Quantitative Easing, Banks' Funding Costs, and Credit Line Fees

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Abstract

This paper empirically and theoretically studies the impact of higher funding costs on banks' credit line fees for US and European firms. We show that funding costs generate frictions related to banks' shareholders (debt overhang cost), and banks transfer the cost to the credit lines' fees. However, our econometric analysis and event studies suggest that the central bank's Quantitative Easing (QE) during the COVID-19 shock was crucial in mitigating these costs, thereby ensuring a cheaper supply of credit to the economy. Our findings shed further light on the intricate relationship between banks' funding costs and 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 euro 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 focus mainly on the 2020 COVID-19 shock. In doing this, our paper speaks to different parts of the literature, for example, credit line pricing, post-2008 funding frictions and their effect on asset prices, as well as central banks' intervention to stabilise financial markets and asset prices.

We make several important contributions. First, our paper is the first to suggest that banks' funding costs post-2008 (see Andersen et al. (2019)) are pervasive and are also affecting the price (and supply) of credit lines to firms. However, empirically and theoretically, we also show that the central bank's Quantitative Easing (QE) can mitigate the cost of this friction to banks and ensure a (cheap) supply of credit to the economy. These are new and important empirical and theoretical results.

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 requirements. 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 financings in the US.

There is a vast literature for US firms on using credit lines for liquidity risk management (Brown et al. (2021), Sufi (2009), and Acharya & Steffen (2020)), while the same literature for Europe is more limited (see Cerrato et al. (2023)). Our paper makes a novel and significant contribution to this literature: 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).

The closest paper to ours is by 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). They propose a framework that explains this feature, focusing on different reference rates, that is, credit-sensitive rates, such as Libor, and risk-free rate SOFR (Secured Overnight Financing Rate).

Our paper adds important empirical and theoretical contributions. From an empirical viewpoint, it complements the empirical analysis in Cooperman et al. (2023) by studying if banks' funding costs (as shareholders' debt overhang costs) drive credit lines' prices in two critical markets, the European and US markets. In so doing, it 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 show that banks' funding costs are associated with credit lines' (drawn but also undrawn) fees. For example, we show that one basis point increase in funding costs (proxied by the difference between the LIBOR minus OIS spread) leads to a six basis point increase in All In Spread Drawn (AISD) spread for European firms but only a three basis point increase for US firms—a different story for the All In Spread Undrawn (AISU). While one basis point increase in funding costs reduces the AISU by three basis points for European firms, it still increases (by three basis points) for US firms. In sum, while debt overhang costs seem similar for US and European borrowers (although different in terms of the impact on fees), the effect on AISU fees is substantially different.

In the second part of the paper, given our empirical results, we ask ourselves whether central banks 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. 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. There is no empirical evidence suggesting that central banks' QE can mitigate debt overhang costs, and it is also unclear if this benefit is transferred to borrowers. This paper addresses these two important issues.

We document empirically and via event studies that central banks' quantitative easing (QE) in March 2020 was effective in reducing banks' funding costs (and shareholders' debt overhang costs, Andersen et al. (2019)), and this contributed to reducing credit lines' fees. We follow Burnside et al. (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 funding value adjustment (FVA) and, therefore, shareholders' debt overhang costs[1].

[1]For the banks, see also discussion in Burnside et al. (2023). They have also used other proxies for FVA, for

Our paper also speaks to the recent and growing literature on financial intermediary's constraints post 2008 and their effect on asset prices (Du et al. (2018), Du et al. (2023), Andersen et al. (2019), Fleckenstein & Longstaff (2020), and Cerrato et al. (2023)). While most of this literature has focused on the US Treasury market, covered interest rate parity (CIP) and mainly dealers' capacity to provide liquidity following new post-2008 leverage ratio regulations, we focus on credit lines and credit lines' fees. Our results extend and complement this literature to the loan market.

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.

In sum, higher banks' funding costs in bad times produce frictions that impact credit lines' prices across Europe and the US, but 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.

example, 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.

2 Data and Statistics

2.1 Data

We collect 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 mainly focus on the COVID-19 shock period.

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 wholesale bank funding spread (Cooperman et al. 2023). Following Burnside et al. (2023), we also collect from Bloomberg 5-year credit default swap (CDS) spreads of 12 representative banks across the two markets. Appendix A provides details of these 12 banks. In our study, we use monthly data unless it is specified otherwise due to event study analysis.

The literature on credit lines' prices uses 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 US and European loan markets (see Carey & Nini (2007), Berg et al. (2016), and Berg et al. (2017)).

Loans may vary in the currency they are labelled in, which could lead to the potential for variations in loan interest rates across different markets due to considerations about exchange rate changes. Given that, the field *Deal Amount Converted* in DealScan converts loans in other currencies into USD. We use this variable to indicate the loan size (*Facility Amount*) since the loan size may affect banks' lending prices to firms. In addition, we construct several indicators, *Maturity*

[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 United Kingdom (UK) firms. Figure D1 in Appendix D 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

1-3Y, *Maturity 3-6Y*, and *Maturity >6Y*, denoting different maturities of loan facilities. The rest is the loans with maturities within one year.

Table 1 presents the summary statistics of all variables. Panel A shows 6-month and 12-month LIBOR-OIS spreads, measuring short-term funding costs. During the sampling period, these were 34.507 bps and 49.852 bps, respectively. We also use banks' CDS spreads as in Burnside et al. (2023) and average them to form an Index. This should measure long-term funding costs based on dealers' rather than market spreads, as with LIBOR minus OIS spreads. This is 66.027 bps. Panels B and C show summary statistics of European and US samples. 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), consistent with Berg et al. (2017).

2.2 Preliminary Statistics

To investigate drawdown fees across US and European markets, we average *All In Spread Drawn* and plot it over the sampling period. Figure 1 shows credit lines' fees (Europe and US) before and after central banks' QE (we select 20 March as FED started QE on 23 March). The pic shows a slope change soon after the FED QE; this is more evident for the US market.

Figure 2 shows the funding spreads over the sample period we study. In line with 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) 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 central bank announcement, we also show separately the 6-month (12-month) LIBOR and 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 these results by using 5-year CDS spreads as a measure of funding costs for the

