	(0.261)	(0.261)	(0.261)
Maturity >6Y	74.968***	74.968***	74.968***	74.968***	14.865***	14.865***	14.865***	14.865***
	(5.104)	(5.104)	(5.104)	(5.104)	(0.978)	(0.978)	(0.978)	(0.978)
Secured	52.900***	52.900***	52.900***	52.900***	10.676***	10.676***	10.676***	10.676***
	(1.189)	(1.189)	(1.189)	(1.189)	(0.182)	(0.182)	(0.182)	(0.182)
ln(#Lenders)	-10.687***	-10.687***	-10.687***	-10.687***	-0.360**	-0.360**	-0.360**	-0.360**
	(1.045)	(1.045)	(1.045)	(1.045)	(0.171)	(0.171)	(0.171)	(0.171)
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	42880	42880	42880	42880	27314	27314	27314	27314
R^2	0.502	0.502	0.502	0.502	0.500	0.500	0.500	0.500

et al. (2017) measure the average credit line drawdown rate (or credit line usage) is around 20%-30% across European and U.S. 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 3 with UWSs, we report the results in Table 5.

In Table 5, the coefficients on LIBOR-OIS spreads for UWS are similar to those in Table 4. Columns (1) to (12) are based on OLS specifications as in equation 3, 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 bps increase in 6-month (12-month) LIBOR-OIS spreads leads to a 0.9 bps (0.5 bps) increase in borrowing fees.

Columns (2), (4), (6), (8), (10), and (12) in Table 5 show the estimation of the interaction term in equation 3. In line with the results presented earlier, QE did help to mitigate banks' funding costs and this benefit was transferred, in part, to borrowers [11].

[11] In Table B2 of Appendix B.1, we also show similar results when long-term funding costs are considered.

Table 5. **Credit Line Fees and Short-Term 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

3.2 Cross-Sectional Analysis

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

$$\Delta \textit{Credit Line Fee}_i \quad = \quad \beta_0 + \beta_1 \Delta \textit{Funding Cost}_i + \epsilon_i \tag{5}$$

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

Table 6. **Cross-Sectional Analysis: Credit Line Fees and Funding Costs (US)**
This table estimates credit line fees on funding costs from a specification in equation 5. 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

4 European Market

In this section, we focus on the European market. Focusing on US and European markets will permit us to study the heterogeneity of credit line fees across markets during the COVID-19 shock.

We use the same econometric framework as before. We regress LIBOR-OIS spreads on credit line drawdown costs and undrawn fees by using equation 3 specification.[12] Table 7 shows the empirical results. In line with the US market, we also note positive and significant coefficients on LIBOR-OIS spreads versus drawdown fees (columns (1) across (4)) using the OLS specification. Lines' prices in Europe seem to be more sensitive to banks' funding costs (see columns 1 and 3) when compared with the US, and also, the impact of QE on funding costs appears to be larger in this country (see columns (2) and (4)).

Our results suggest that the ECB asset purchase programs also contributed to mitigating banks' funding costs with a beneficial effect on lines' prices, Table 7). Banks raise the fees on undrawn credit lines (columns (6) and (8)).[13]

Combining drawdown cost and undrawn fee, we use UWS to study if banks' short-term funding costs are associated with lines' fees. Table 8 shows the results using equation 3 specification. We find similar results as for the US market (Table 5) on funding costs and their interaction with the COVID-19 shock.[14]

[12] In Table B4 of Appendix B.2, we regress corporate borrowing fees of credit lines on bank funding costs.

[13] Table B4 in Appendix B.2 reports the results by using long term funding costs.

[14] In Table B5 of Appendix B.2, we support these results using debt overhang costs as proxied by banks' CDS spreads.

Table 7. **Credit Line Fees and Short-Term Funding Costs (Europe)**

This table estimates corporate borrowing fees on 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 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

Table 8. **Credit Line Fees and Short-Term Funding Costs (Europe)**

This table estimates corporate borrowing costs 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 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

5 A Theoretical Model

This section provides a model to study the mechanism behind our empirical results. The model is an extension of Cooperman et al. (2023) where we introduce and study the effect of QE on lines' fees.

5.1 Basic structure

Figure 6 summarises our model. At the start date ($t = 0$), the bank and the corporate borrower start a negotiation about the fixed spread s over the variable reference rate $R = r + W$ (bank's borrowing cost) where r and W represent the risk-free rate and the bank's credit spread respectively.

Ours is a risk neutral bank and we are interested to understand 1. whether QE is benficial for the equity holder of the banks; 2 if this beneficial effect is passed by the bank to the borrower via cheper credit lines fees as suggested by our empirical analysis. At $t = 1$, the information of risk-free rate (r) and credit spread (W) is revealed, and then the borrower draws down an amount of q. The net present value of depositing drawn funds into the bank account at $t = 1$ and obtaining cash next period should be zero, $-\varphi q + \delta(1 + r)\varphi q = 0$, in which $\delta = 1/(1 + r)$[15]. Given the deposit fraction, the bank needs to fund the undeposited fraction $(1 - \varphi)$ in the wholesale market (we assume the unsecured market) at the credit spread W over risk-free rate r[16]. Assume also a risk-based capital requirement for bank shareholders to fund this undeposited fraction[17]. The bank funds the quantity $(1+C)(1-\varphi)q$, where C is a constant capital ratio. Therefore as in Cooperman et al. (2023), we preserve the possibility of regulatory 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 to the bank q with a fee s over the reference rate $r + W$; the bank needs to repay the cost of wholesale funding $(1 + C)(1 - \varphi)q$ with the spread W. As in Cooperman et al. (2023), the bank can pay the depositor and wholesale funding market only if it stays solvent at $t = 2$. Again as in Cooperman et al. (2023), we assume that the bank will not default before the loan's maturity.

