Lending to Hedge Funds: Does Competition Erode Bank Risk Management?*

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- preliminary draft -

Abstract

We study the impact of hedge funds' bargaining power on banks' risk management practices in secured lending transactions. Our analysis reveals that, on the same day, for identical collateral and under identical repo contracts, banks require significantly lower haircuts from hedge funds with greater bargaining power, even when controlling for their probability of default. This effect is further validated by an exogenous variation in hedge funds' bargaining power, stemming from Credit Suisse's exit from the prime brokerage business. Additionally, our findings indicate that higher bargaining power among hedge funds significantly increases the risk of insufficient haircuts according to standard value-at-risk models, particularly for collateral eligible for monetary policy operations.

JEL Codes: G14, G21, G23, G24

Keywords: bank lending, hedge funds, competition, repurchase agreements

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1 Introduction

Non-bank financial intermediaries (NBFIs) have overtaken banks to become the largest financial intermediaries globally. Recent work by Acharya, Cetorelli, and Tuckman (2024) highlights this trend and emphasizes the growing interconnectedness between the activities and risks of NBFIs and banks. This trend is particularly pronounced in the growth of highly leveraged entities such as hedge funds. Over the past decade, the hedge fund industry's assets under management more than tripled, rising from $1.48 trillion in 2012 to $4.84 trillion in 2022.[1] Assessing the risks posed by the hedge fund sector to the broader financial system is challenging, yet several incidents highlight that these risks can be significant. One of the most notable examples occurred in 1998, when the Federal Reserve Bank of New York orchestrated the recapitalization of Long-Term Capital Management (LTCM) to avert its imminent collapse. This intervention stemmed from concerns that LTCM's failure could lead to widespread disruptions throughout the financial system. More recently, in March 2021, Archegos Capital Management, a family office employing strategies akin to those of hedge funds, defaulted on its loan agreements. This default resulted in approximately $5.5 billion in losses for Credit Suisse and over $10 billion in losses for banks wordwide.[2]

Despite these facts, there is still a limited understanding of how banks are interconnected with hedge funds and how banks manage their risk exposure to these highly leveraged and opaque market participants. A major concern among regulators is that, as hedge funds are lucrative clients, the competition for their business may compromise banks' risk management practices (Bernanke, 2006). Moreover, as an increasing number of hedge funds have shifted from single to multiple broker relationships in the recent past (Dahlquist, Rottke, Sokolovski, and Sverdrup, 2024)[3], their bargaining power in negotiations with banks has presumably grown even stronger. In this paper, we examine how this enhanced bargaining power impacts the bank-hedge fund

[1] Source: BarclayHedge https://www.barclayhedge.com/solutions/assets-under-management/hedge-fund-assets-under-management/hedge-fund-industry. The total assets of the entire NBFI sector experienced a growth by 78% in the same time period, increasing from $122.46 trillion in 2012 to $217.88 trillion in 2022 (FSB, 2023).

[2] https://www.ft.com/content/c480d5c0-ccf7-41de-8f56-03686a4556b6

[3] Dahlquist, Rottke, Sokolovski, and Sverdrup (2024) report that the proportion of hedge funds with multiple prime brokers in the Eurekahedge database rose significantly from approximately 10% in 2006 to about 45% in 2021.

relationship, specifically focusing on banks' risk management practices.

To explore this question, we examine banks' secured lending transactions with hedge funds through repurchase agreements (repos), which constitute the primary method of lending. While substantial exposures to hedge funds can also arise through over-the-counter (OTC) derivative transactions, repo transactions offer an ideal testing ground for identifying weaknesses in risk management practices. Due to their standardization and high frequency, repos enable the comparison of numerous identical transactions executed by a single bank with various hedge funds on any given day. This consistency across transactions facilitates the identification of potential gaps in risk management that may not be as easily observable in more complex or customized transactions, such as OTC derivatives. Exploiting these facts, we examine the variation in haircuts in relation to the bargaining power of hedge funds using a saturated regression framework approach. Essentially, our most saturated regression model examines how haircuts for identical collateral on the same day from the same bank vary in relation to the concentration of hedge funds' funding, while adjusting for the respective probability of default. Our findings show that hedge funds with a less concentrated funding structure, and consequently greater bargaining power, are subjected to lower haircuts. The influence of bargaining power on haircuts is substantial: a reduction in hedge funds' funding concentration equivalent to the interquartile range is associated with an decrease in haircuts by about 0.51 percentage points. For reference, the within security-day variation of haircuts has a standard deviation of 0.91 percentage points. We find that bargaining power plays an especially prominent role in the context of medium-to-low investment grade bonds that qualify for central bank operations with the ECB.

To address the endogeneity of hedge funds' funding structures and the number of their lending relationships, we exploit an exogenous shift in bargaining power provided by a natural experiment. Following the default of Archegos, Credit Suisse declared its intention to exit the prime brokerage market. This decision acted as an adverse shock to the bargaining power of hedge funds that had existing relationships with Credit Suisse. In line with the hypothesis that bargaining power was reduced, our findings indicate a significant increase in haircuts for hedge funds

previously associated with Credit Suisse after the announcement. On average, haircuts rose by 0.49 percentage points within a bank and hedge fund relationship using the same collateral. In contrast, counterparties without a prior relationship with Credit Suisse experienced no change in haircut levels post-announcement.