[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

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

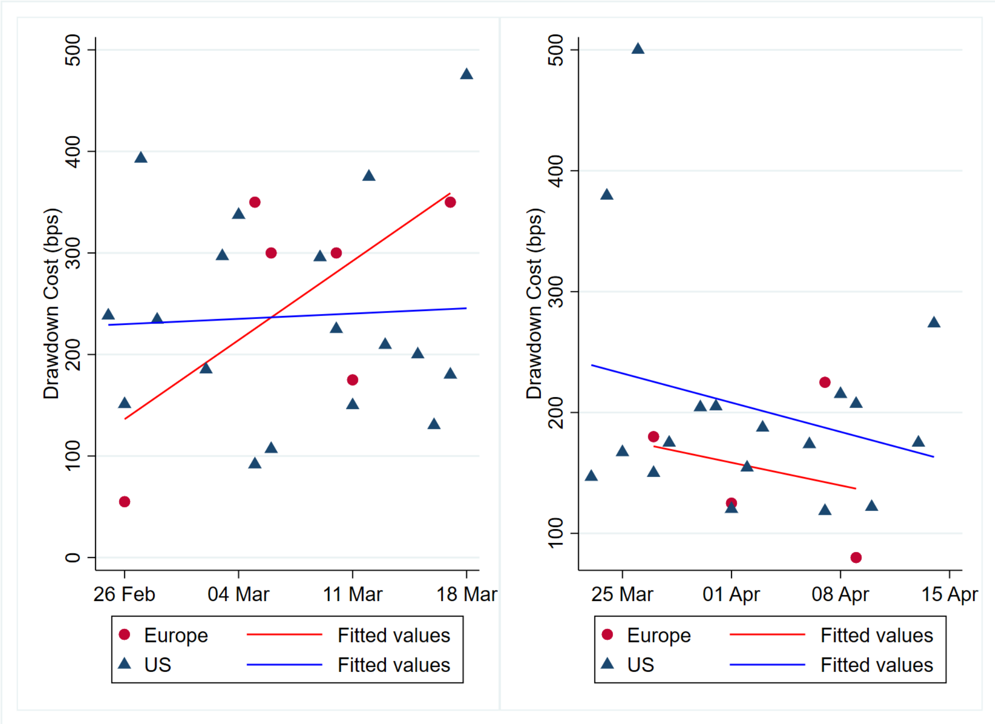


Figure 1. Drawdown Cost. This figure plots the daily average drawdown fee (*All In Spread Drawn*). The red solid line indicates the AISD fees in the European market. The blue solid line indicates the AISD fee in the US market.

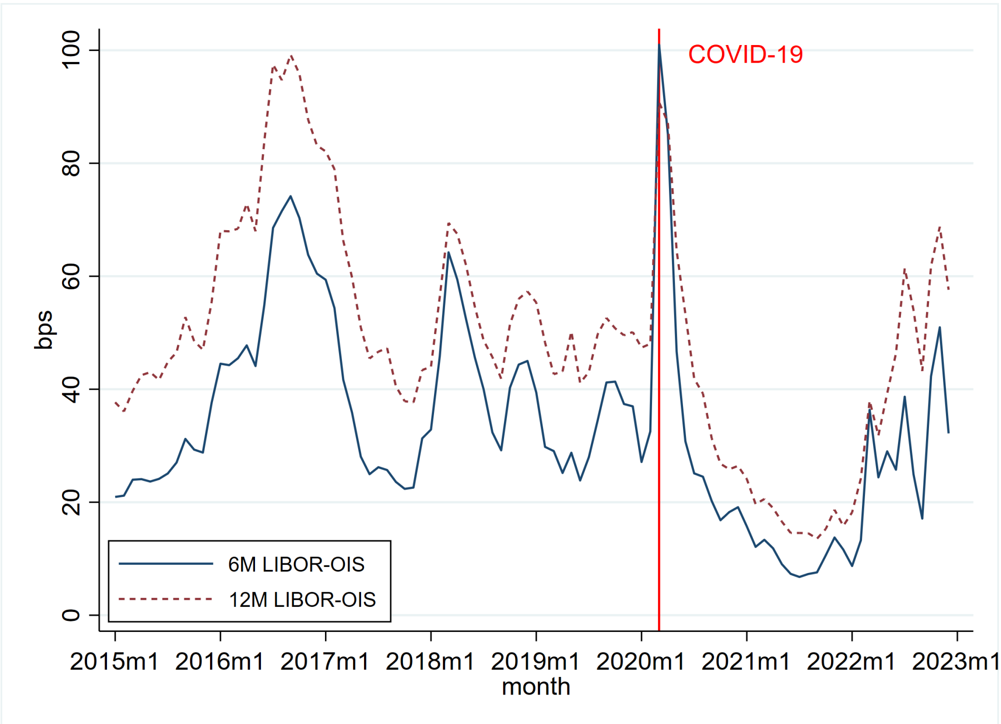


Figure 2. LIBOR-OIS Spread. This figure plots the monthly LIBOR-OIS spread. The blue solid line represents the spread between the 6-month LIBOR-OIS rate. The red dashed line represents the spread 12-month LIBOR-OIS rate. The solid red line represents when the WHO announced the COVID-19 pandemic.

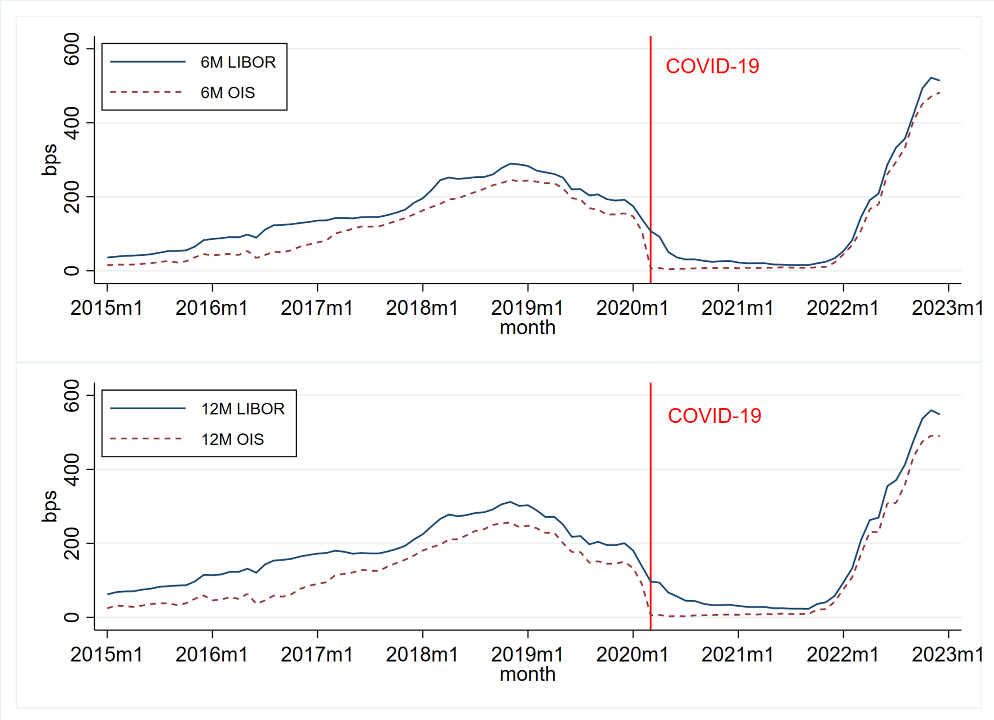


Figure 3. LIBOR and OIS Rates. This figure plots monthly LIBOR and OIS rates. The upper plot shows the rates of 6-month LIBOR (blue solid line) and OIS (red dashed line). The lower plot shows the rates of 12-month LIBOR (blue solid line) and OIS (red dashed line). The solid red line refers to the period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

bank. 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. Overall, the evidence so far suggests that banks lowered credit line fees soon after central banks started QE.