Following Andersen et al. (2019) and Cooperman et al. (2023), we define the risk-neutral value (marginal) of the equity to bank's shareholders at time $t = 1$ as

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

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

[16]Cooperman et al. (2023) equate banks' wholesale funding spread S to credit spread W, that this our bank is of LIBOR-quality as we do not study in this paper the effect of QE on a risk insensitive rate as the new SOFR

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

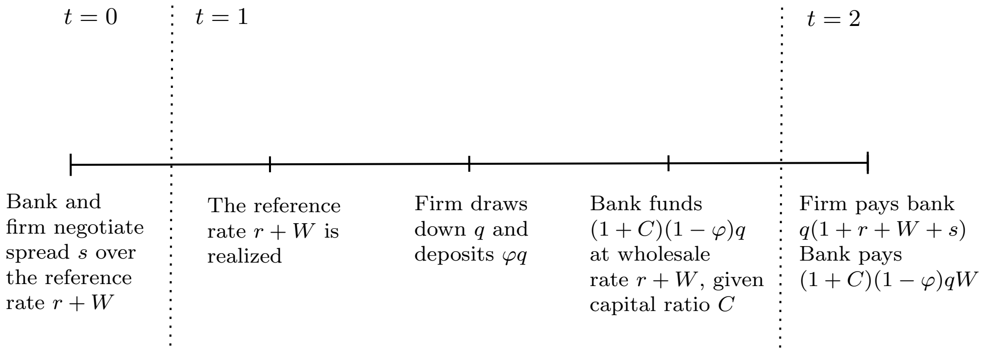


Figure 6. Timeline of model

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 bank shareholders' debt-overhang cost for financing via the wholesale market $(1 - \varphi)q$ at the spread W. Rearranging equation 6, we obtain the marginal profit

$$G = p_1 \delta q \, [\underbrace{(W + s)}_{\text{Unit Profit}} \; - \; \underbrace{(1 + C)(1 - \varphi)W}_{\text{Unit Cost}} \;]. \tag{7}$$

From equation 7, bank shareholders obtain $W + s$ for each dollar lending to borrowers via credit lines. Meanwhile, they bear debt overhang costs, $(1 + C)(1 - \varphi)W$, for funding it via the wholesale market.

Bank shareholders' break-even value suggests $\mathbb{E}(G) = 0$. It follows that:

$$s = \frac{\mathbb{E}[\delta p_1 (1 + C)(1 - \varphi)qW] - \mathbb{E}[\delta p_1 q W]}{\mathbb{E}[\delta p_1 q]} \tag{8}$$

The first term in equation 8 is debt overhang costs when funding via the wholesale market. The second term is compensation lending via credit lines. Equation 8 shows that at time $t = 0$, the contractual new drawdown spread s depends on the bank's debt overhang cost at time $t = 1$ and the corresponding compensation from lending credit lines.

Proposition 1 (The Contractual Spread to Shareholders of Credit Line Financing): *If we assume that the deposit fraction is constant*[18]*, it follows that the contractual fee s is well defined and is given by:*

$$s = \eta - \kappa + \frac{cov_1(q, \tau_q)}{\delta p_1 q} \tag{9}$$

[18]We relax this assumpltion in Proposition 3.

where

- $\eta = (1+C)(1-\varphi)W$ *reprents costs related to regulatory frictions.*
- $\kappa = W$ *is the credit spread.*
- $\tau_q = \delta p_1(1+C)(1-\varphi)W$ *is the banks' debt overhang cost at time 1 conditional on time 2.*

Appendix D.1 includes a proof of Proportion 1. The term $cov_1(q, \tau_q)$ in equation 9 is that the debt overhang cost of the bank funding each dollar of credit line drawdowns is correlated with the drawn quantities. The first-order difference of the covariance to the credit spread W, is calculated as follows:

$$\frac{\partial cov_1(q, \tau_q)}{\partial W} = \gamma \tag{10}$$

where γ is a constant. This implies that debt overhang cost and banks' credit spread increase linearly, leading to the the following results.

Proposition 2 (Central Bank Intervention): *Consider the contractual fee s defined by equation 9. If there is no central bank intervention, $\gamma \gg \delta p_1 q[1-(1+C)(1-\varphi)]$, the first-order difference of contractual fee to the credit spread is:*

$$\frac{\partial s}{\partial W} = (1+C)(1-\varphi) - 1 + \frac{\gamma}{\delta p_1 q} \gg 0. \tag{11}$$

If there is central bank intervention, $\gamma \sim 0$, the first-order difference of the contractual fee is:

$$\frac{\partial s}{\partial W} = (1+C)(1-\varphi) - 1 + O\left(\frac{\gamma}{\delta p_1 q}\right) \quad \text{as } \gamma \to 0. \tag{12}$$

Appendix D.2 includes a proof of 2. Equation 11 describes the first case of no central bank intervention. Thus, debt overhang costs to banks' shareholders increase when borrowers draw large lines, and banks raise the drawdown fees.

Equation 12 shows the case where central banks use QE to stabilise the market. In this case, asset purchase programmes lower credit spreads and debt overhang pressure.