We now aim to shed further light on the evidence presented earlier. First, did central banks' QE reduce banks' funding costs? To answer this question, we do a simple event study, setting a window of one month before and after March 2020. Table 2 shows that IBOR-OIS spreads (6-month and 12-month) saw an increase to 68 (43) bps from February 2020 to March 2020, while they reversed after that period. CDS spreads also declined. In line with this trend, lines' fees, on average, increased between February 2020 and March 2020 and decreased from March 2020 to April 2020. the decline in fees is more persistent for the US market. As for commitment fees, both markets had a bounce-back trend within these three months, while the change in the US market was more pronounced than in the European market. Total loan size increased a lot from February to March. European loans were almost three times larger than before [6].

These preliminary results confirm that credit line fees first increased in March 2020 but soon

[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.

[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).

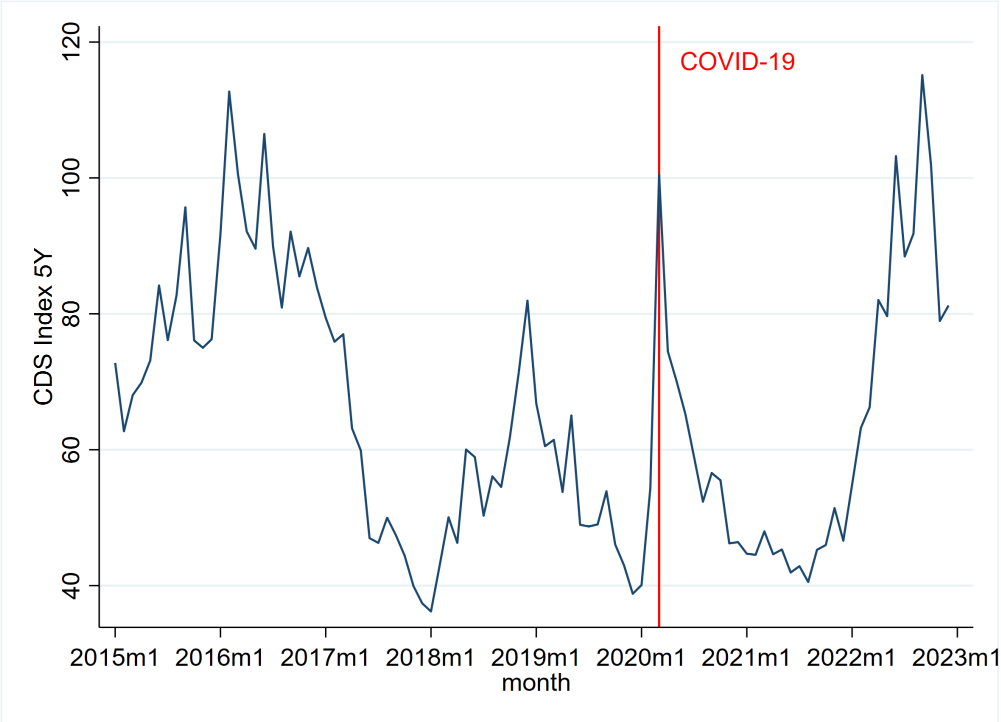


Figure 4. CDS Index. This figure plots the monthly 5-year CDS index. The index is a monthly average of 12 representative banks' 5-year CDS spread. The solid red line represents when the WHO announced the COVID-19 pandemic.

after reversed in line with central banks' asset purchase programs. The next section builds on the empirical evidence reported in this section. It employs higher-frequency data to understand if central banks' QE has effectively reduced banks' financing costs and if banks have transferred part of this benefit to firms (borrowers).

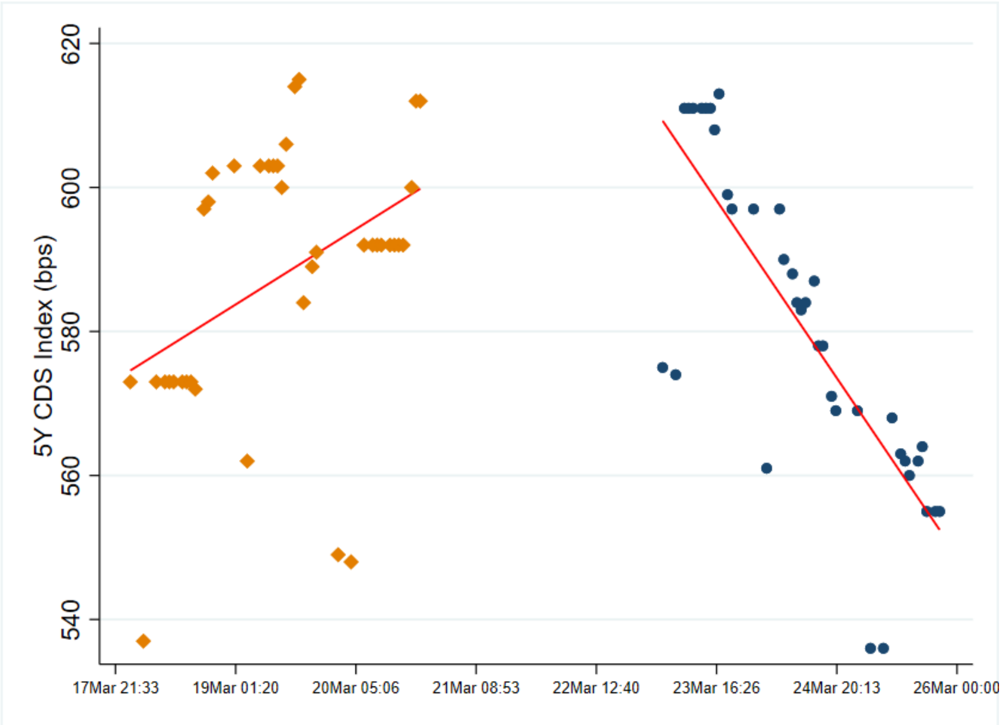
2.3 Time Series Event Study

In this section, we assume a narrow window around the ECB and the FED QE (17 March to 26 March) to account for the possibility that other factors may drive our results. We use hourly data on banks' CDS from Bloomberg. The narrow window allows us to exclude other factors which may have had an impact on credit spreads[7].

Figure 5 shows the intraday CDS index scatter plot around the window. Both markets (Panels A and B) show an inverse V-shape slope. 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 were 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 this date, the slope coefficients became -22.79 bps with t-statistic of -9.46 in Europe and -23.30 bps with t-statistic of -17.77 for the US.

[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).

Panel A: Europe



Panel B: US

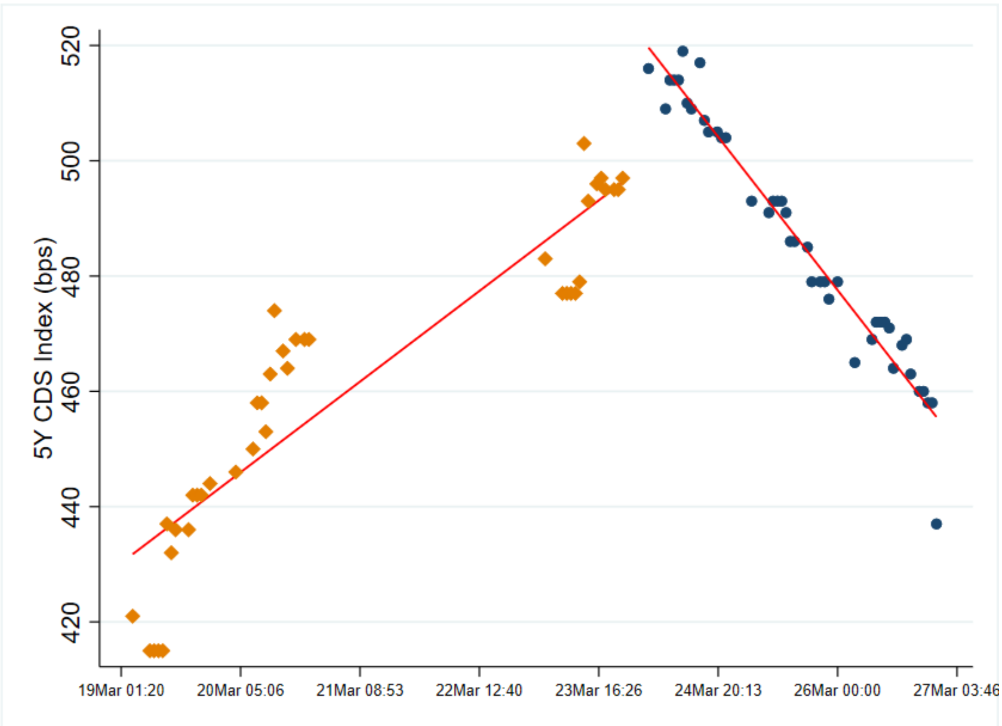


Figure 5. Intraday CDS Index. This figure plots the intraday 5-year CDS index in a narrow window during the ECB and the Federal Reserve QE. Panel A plots the intraday data for European banks, while Panel B plots the data for US banks. The diamond-yellow scatter represents the CDS spread before central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

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%.

	Jan-20	Feb-20	Mar-20	Apr-20	May-20
LIBOR-OIS 6M (bps)	27.125	32.525	101	85.175	46.675
LIBOR-OIS 12M (bps)	47.363	48.05	90.79	87.25	64.55
LIBOR 6M (bps)	174.525	139.725	107.2	92.225	50.975
LIBOR 12M (bps)	180.663	138.15	96.85	93.95	67.35
OIS 6M (bps)	147.4	107.2	6.2	7.05	4.3
OIS 12M (bps)	133.3	90.1	6.06	6.7	2.8
CDS Index 5Y (bps)	40.087	54.307	100.496	74.459	70.066
Europe					
All In Spread Drawn (bps)	336.774	171.928	214.595	164.818	215.409
All In Spread Undrawn (bps)	(omitted)	50.885	50	54.763	40.25
Total Facility Amount (billion USD)	264.081	399.44	1,184.66	1,161.20	488.161
US					
All In Spread Drawn (bps)	243.622	235.129	196.042	176.372	206.812
All In Spread Undrawn (bps)	23.042	21.331	17.086	28.722	30.036
Total Facility Amount (billion USD)	457.342	749.545	1,647.63	1,238.65	362.365

Next, we study credit line fees and funding costs before and after QE. We do not have high-frequency data on lines' fees. Therefore, we use daily data for this analysis. We run a simple panel OLS with credit line fees as the dependent variable and funding costs as the independent variable (we use banks' CDS spreads here). The regression includes an intercept. Figure 6 plots the fitted line. The figure is consistent with the empirical results reported in the previous section. It suggests that QE was instrumental in reducing banks' funding costs and lines' fees[8].

2.4 The Effect of Central Bank Intervention

In this section we study further the effect of QE on banks' fudning costs. We regress LIBOR-OIS spreads over the period associated with QE, March 2020, and a dummy. Equation 1 details the specification.

$$LIBOR\text{-}OIS_t = \alpha_0 + \alpha_0 CB_t + \epsilon_t \quad (1)$$

[8] Cerrato et al. (2023) show for the European market that at the peak of the COVID-19 shock, lenders and borrowers cooperate in the sense that banks supply the necessary contingent liquidity to firms following the shock. The results in this paper explain why that happened.

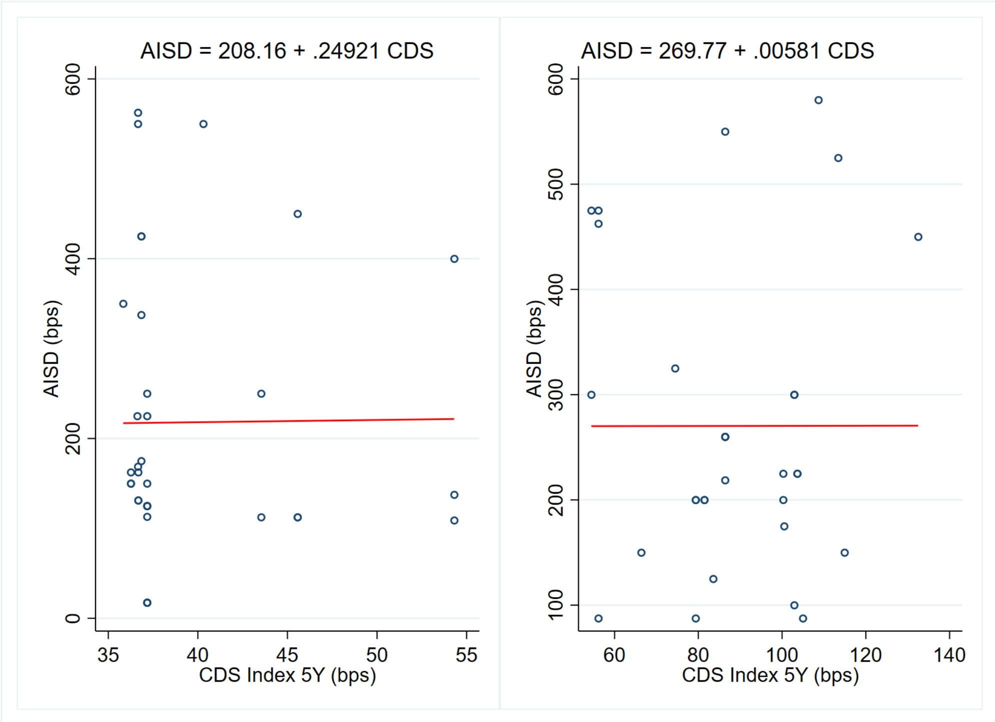


Figure 6. Drawdown Fees and Funding Costs. This figure plots corporate borrowers' average drawdown fee and banks' funding costs measured by 5-year CDS spreads. The sampling frequency is daily from February 2020 to April 2020. The left plot indicates the relationship between drawdown cost and debt overhang cost before the quantitative easing (QE), while the right plot indicates the relationship after QE. The red line is the fitted line.

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[9]. 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. These results align with the theoretical prediction in Cooperman et al. (2023). We empirically find that during the COVID-19 pandemic, short-term wholesale funding costs decreased.

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

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

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

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

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 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.