Cooperman et al. (2023) argue that borrowers' deposits following credit line drawdowns are positively associated with credit spreads. We assume the deposit fraction φ is an increasing function of credit spreads, denoted $\varphi = \Phi(W)$. Equation 9 can be rewritten as

$$s^* = \eta^* - \kappa + \frac{cov_1(q, \tau_q^*)}{\delta p_1 q} \tag{13}$$

where s^* denotes the contractual spread on credit lines. $\eta^* = (1 + C)(1 - \Phi(W))W$ is debt overhang costs for shareholders. $\tau_q^* = \delta p_1(1 + C)(1 - \Phi(W))W$ defines debt overhang costs at time 1 conditional on survival at time 2. The first-order difference of the covariance between credit line drawdowns and debt overhang cost with respect to credit spread is, for simplicity, a constant expressed by

$$\frac{\partial cov_1(q, \tau_q^*)}{\partial W} = \gamma^*. \tag{14}$$

We have the following result.

Proposition 3 (Central Bank Intervention): *Consider the contractual spread s^* defined by equation 9 and an increasing depositing function $\Phi(W)$ with a first order $\Phi'(W) > 0$. If there is no central bank intervention, $\gamma^* \gg \delta p_1 q[1-(1+C)(1-\Phi'(W)W-\Phi(W))]$ and the first-order difference of contractual credit line spread to the credit spread is:*

$$\frac{\partial s^*}{\partial W} = (1 + C)(1 - \Phi'(W)W - \Phi(W)) - 1 + \frac{\gamma^*}{\delta p_1 q} \gg 0. \tag{15}$$

If there is central bank intervention, $\gamma^* \sim 0$ and the first-order difference of contractual credit line spread is:

$$\frac{\partial s^*}{\partial W} = (1 + C)(1 - \Phi'(W)W - \Phi(W)) - 1 + O\left(\frac{\gamma^*}{\delta p_1 q}\right) \quad \text{as } \gamma^* \to 0. \tag{16}$$

Appendix D.3 includes a proof of Proportion 3. Basically, γ^* dominates equation 15 when there is no central bank intervention, even though firms' depositing increases as credit spreads increase. However, central bank QE can mitigate this effect. Given this, we cannow consider how credit spread itself affects the slope of s.

5.2 Calibration

In this section, we calibrate our model to a set of parameters to study how debt overhang costs affect the contractual spread of credit lines.

5.2.1 Baseline Model

We start by parameterizing the model in equation 9. In our baseline model, the capital requirement ratio is set up as $C = 5\%$ [19], the discount factor is $\delta = 0.99$, the bank's survival probability is set to $p_1 = 0.99$, the firms' credit line drawdowns is $q = 20\%$, and the firms' deposited fraction is $\varphi = 10\%$. In the case of no central bank intervention as defined in Proposition 2, the covariance is specified as

$$cov_1(q, \tau_q) = \gamma W + \epsilon, \tag{17}$$

for positive constants γ and ϵ, where W is the credit spread. We take a baseline assumption of $\gamma = 0.1$ which is sufficiently large[20], and $\epsilon = 10$ bps. However, central bank intervention can reduce γ to a lower level, even close to zero (for example, $\gamma = 0.001$).

Figure 7 illustrates the results. Given the baseline model, the drawdown cost (fee) s is positively associated with credit spread W when central banks do not intervene in the market (solid blue line). This becomes flatter but positive once there is central bank intervention-QE (dashed red line).

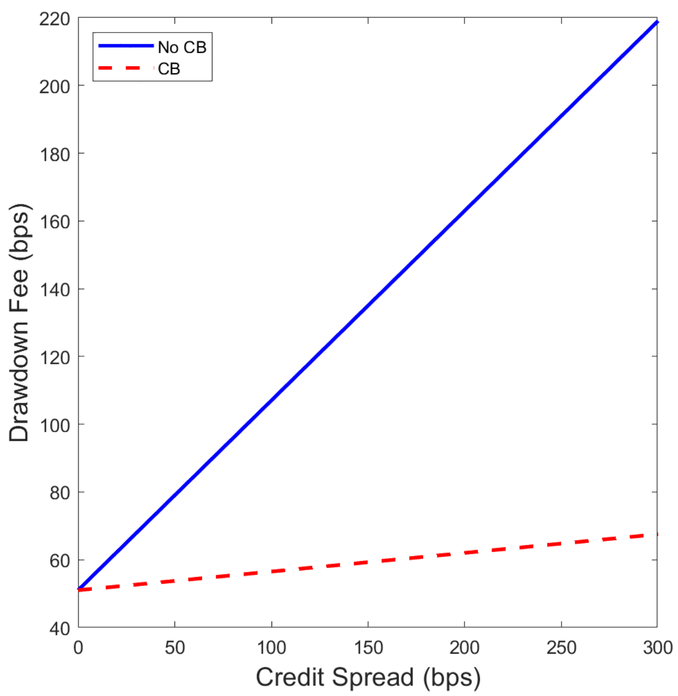


Figure 7. Drawdown Cost and Credit Spread. This figure plots the calibrated model of corporate drawdown cost correlated to credit spread. The parameterization is $\{\delta, C, p_1, q, \varphi, \epsilon\} = \{0.99, 5\%, 0.99, 20\%, 10\%, 10 \text{ bps}\}$. The solid blue line represents the case in which no central bank intervention exists. The dashed red line represents the case where the central bank intervenes in the market.

[19] According to Favara et al. (2022), U.S. global systemically important banks (GSIBs) must hold a ratio of Tier 1 capital to total leverage exposure of at least 5%.

[20] Given the parameterization and Appendix D.2, we have $\gamma_0 = \delta p_1 q[1 - (1 + C)(1 - \varphi)] = 0.99 \times 0.99 \times 20\% \times [1 - (1 + 5\%)(1 - 10\%)] = 0.011$. This number is much lower than our assumption of γ.