	(1) LIBOR-OIS 6M	(2) LIBOR-OIS 12M	(3) CDS Index 5Y
CB	-12.595***	-20.099***	-2.530***
	(0.092)	(0.096)	(0.102)
Constant	38.637***	55.963***	66.425***
	(0.056)	(0.059)	(0.062)
Observations	157155	157155	157155
R^2	0.106	0.219	0.004

3 US Market

The results earlier suggest that central banks' QE in March 2020 reduced banks' funding costs, and banks lowered credit lines' fees and conveyed credit to the real economy. In the following sections, we provide robust empirical evidence supporting these results. In so doing, we make two important contributions. First, we complement and provide further empirical support to the theoretical prediction in Cooperman et al. (2023) that banks' funding costs are highly correlated to credit lines's drawdowns. Empirically, we show that this result also extends to credit line prices. Furthermore, we extend that analysis to cross-country (US and Europe) as well as undrawn fees. Therefore, our results also help better understand credit line fee dynamics in the US and Europe. In this sense, our results complement Berg et al. (2016) and Berg et al. (2017). Finally, and more importantly, we show that central banks' QE is instrumental in reducing banks' funding costs (and, consequently, debt overhang costs for shareholders) and beneficial for firms as they could access cheaper credit.

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[10]. We employ the following regression:

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

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 and April 2020 when central banks' QE happened. $\textit{ln(Loan Amount)}_{i,t}$ 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 the OLS regression of equation 3. Let us 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 loan rates on credit line drawdowns. 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 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.

Section 2.4 shows that central bank intervention mitigates the correlation between banks' funding costs and firms' borrowing costs. 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 between March and April 2020. Similar results only hold if the dummy is set equal to one in March 2020. As pointed out in Cooperman et al. (2023), higher funding costs are debt overhang costs for banks'

[10]Following Burnside et al. (2023), we use the CDS index to proxy for banks' funding costs. Table B1 in Appendix B.1 shows the results.

shareholders, and this friction introduces a wedge in the lines' fees equal to the covariance between borrowing costs and the amount of drawdown. It follows that banks will price this cost in the lines' fees proportionally to the wedge. Our model confirms this result and extends 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. This effect is positive but much lower in size than the estimated coefficient on LIBOR-OIS spread alone. These results further suggest that during the pandemic shock, the FED asset purchase program contributed to the supply of credit to the real economy [11]. This result is new and very important as it suggests that central banks' QE is not only necessary 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 this mechanism.

Although the literature on loan facilities' fees use all-in-spread-drawn as a key 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:

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

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 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, a 1 bps increase in

[11]Similarly, we also report the results of how banks' long-term debt overhang cost affects corporate drawdown fees 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

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 on interaction term in equation 3. In line with the results presented earlier, the combined size of the coefficents on LIBOR-ois spread and dummy is positive a small [12].

[12]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 drawdowns 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

4 European Market

This section focuses on the European market. Focusing on these two important markets, we also aim to study the heterogeneity of credit line fees across markets during the COVID-19 shock and the cross-country impact of central banks' QE.

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.[13] Table 6 shows the empirical results. In line with the US market, we note positive and significant coefficients on LIBOR-OIS spreads versus drawdown fees (columns (1) across (4)) using the OLS specification. Unlike US banks (Table 4), European banks reduce firms' fees for undrawn credit lines. The coefficients of spreads on undrawn fees are negative and significant (columns (5) across (8)).

ECB asset purchase programs also contributed to lower the lending fees (columns (2) and (4) in Table 6). Banks raise the fees on undrawn credit lines (columns (6) and (8)).[14]

Combining drawdown cost and undrawn fee, we use UWS to study if banks' short-term funding costs are associated with lines' fees. Table 7 shows the results using equation 3 specification. We find similar results as for the US market (Table 5) both on funding costs and their interaction with the shock.[15]

[13]In Table B3 of Appendix B.2, we regress corporate borrowing fees of credit lines on bank funding costs.

[14]Table B3 in Appendix B.2 reports the results by using long term funding costs.

[15]In Table B4 of Appendix B.2, we show the regression results of UWS on bank shareholders' long-term debt overhang costs.

Table 6. **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 7. **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 drawdowns 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 Simple Theoretical Model

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

5.1 Basic structure

Figure 7 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. 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 $\delta = 1/(1+r)$[16]. 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[17]. Assume also a risk-based capital requirement for bank shareholders to fund this undeposited fraction[18]. The bank funds the quantity $(1 + C)(1 - \varphi)q$, where C is a constant capital ratio.

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 $t = 2$. We assume that the bank will not default before the loan's maturity.

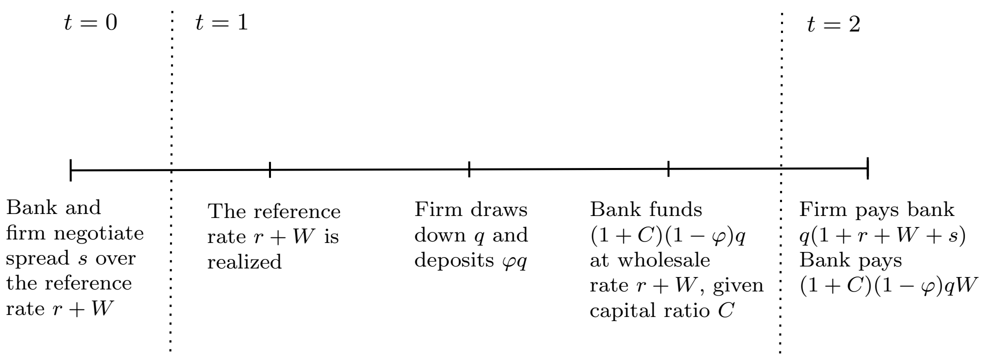


Figure 7. Timeline of model

Following Andersen et al. (2019) and Cooperman et al. (2023), we define the risk-neutral value

[16]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.
[17]Cooperman et al. (2023) equate banks' wholesale funding spread S to credit spread W, that this our bank is of LIBOR-quality.
[18]See Favara et al. (2022) and Basel Committee on Banking Supervision (2018).

(marginal) of the equity to bank's shareholders at time $t = 1$ as

$$G = \underbrace{p_1[\delta(1+r+W+s)q - q]}_{\text{Profit on Drawdowns}} - \underbrace{p_1\delta(1+C)(1-\varphi)qW}_{\text{Debt Overhang Costs}} \tag{5}$$

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 5, we obtain the marginal profit

$$G = p_1\delta q\ [\underbrace{(W+s)}_{\text{Unit Profit}} - \underbrace{(1+C)(1-\varphi)W}_{\text{Unit Cost}}\ ]. \tag{6}$$

From equation 6, 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:

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

The first term in equation 7 is debt overhang costs when funding via the wholesale market. The second term is compensation lending via credit lines. Equation 7 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*[19]*, it follows that the contractual fee s is well defined and is given by:*

$$s = \eta - \kappa + \frac{cov_1(q, \tau_q)}{\delta p_1 q} \tag{8}$$

where

- $\eta = (1+C)(1-\varphi)W$ *reprents costs related to regulatory frictions.*
- $\kappa = W$ *is the credit spread.*

[19] We relax this assumpltion in Proposition 3.

- $\tau_q = \delta p_1(1+C)(1-\varphi)W$ *is the banks' debt overhang cost at time 1 conditional on time 2.*

Appendix C.1 includes a proof of Proportion 1. The term $cov_1(q, \tau_q)$ in equation 8 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:

$$\frac{\partial cov_1(q, \tau_q)}{\partial W} = \gamma \tag{9}$$

where γ is a constant. This implies that the covariance between debt overhang cost and the credit spread increases linearly, bringing the following results.

Proposition 2 (Central Bank Intervention): *Consider the contractual fee s defined by equation 8. If there is no central bank intervention, $\gamma \gg \delta p_1 q[1-(1+C)(1-\varphi)]$ and the first-order difference of contractual fee to the credit spread is:*

$$\frac{\partial s}{\partial W} = (1+C)(1-\varphi) - 1 + \frac{\gamma}{\delta p_1 q} \gg 0. \tag{10}$$

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

$$\frac{\partial s}{\partial W} = (1+C)(1-\varphi) - 1 + O\left(\frac{\gamma}{\delta p_1 q}\right) \quad \text{as } \gamma \to 0. \tag{11}$$

Appendix C.2 includes a proof of Proportion 2. Equation 10 describes the first case of no central bank intervention. Thus, bank shareholders face an increasing debt overhang cost as corporate borrowers keep drawing down credit lines. The association between debt overhang cost and the drawdowns increases as credit spreads increase. Banks raise the drawdown fee.

Equation 11 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 8 can be rewritten as

$$s^* = \eta^* - \kappa + \frac{cov_1(q, \tau_q^*)}{\delta p_1 q} \tag{12}$$

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

$$\frac{\partial cov_1(q, \tau_q^*)}{\partial W} = \gamma^*. \tag{13}$$

We have the following result.

Proposition 3 (Central Bank Intervention): *Consider the contractual spread* s^* *defined by equation* 8 *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:*

$$\frac{\partial s^*}{\partial W} = (1+C)(1-\Phi'(W)W-\Phi(W)) - 1 + \frac{\gamma^*}{\delta p_1 q} \gg 0. \tag{14}$$

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

$$\frac{\partial s^*}{\partial W} = (1+C)(1-\Phi'(W)W-\Phi(W)) - 1 + O\left(\frac{\gamma^*}{\delta p_1 q}\right) \quad \text{as } \gamma^* \to 0. \tag{15}$$

Appendix C.3 includes a proof of Proportion 3. Basically, γ^* dominates equation 14 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 can see how the 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 8. In our baseline model, the capital requirement ratio is set up as $C = 5\%$ [20], 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

[20]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%.

$\varphi = 10\%$. In the case of no central bank intervention as defined in Proposition 2, the covariance is specified as

$$cov_1(q, \tau_q) = \gamma W + \epsilon, \tag{16}$$

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[21], 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 8 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).

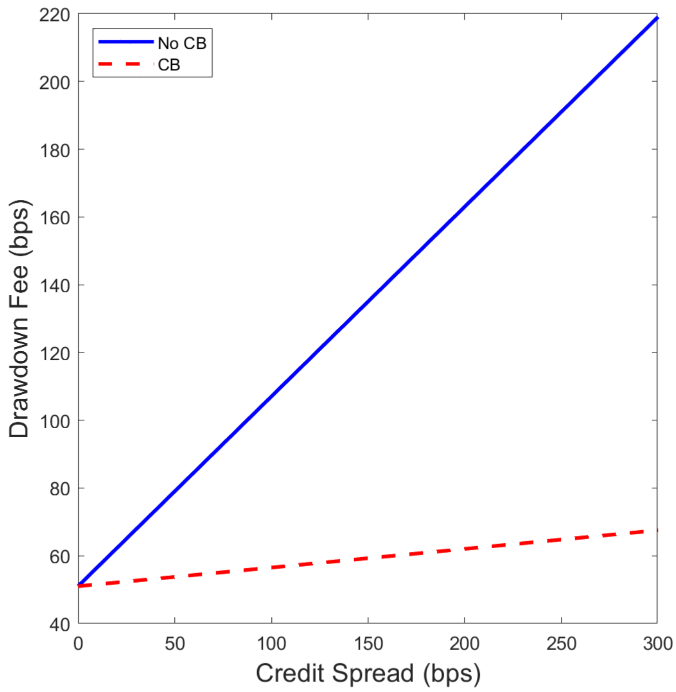


Figure 8. Drawdown Cost and Credit Spread. This figure plots the calibrated model of corporate drawdown cost correlated to credit spread. The parameterization is $\{\delta, C, p_1, q, \varphi, \epsilon\} = \{0.99, 5\%, 0.99, 20\%, 10\%, 10 \text{ bps}\}$. The solid blue line represents the case in which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

Cooperman et al. (2023) for the US and Cerrato et al. (2023) for Europe, shows 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)

[21] Given the parameterization and Appendix C.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.

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

$$\Phi(W) = aW^b. \tag{17}$$

where $a > 0$ defines the linear relationship between credit spread and drawdown fee and the elasticity term $b > 0$ captures the exponentially increasing relationship[22]. Based on equation 12, the contractual spread of a credit line drawdown can be rewritten as:

$$s^* = (1 + C)(1 - aW^b)W - W + \frac{cov_1(q, \tau_q^*)}{\delta p_1 q}, \tag{18}$$

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

$$cov_1(q, \tau_q^*) = \gamma^* W + \epsilon. \tag{19}$$

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 9 reports the results.

5.2.2 Sensitivity to Capital Requirement

Equations 11 and 15 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 10 and 11.

Given the assumption of constant deposited fraction (φ), we plot different levels (3% to 6%) of capital requirement in Figure 10. 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 deposit fraction ($\Phi(W)$) in Figure 11, we find a slight fall in the increment, from 1.5 bps to 1.4583 bps. In a nutshell,as expected capital requirement is positively correlated with drawdown cost and it increases fees.

[22] 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.

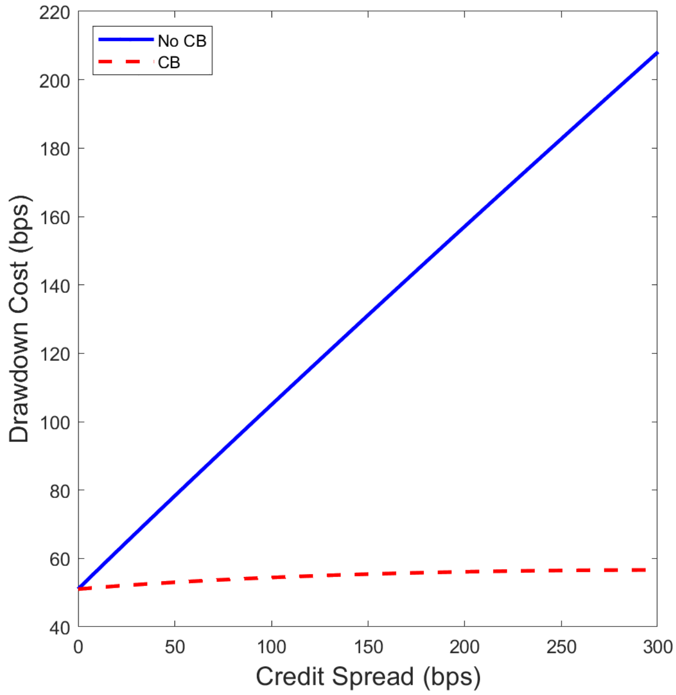


Figure 9. Drawdown Cost and Credit Spread. This figure plots the calibrated model of corporate drawdown cost correlated to credit spread. The parameterization is $\{\delta, C, p_1, q, a, b, \epsilon\} = \{0.99, 5\%, 0.99, 20\%, 0.2, 0.5, 10 \text{ bps}\}$. The solid blue line represents the case in which no central bank intervention exists. The dashed red line represents the case in which central bank intervenes in the market.