Cooperman et al. (2023) for the US and Cerrato et al. (2023) for Europe show that during the COVID-19 crisis, corporate drawdowns were mainly driven by precautionary reasons and not by investments. Figure 2 shows a high LIBOR-OIS spread. This suggests that the borrower's deposited fraction of the drawdown might be endogenous. Particularly, the deposited fraction is positively correlated to credit spread (see also Cooperman et al. (2023))). Cooperman et al. (2023) show that the deposited fraction increases with the LIBOR-OIS spread. For simplicity, we let the function of deposited fraction φ to be $\Phi(W)$ be

$$\Phi(W) = aW^b. \tag{18}$$

where $a > 0$ defines the linear relationship between credit spread and drawdown fee and the elasticity term $b > 0$ captures the exponentially increasing relationship[21]. Based on equation 13, the contractual spread of a credit line drawdown can be rewritten as:

$$s^* = (1 + C)(1 - aW^b)W - W + \frac{cov_1(q, \tau_q^*)}{\delta p_1 q}, \tag{19}$$

where the covariance between drawn quantities q and the marginal debt overhang cost τ_q^* is specified by

$$cov_1(q, \tau_q^*) = \gamma^* W + \epsilon. \tag{20}$$

γ^* is also a positive constant. Again, we assume that: 1) $\gamma^* = 0.1$ if there is no central bank intervention, and 2) $\gamma^* = 0.001$ if there is central bank intervention. Figure 8 reports the results.

5.2.2 Sensitivity to Capital Requirement

Equations 12 and 16 show that even when debt overhang cost is minimal, there is a cost related to regulatory frictions, which is, in our case, the capital requirement (C). We investigate the effect of this cost across banks and report it in Figures 9 and 10.

Given the assumption of constant deposited fraction (φ), we plot different levels (3% to 6%) of capital requirement in Figure 9. We show that increasing the capital requirement by 1% will cause an average 1.5 bps rise in drawdown cost. While we relax the assumption and apply endogenous

[21] Cooperman et al. (2023) define the deposited fraction as a logistic function

$$\Phi(W) = \frac{D}{1 + e^{-m(W - W_0)}},$$

which is also increasing with respect to credit spread.

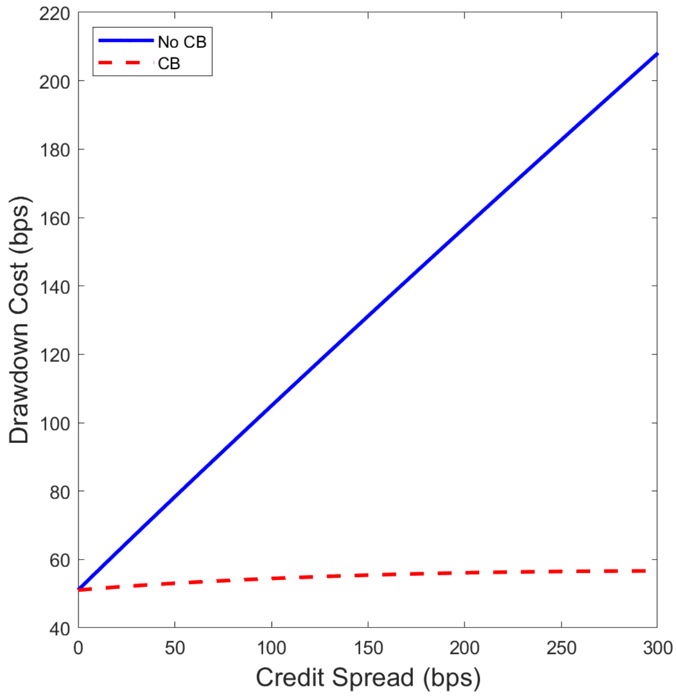


Figure 8. Drawdown Cost and Credit Spread. This figure plots the calibrated model of corporate drawdown cost correlated to credit spread. The parameterization is $\{\delta, C, p_1, q, a, b, \epsilon\} = \{0.99, 5\%, 0.99, 20\%, 0.2, 0.5, 10 \text{ bps}\}$. The solid blue line represents the case in which no central bank intervention exists. The dashed red line represents the case in which the central bank intervenes in the market.

deposit fraction ($\Phi(W)$) in Figure 10, we find a slight fall in the increment, from 1.5 bps to 1.4583 bps. In a nutshell, as expected, capital requirement positively correlates with drawdown cost, increasing fees.