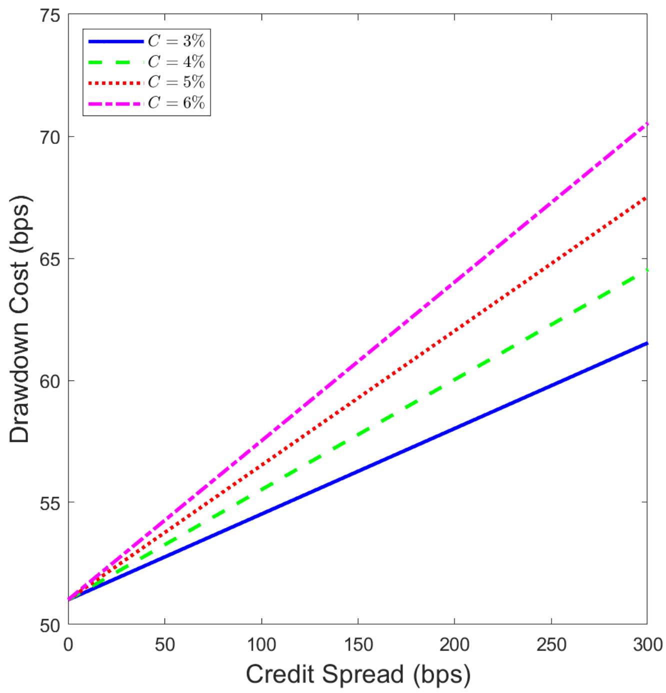


Figure 10. Capital Requirement Sensitivity with Intervention. This figure plots the calibrated model of corporate drawdown cost correlated to credit spread in which central banks intervene in the markets. The parameterization is $\{\delta, p_1, q, a, b, \varphi, \epsilon\} = \{0.99, 0.99, 20\%, 0\%,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

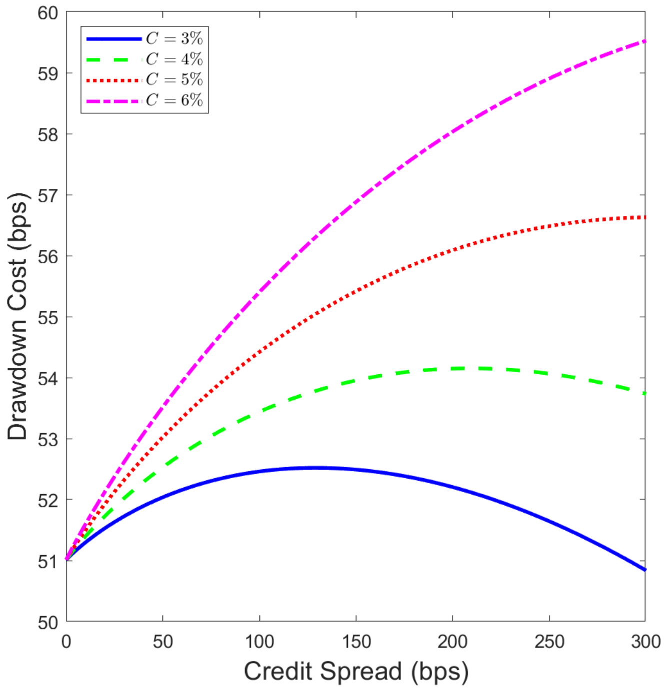


Figure 11. Complemented Capital Requirement Sensitivity with Intervention. This figure plots the calibrated model of corporate drawdown cost correlated to credit spread in which central banks intervene in the markets. The parameterization is $\{\delta, p_1, q, a, b, \epsilon\} = \{0.99, 0.99, 20\%, 0.2, 0.5, 10 \text{ bps}\}$. The solid blue line represents the case in which the capital requirement is 3%. The dashed green line represents the capital requirement is 4%. The dotted red line represents the capital requirement is 5%. The dash-dot pink line represents the capital requirement is 6%.

6 Conclusion

This paper adds to the growing literature on banks' funding costs post-2008 and examines whether this cost creates friction on banks' intermediation. We extend this literature to the credit line market. A large part of the literature focuses on regulatory frictions (leverage ratio requirements) as supportive evidence that this poses a cost for banks and prevents them from intermediating assets, particularly when the markets need liquidity. Following this literature, recently, Cooperman et al. (2023) shows that funding costs are debt overhang costs for banks' shareholders and are also relevant for the intermediation of credit lines. They show that the covariance between banks' funding costs and credit line drawdown is debt overhang costs for banks' equity holders. This paper complements and extends this important result empirically and theoretically. First, we show empirically, across two important markets (Europe and the US), that debt overhang costs are important to understand the price of the line of credit during the COVID-19 shock. This result adds further light on cross-market lines price discussed in Berg et al. (2017). We also report evidence 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 explains why QE effectively mitigates debt overhang costs and reduces lines' fees.

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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:

$$\begin{aligned} Y_{i,t} \quad = \quad & \beta_0 + \beta_1 \textit{CDS Index}_t + \beta_2 \textit{CDS Index}_t \times CB_t + \beta_3 \textit{ln(Loan Amount)}_{i,t} \\ & + \beta_4 \textit{Maturity 1-3yr}_{i,t} + \beta_5 \textit{Maturity 3-6yr}_{i,t} + \beta_6 \textit{Maturity} > \textit{6yr}_{i,t} + \beta_7 \textit{Secured}_{i,t} \\ & + \beta_8 \textit{ln(\#Lenders)}_{i,t} + \gamma X_{i,t} + \epsilon_{i,t} \end{aligned} \tag{20}$$

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[23]. CB_t is a time dummy indicating the shock in March 2020 and April 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. Time, industry, and loan purpose fixed effects 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 20. Similarly, a 1 bps increase in the CDS index results in a 4.2 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 20, the coefficient of the interaction on drawdown cost (AISD) is significant and positive (columns (2)). Regarding the commitment fee (AISU) in column (4), the coefficient on interaction is still significant and positive.

Similarly, we study how long-term debt overhang costs drive firms' comprehensive borrowing

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

costs. We use the usage-weighted spread (UWS) and run the panel regression in equation 20. 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, increases firms' general cost of borrowing credit lines.

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.

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		0.614***		0.236***
		(0.097)		(0.013)
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		0.309***		0.282***		0.254***
		(0.032)		(0.027)		(0.024)
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

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 20, we regress the proxy for banks' long-term debt overhang cost, a CDS index, on borrowing cost of credit line drawdowns (*All In Spread Drawn*) and the fee of retaining undrawn credit lines (*All In Spread Undrawn*). Table B3 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 inversely cut two types of lending prices.

Next, we use the European sample to investigate banks' long-term debt overhang cost on firms' comprehensive borrowing cost. Substituting LHS of equation 20 with UWS, a measure combining both drawn and undrawn costs, we run the specification and obtain the results in Table B4. 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 positive in columns (2), (4), and (6).

Table B3. **Credit Line Fees 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		-0.248		-0.001
		(0.173)		(0.073)
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 B4. **Comprehensive Credit Line Cost 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		0.115		0.141**		0.167**
		(0.075)		(0.071)		(0.068)
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 Proof

C.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:

$$\begin{aligned}\mathbb{E}[\tau] &= \mathbb{E}[p_1\delta(1+C)(1-\varphi)qW] \\ &= \mathbb{E}[q]\,\mathbb{E}[p_1\delta(1+C)(1-\varphi)W] + cov_1(q, p_1\delta(1+C)(1-\varphi)W) \end{aligned} \tag{21}$$

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 7 as:

$$\begin{aligned} s &= \frac{\mathbb{E}[\tau_q q] - \mathbb{E}[\delta p_1 qW]}{\mathbb{E}[\delta p_1 q]} \\ &= \frac{\mathbb{E}[\tau_q]\,\mathbb{E}[q] + cov_1(q,\tau_q) - \mathbb{E}[\delta p_1 qW]}{\mathbb{E}[\delta p_1 q]} \\ &= \frac{\tau_q q + cov_1(q,\tau_q) - \delta p_1 qW}{\delta p_1 q} \\ &= (1+C)(1-\varphi)W - W + \frac{cov_1(q,\tau_q)}{\delta p_1 q} \end{aligned} \tag{22}$$

Inserting $\eta = (1+C)(1-\varphi)W$ and $\kappa = W$ into equation 22 provides equation 8.

C.2 Proof of Proposition 2

We first consider the case where central banks do not intervene in the market. Given Proportion 1 and equation 9, we derive the first-order contractual spread s associated with credit spread W as:

$$\begin{aligned} \frac{\partial s}{\partial W} &= \frac{\partial \eta}{\partial W} - \frac{\partial \kappa}{\partial W} + \frac{\partial}{\partial W}\frac{cov_1(q,\tau_q)}{\delta p_1 q} \\ &= \frac{\partial (1+C)(1-\varphi)W}{\partial W} - \frac{\partial W}{\partial W} + \frac{1}{\delta p_1 q}\frac{\partial cov_1(q,\tau_q)}{\partial W} \\ &= (1+C)(1-\varphi) - 1 + \frac{\gamma}{\delta p_1 q} \end{aligned} \tag{23}$$

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

$$\gamma_0 = \delta p_1 q[1 - (1+C)(1-\varphi)]. \tag{24}$$

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

$$f(x) = O(x) \quad \text{as } x \to 0 \tag{25}$$

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

$$|f(x)| \leq Mx. \tag{26}$$

Then, we can rewrite equation 23 as

$$\begin{aligned} \frac{\partial s}{\partial W} &= (1+C)(1-\varphi) - 1 + f(x) \\ &= (1+C)(1-\varphi) - 1 + O\left(\frac{\gamma}{\delta p_1 q}\right) \end{aligned} \tag{27}$$

when γ is approaching zero.

C.3 Proof of Proposition 3

Given equation 12, we first derive the first order of the contractual spread s^* with respect to credit spread W, which yields

$$\begin{aligned} \frac{\partial s^*}{\partial W} &= \frac{\partial \eta^*}{\partial W} - \frac{\partial \kappa}{\partial W} + \frac{\partial}{\partial W}\frac{cov_1(q,\tau_q^*)}{\delta p_1 q} \\ &= \frac{\partial (1+C)\left(1-\Phi(W)\right)W}{\partial W} - \frac{\partial W}{\partial W} + \frac{1}{\delta p_1 q}\frac{\partial cov_1(q,\tau_q^*)}{\partial W} \\ &= (1+C)(1-\Phi'(W)W - \Phi(W)) - 1 + \frac{\gamma^*}{\delta p_1 q} \end{aligned} \tag{28}$$

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

$$\gamma_0^* = \delta p_1 q \left[1 - (1+C)(1 - \Phi'(W)W - \Phi(W))\right] \tag{29}$$

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 $\gamma^* \gg \gamma_0 = \delta p_1 q\,[1 - (1+C)(1 - \Phi'(W)W - \Phi(W))]$. 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

$$g(x') = O(x') \quad \text{as } x' \to 0 \tag{30}$$

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

$$|f(x')| \leq M'x'. \tag{31}$$

We can then rewrite equation 28 as

$$\begin{aligned} \frac{\partial s^*}{\partial W} &= (1+C)(1 - \Phi'(W)W - \Phi(W)) - 1 + g(x') \\ &= (1+C)(1 - \Phi'(W)W - \Phi(W)) - 1 + O\left(\frac{\gamma^*}{\delta p_1 q}\right) \end{aligned} \tag{32}$$

in which γ is close to zero.

D Credit Line Suppliers for European and US Firms

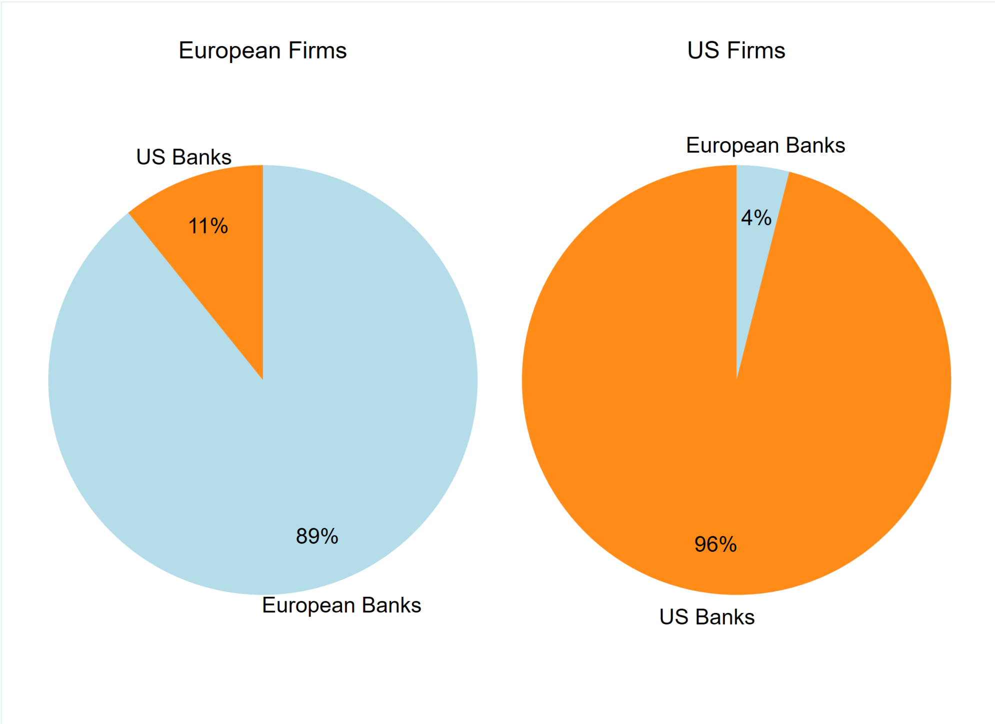

Figure D1. Distribution of Credit Line Suppliers. This figure plots the distribution of credit line suppliers in European and US markets. The left plot shows the proportions of credit line suppliers in European market. The right plot shows the proportions of credit line suppliers in US market.