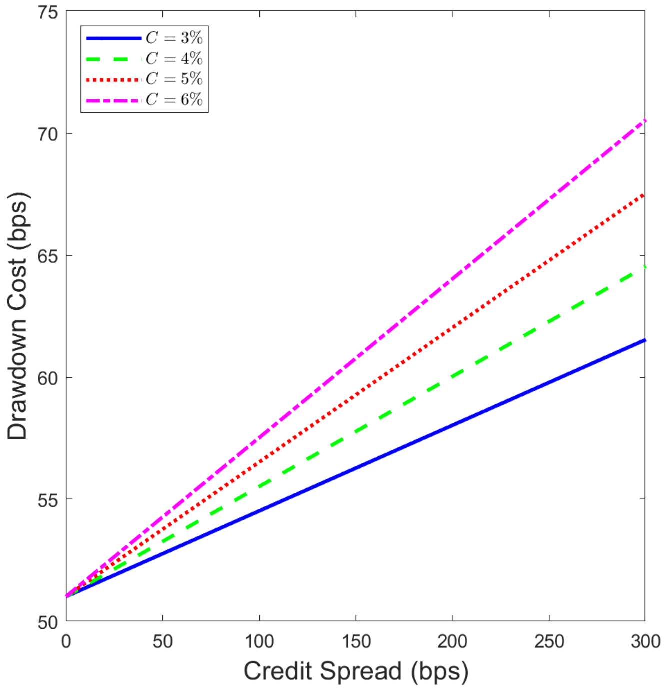


Figure 9. Capital Requirement Sensitivity with Intervention. This figure plots the calibrated model of corporate drawdown cost correlated to credit spread in which central banks intervene in the markets. The parameterization is $\{\delta, p_1, q, a, b, \varphi, \epsilon\} = \{0.99, 0.99, 20\%, 0\%, 10 \text{ bps}\}$. The solid blue line represents the case in which the capital requirement is 3%. The dashed green line represents the capital requirement of 4%. The dotted red line represents the capital requirement is 5%. The dash-dot pink line represents the capital requirement of 6%.

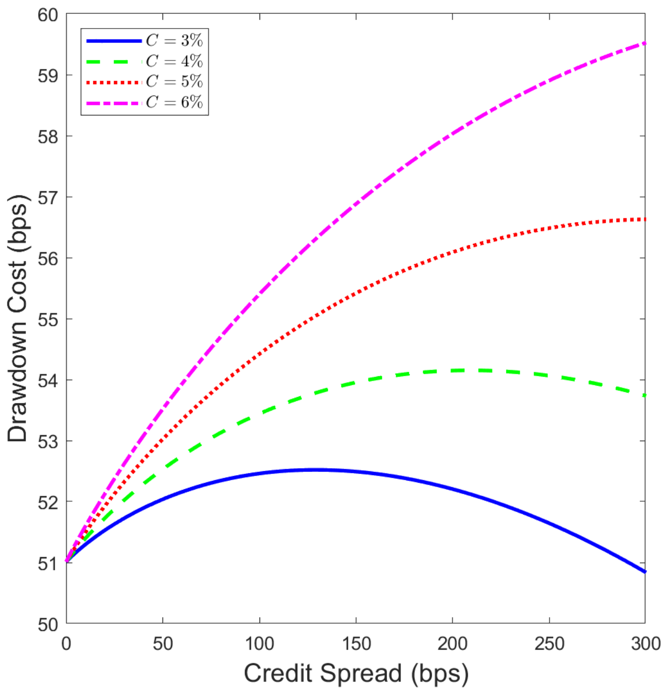


Figure 10. Complemented Capital Requirement Sensitivity with Intervention. This figure plots the calibrated model of corporate drawdown cost correlated to credit spread in which central banks intervene in the markets. The parameterization is $\{\delta, p_1, q, a, b, \epsilon\} = \{0.99, 0.99, 20\%, 0.2, 0.5, 10 \text{ bps}\}$. The solid blue line represents the case in which the capital requirement is 3%. The dashed green line represents the capital requirement of 4%. The dotted red line represents the capital requirement is 5%. The dash-dot pink line represents the capital requirement of 6%.

6 Conclusion

This paper empirically and theoretically studies the price credit lines and their association with banks' funding costs following the COVID-19 shock and central banks' QE. Recently, Cooperman et al. (2023) show that banks' funding costs are debt overhang costs for banks' shareholders and are associated with lines of credit draw-downs. They focus on the switch from LIBOR to SOFR rates. This paper complements and extends that important result empirically and theoretically. First, we document empirically, across two important markets (Europe and the US), that debt overhang costs are indeed essential and incorporated in the price of the line of credit. This was the case during the COVID-19 shock and not only. Our results also add further light on cross-market lines price discussed in Berg et al. (2017). Additionally, we report evidence suggesting that at the peak of the COVID-19 shock, central banks' QE mitigated debt overhang costs, and banks transferred this benefit to firms via lower credit line fees. Finally, we present and discuss a theoretical framework which suggests why QE effectively mitigates debt overhang costs and reduces lines' prices.

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Appendices

A Description of Variables

Table A1. **Description of Variable**

Variable	Description	Source
All In Spread Drawn	The sum of the spread over LIBOR or EURIBOR plus the facility fee.	DealScan
All In Spread Undrawn	The sum of the commitment fee plus the facility fee.	DealScan
Revolver	A dummy that equals one indicating revolving credit facilities or credit lines, and zero otherwise. Include loan types as "Revolver/Line >= 1 Yr.", "364-Day Facility", "Revolver/Line < 1 Yr.", and "Revolver/Term Loan" within *Tranche Type* in DealScan.	DealScan
Facility Amount	Facility amount with unit million USD. It is indicated in the field *Deal Amount Converted* which converts other currencies into USD.	DealScan
Maturity	Loan maturity measured in years, equal to *Tenor Maturity* divided by 12.	DealScan
Maturity 1-3yr	A dummy that equals to one indicating loan maturity between 1 and 3 years, and zero otherwise.	DealScan
Maturity 3-6yr	A dummy that equals to one indicating loan maturity between 3 and 6 years, and zero otherwise.	DealScan
Maturity >6yr	A dummy that equals to one indicating loan maturity greater than 6 years, and zero otherwise.	DealScan
Purpose: General	A dummy that equals to one indicating the loan facility is for general purpose, and zero otherwise. It includes "General Purpose" as indicated within *Deal Purpose* in DealScan.	DealScan

(Continued on next page)

Table A1 – continued from previous page

Variable	Description	Source
Purpose: Acquisition	A dummy that equals to one indicating the loan facility is for acquisition purpose, and zero otherwise. It includes "Acquisition", "Leveraged Buyout", "Sponsored Buyout", and "Takeover" as indicated within *Deal Purpose* in DealScan.	DealScan
Purpose: Investment	A dummy that equals to one indicating the loan facility is for acquisition purpose, and zero otherwise. It includes "Project Finance", "Working capital", and "Capital expenditure" as indicated within *Deal Purpose* in DealScan.	DealScan
Purpose: Ship	A dummy that equals to one indicating the loan facility is for ship, plane, and SPV finance purpose, and zero otherwise. It includes "Ship finance" and "Aircraft & Ship finance" as indicated within *Deal Purpose* in DealScan.	DealScan
Purpose: Refinancing	A dummy that equals to one indicating the loan facility is for refinancing purpose, and zero otherwise. It includes "General Purpose/Refinance" as indicated within *Deal Purpose* in DealScan.	DealScan
Purpose: Real Estate	A dummy that equals to one indicating the loan facility is for refinancing purpose, and zero otherwise. It includes "Real estate loan" as indicated within *Deal Purpose* in DealScan.	DealScan
Purpose: Dividend	A dummy that equals to one indicating the loan facility is for dividend recapitalization purpose, and zero otherwise. It includes "Dividend Recapitalization" as indicated within *Deal Purpose* in DealScan.	DealScan

(Continued on next page)

Table A1 – continued from previous page

Variable	Description	Source
Secured	A dummy that equals to one indicating the loan facility is secured by collateral, and zero otherwise. It includes "Yes" as indicated within *Secured* in DealScan.	DealScan
ln(#Lenders)	The natural logarithm of the number of lenders from *Number of Lenders* in DealScan.	DealScan
LIBOR-OIS 6M	The spread between 6-month LIBOR rate and 6-month overnight index swap rates (OIS).	Bloomberg
LIBOR-OIS 12M	The spread between 12-month LIBOR rate and 12-month overnight index swap rates (OIS).	Bloomberg
CDS Index	The average of 12 banks' monthly 5-year CDS spreads. 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 which are representative European and US banks.	Bloomberg

B Long-Term Debt Overhang Costs

B.1 US Market

In Section 3, we find that the positive correlation between banks' short-term debt overhang cost and corporate borrowing cost can be weakened given central bank intervention. This section examines whether it holds for banks' long-term debt overhang cost.

Similar to equation 3, we construct an OLS specification to regress borrowing costs on a CDS index, measuring banks' long-term overhang cost as follows:

$$\begin{aligned} Y_{i,t} \quad = \quad & \beta_0 + \beta_1 \textit{CDS Index}_t + \beta_2 \textit{CDS Index}_t \times CB_t + \beta_3 \textit{ln(Loan Amount)}_{i,t} \\ & + \beta_4 \textit{Maturity 1-3yr}_{i,t} + \beta_5 \textit{Maturity 3-6yr}_{i,t} + \beta_6 \textit{Maturity} > \textit{6yr}_{i,t} + \beta_7 \textit{Secured}_{i,t} \\ & + \beta_8 \textit{ln(\#Lenders)}_{i,t} + \gamma X_{i,t} + \epsilon_{i,t} \end{aligned} \tag{21}$$

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[22]. 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 B1 show the estimation of corporate borrowing costs on the 5-year CDS index in OLS specification of equation 21. Similarly, a 1 bps increase in the CDS index results in a 4.3 bps increase in drawdown costs (AISD) and a 0.5 bps 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 4.

Columns (2) and (4) of Table B1 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 21, 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 long-term debt overhang costs drive firms' comprehensive borrowing

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

costs. We use the usage-weighted spread (UWS) and run the panel regression in equation 21. Columns (1) across (6) in Table B2 show the results of firms' comprehensive borrowing costs (UWS) on the 5-year CDS index, also in OLS specification. Positive coefficients reveal that banks' long-term debt overhang costs increase their overall lending prices to corporate borrowers. Moreover, the comprehensive cost with a 30% drawdown assumption has the greatest value, suggesting that a 1 bps increase in the 5-year CDS index leads to a 1.2 bps rise in the borrowing cost. Compared to the short-term debt overhang cost results in Table 5, long-term one again has a greater impact on deciding banks' lending price to firms.

Columns (2), (4), and (6) of Table B2 report the regression results of the interaction term in the OLS specification. Given central bank intervention, 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 bps increase in the 5-year CDS index merely causes a 0.856 bps rise in the borrowing cost, compared with the 1.2 bps before.

To sum up, confronting debt overhang costs in banking systems, US banks moved drawn and undrawn costs in the same direction. Banks normally increase both costs; When the central bank intervenes, they reduce two costs. Instead of controlling corporate credit line usage like European banks, US banks prefer to manipulate the total amount of this revolving credit facility. From other perspectives, it explains that although the US market has more loan facilities than the European market in March 2020 (1,627.63 > 1,184.66), the percentage increment from last month (119.82%) is smaller than the one in the European market (196.58%), described in Table 2.

Similar to Section 3, we also estimate cross-section regression in the form of equation 5, using CDS spreads as a proxy for funding costs. Table B3 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.

B.2 European Market

In Section 4, 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 intervention, 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 21, 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

Table B1. **Credit Line Fees and Long-Term Funding Costs (US)**

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 intervention (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 B2. **Comprehensive Credit Line Cost on Long-Term 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 intervention (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 B3. **Cross-Sectional Analysis: Credit Line Fees and Funding Costs (US)**
This table estimates credit line fees on funding costs from a specification in equation 5. 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 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

fee of retaining undrawn credit lines (*All In Spread Undrawn*). Table B4 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 intervention (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 21 with UWS, a measure combining both drawn and undrawn costs, we run the specification and obtain the results in Table B5. Similar to the US sample (Table B2), 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 intervention, the coefficients of interaction are negative in columns (2), (4), and (6).

Table B4. **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 intervention (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 B5. **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 intervention (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

C 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:

$$Y_{i,t} = \beta_0 + \beta_1 QE_t + \beta_2 Funding\ Cost_t + \beta_3 Funding\ Cost_t \times QE_t + \gamma_i + \eta_t + \epsilon_{i,t} \quad (22)$$

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 C1 reports the results. We also find similar results in the European sample reported in Table C2.

Table C1. **Cross-Sectional Analysis: Credit Line Prices and Funding Costs (US)** This table estimates credit line fees on funding costs from a specification in equation 22. 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 C2. **Cross-Sectional Analysis: Credit Line Prices and Funding Costs (Europe)** This table estimates credit line fees on funding costs from a specification in equation 22. 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

D Proof

D.1 Proof of Proposition 1

Let $\tau = p_1\delta(1+C)(1-\varphi)qW$ denotes the bank debt overhang cost. We can introduce the covariance function and write the expectation of τ as:

$$\begin{aligned}\mathbb{E}[\tau] &= \mathbb{E}[p_1\delta(1+C)(1-\varphi)qW] \\ &= \mathbb{E}[q]\,\mathbb{E}[p_1\delta(1+C)(1-\varphi)W] + cov_1(q, p_1\delta(1+C)(1-\varphi)W) \qquad (23)\end{aligned}$$

where $cov_1(q, p_1\delta(1+C)(1-\varphi)W)$ is the covariance between the firm's drawdowns and the bank's debt overhang cost of financing each dollar of drawn quantities conditional the information reveal at time $t = 1$. Let $\tau_q = p_1\delta(1+C)(1-\varphi)W$ denotes the marginal debt overhang cost of the bank. We can rewrite equation 8 as:

$$\begin{aligned}s &= \frac{\mathbb{E}[\tau_q q] - \mathbb{E}[\delta p_1 qW]}{\mathbb{E}[\delta p_1 q]} \\ &= \frac{\mathbb{E}[\tau_q]\,\mathbb{E}[q] + cov_1(q, \tau_q) - \mathbb{E}[\delta p_1 qW]}{\mathbb{E}[\delta p_1 q]} \\ &= \frac{\tau_q q + cov_1(q, \tau_q) - \delta p_1 qW}{\delta p_1 q} \\ &= (1+C)(1-\varphi)W - W + \frac{cov_1(q, \tau_q)}{\delta p_1 q} \qquad (24)\end{aligned}$$

Inserting $\eta = (1+C)(1-\varphi)W$ and $\kappa = W$ into equation 24 provides equation 9.

D.2 Proof of Proposition 2

We first consider the case where central banks do not intervene in the market. Given Proportion 1 and equation 10, we derive the first-order contractual spread s associated with credit spread W as:

$$\begin{aligned}\frac{\partial s}{\partial W} &= \frac{\partial \eta}{\partial W} - \frac{\partial \kappa}{\partial W} + \frac{\partial}{\partial W}\frac{cov_1(q, \tau_q)}{\delta p_1 q} \\ &= \frac{\partial(1+C)(1-\varphi)W}{\partial W} - \frac{\partial W}{\partial W} + \frac{1}{\delta p_1 q}\frac{\partial cov_1(q, \tau_q)}{\partial W} \\ &= (1+C)(1-\varphi) - 1 + \frac{\gamma}{\delta p_1 q} \qquad (25)\end{aligned}$$

Next, we equate $\partial s/\partial W = 0$ and rearrange the equation, providing

$$\gamma_0 = \delta p_1 q[1 - (1+C)(1-\varphi)]. \qquad (26)$$

where γ_0 is the threshold of marginal covariance leading to a null marginal change in contractual spread. Since $\delta, p_1, q, C, \varphi \in [0,1]$, $\delta p_1 q[1-(1+C)(1-\varphi)]$ is close to zero. Nevertheless, the first-order covariance is sensitive to the changes in credit spread, suggesting that γ should be sufficiently large. Given this, γ should be significantly greater than the threshold γ_0, yielding $\gamma \gg \gamma_0 = \delta p_1 q[1-(1+C)(1-\varphi)]$. Consequently, $\partial s/\partial W \gg 0$.

If central banks intervene in the market at a bad time, banks acquire sufficient liquidity through monetary policies like asset purchase programmes. Consequently, in principle, banks are free of default risk, leading to a minor correlation with borrowers' default risks. Meanwhile, shareholders' marginal debt overhang costs are almost unrelated to firms' drawdown amount, which means the covariance $cov_1(\cdot)$ is close to zero.

Since $0 \ll \delta, p_1, q < 1$ and $\gamma \sim 0$, $\gamma/(\delta p_1 q) \sim 0$. We let $x = \gamma/(\delta p_1 q)$ and define a function $f(x)$ which is a big O of x such that

$$f(x) = O(x) \quad \text{as } x \to 0 \tag{27}$$

where there exist positive number d and M such that for all defined x with $0 < |x - 0| < d$,

$$|f(x)| \leq Mx. \tag{28}$$

Then, we can rewrite equation 25 as

$$\begin{aligned} \frac{\partial s}{\partial W} &= (1+C)(1-\varphi) - 1 + f(x) \\ &= (1+C)(1-\varphi) - 1 + O\left(\frac{\gamma}{\delta p_1 q}\right) \end{aligned} \tag{29}$$

when γ is approaching zero.

D.3 Proof of Proposition 3

Given equation 13, we first derive the first order of the contractual spread s^* with respect to credit spread W, which yields

$$\begin{aligned} \frac{\partial s^*}{\partial W} &= \frac{\partial \eta^*}{\partial W} - \frac{\partial \kappa}{\partial W} + \frac{\partial}{\partial W}\frac{cov_1(q,\tau_q^*)}{\delta p_1 q} \\ &= \frac{\partial (1+C)\,(1-\Phi(W))\,W}{\partial W} - \frac{\partial W}{\partial W} + \frac{1}{\delta p_1 q}\frac{\partial cov_1(q,\tau_q^*)}{\partial W} \\ &= (1+C)(1-\Phi'(W)W - \Phi(W)) - 1 + \frac{\gamma^*}{\delta p_1 q} \end{aligned} \tag{30}$$

where γ^* denotes the marginal change in covariance between drawn quanitities q and the unit debt overhang cost τ_q^*. Suppose we make $\partial s^*/\partial W$ equal to zero and rearrange it, we obtain

$$\gamma_0^* = \delta p_1 q \left[1 - (1+C)(1 - \Phi'(W)W - \Phi(W))\right] \tag{31}$$

where γ_0^* denotes the threshold of the marginal covariance that leads to $\partial s^*/\partial W = 0$. However, $cov_1(q, \tau_q^*)$ should be sufficiently large, suggesting that banks suffer a high level of default risk against the drawn funds from credit lines without central bank intervention. In this way, γ^* is much greater than the threshold γ_0^*, which is $\gamma^* \gg \gamma_0 = \delta p_1 q \left[1 - (1+C)(1 - \Phi'(W)W - \Phi(W))\right]$. As a result, the marginal change in contractual spread $\partial s^*/\partial W \gg 0$.

Suppose central bank intervention exists at a bad time. Banks are nearly solvent by acquiring liquidity from monetary policies (like asset purchase programmes). At this moment, firms' default risks are hardly correlated to banks' risk profiles, leading to γ^* close to zero.

Since $0 \ll \delta, p_1, q < 1$ and $\gamma^* \sim 0$, we have $\gamma^*/(\delta p_1 q) \sim 0$. We again let $x' = \gamma^*/(\delta p_1 q)$ and set up a function $g(x')$ which is a big O of x', providing that

$$g(x') = O(x') \quad \text{as } x' \to 0 \tag{32}$$

where there exist positive number d' and M' such that for all x' with $0 < |x' - 0| < d'$,

$$|f(x')| \leq M'x'. \tag{33}$$

We can then rewrite equation 30 as

$$\begin{aligned} \frac{\partial s^*}{\partial W} &= (1+C)(1 - \Phi'(W)W - \Phi(W)) - 1 + g(x') \\ &= (1+C)(1 - \Phi'(W)W - \Phi(W)) - 1 + O\left(\frac{\gamma^*}{\delta p_1 q}\right) \end{aligned} \tag{34}$$

in which γ is close to zero.

E 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.

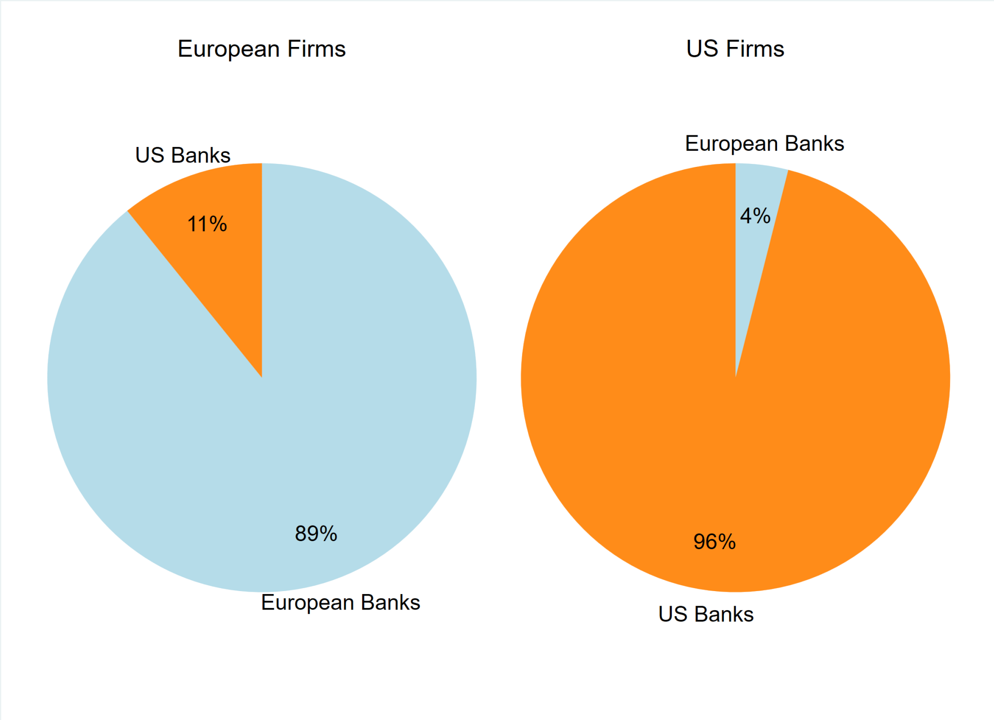

Figure D1. Distribution of Credit Line Suppliers. This figure plots the distribution of credit line suppliers in European and US markets. The left plot shows the proportions of credit line suppliers in European market. The right plot shows the proportions of credit line suppliers in US market.