Lastly, we evaluate the adequacy of the haircuts imposed by banks using conventional value-at-risk (VaR) models. Specifically, we estimate the VaR based on historical return distributions and also employ the Exponentially Weighted Moving Average (EWMA) and Generalized Autoregressive Conditional Heteroskedasticity (GARCH) models. The VaRs calculated through these methods serve as benchmarks for the model-implied haircuts, which we compare to the actual haircuts applied in repo transactions. Across all methods and at every conventional VaR confidence level, we consistently observe that a lower funding concentration, which implies increased bargaining power, is associated with a higher probability of the haircut being insufficient. Our analysis indicates that the risk of inadequate haircuts, influenced by bargaining power, is especially pronounced for securities with medium to low investment grade ratings. Within this rating category, the concern for insufficient haircut levels, attributable to bargaining power, is particularly prevalent for securities eligible for ECB operations.

2 Related Literature

This paper builds on previous studies documenting interactions between banks and non-bank financial intermediaries, such as hedge funds. Hedge funds' involvement has been scrutinized due to their significant role in leveraging and potential to contribute to systemic risk. Brunnermeier and Pedersen (2009) explore how hedge funds' reliance on short-term funding can lead to liquidity spirals and market instability. Gennaioli, Shleifer, and Vishny (2013) provide a theoretical framework for how interconnectedness can lead to contagion and systemic risk, which is explored further by Acharya and Viswanathan (2011) examining the interplay between different type of institutions. To our understanding, we are the first paper empirically investigating

lending between banks and hedge funds using granular transaction-level data.

Our analysis contributes to the literature on repo markets. Auh and Landoni (2022) document higher margins and spreads for lower-quality loans in secured lending transactions. Furthermore borrower tend to pay a premium when their default risk is positively correlated with collateral risk Barbiero, Schepens, and Sigaux (2024). Gorton and Metrick (2012) provided a comprehensive analysis of the role of banks in the repo market during the financial crisis of 2007-2008, highlighting the liquidity issues that emerged. Extending this work, Krishnamurthy, Nagel, and Orlov (2014) examined the changes in banks' repo lending practices post-crisis, noting a shift towards greater risk aversion. Clark, Copeland, Kahn, Martin, McCormick, Riordan, and Wessel (2021) provided an up-to-date assessment of the evolving role of banks in the repo market. These studies collectively underscore the critical role of banks in maintaining the stability and efficiency of repo markets. Our paper complements this literature by analyzing risk management practices as well as their adequacy.

In addition, our paper extends the literature on broker relationships. Kruttli, Monin, and Watugala (2022) show that an idiosyncratic liquidity shock to a prime broker decreases credit availability and worsens credit conditions of connected hedge funds, suggesting imperfect substitutability across credit sources. A sudden exit of a prime broker exposes hedge funds to severe funding risks (Di Maggio, Kermani, and Song, 2017) and led to a change from single to multiple broker relationships after the collapse of Lehman Brothers in 2008 (Agarwal, Ruenzi, and Weigert, 2017). Co-movement in returns of hedge funds sharing the same prime broker seem to be driven by information sharing rather than a result of the prime broker spreading funding liquidity shocks (Chung and Kang, 2016). We add to the literature the aspect of competition, for which the standardized repo contracts as well as the quasi exogenous shock of Credit Suisse leaving prime brokerage business provides us with an ideal setting.

3 Institutional Background

In the following section we provide background on hedge funds as well as their linkages to the banking sector, as discussed in detail by Kambhu, Schuermann, and Stiroh (2007).

Hedge funds are private, largely unregulated investment pools that provide managers with significant flexibility in both investment strategies and financial instruments. They can invest in a wide range of assets, employ complex tactics such as short-selling and derivatives, and make extensive use of leverage. Their regulatory exemptions are often justified by the fact that they primarily serve accredited investors and large institutions, which are deemed more capable of bearing the associated risks. However, when hedge funds are interconnected with other systemically important entities in the financial system, they can pose significant risk to the broader financial system. While banks of course maintain various relationships with both other banks and non-bank entities, Kambhu, Schuermann, and Stiroh (2007) emphasize that hedge funds warrant special attention due to their combination of unrestricted trading strategies, extensive use of leverage, lack of transparency to outsiders, and convex compensation structures. Notable examples of collapses with widespread repercussions include the failure of Long-Term Capital Management (LTCM) in 1998 and the default of Archegos Capital Management, a family office, in 2021.

Hedge funds engage with the regulated banking sector primarily through prime brokerage relationships. Beyond trading and execution services, a key function of prime brokers is the extension of credit to hedge funds, typically through margin loans and repurchase agreements (repos). In our paper, we focus on repo transactions, as they represent the predominant form of secured lending to hedge funds in our sample. In a repo transaction, the bank lends cash to the hedge fund in exchange for specific securities used as collateral. This structure ensures that, in the event of a hedge fund default, the bank retains the securities as protection. To mitigate risk, banks apply a haircut or initial margin to the collateral, ensuring its value exceeds the loan amount and adequately covers potential fluctuations in the collateral's market value. Typically, a haircut is set to account for fluctuations in value up to a specified confidence level, such as 95%

or 99%, over a defined time horizon (Value-at-risk, VaR). In addition, if the value of the collateral drops below this threshold, banks apply a variation margin to rebalance their exposure. Our study focuses on the analysis of initial margin, as data on variation margin and margin calls are unavailable.

The prime broker plays a crucial role for a hedge fund, serving as the primary source of financing. This importance was highlighted by the bankruptcy of Lehman Brothers, which had a significant impact on hedge fund performance, as demonstrated by Aragon and Strahan (2012). Consequently, an increasing number of hedge funds have transitioned from relying on a single broker to establishing multiple broker relationships in recent years (Dahlquist, Rottke, Sokolovski, and Sverdrup, 2024). However, establishing and maintaining a broker-hedge fund relationship is not without costs. First, to establish a relationship with a prime broker, an extensive onboarding process is required. Due to the high costs associated with onboarding and the ongoing monitoring required by the bank, contracts often stipulate a minimum transaction volume. Additionally, hedge funds incur administrative expenses to manage these relationships, creating friction for both the lender and the borrower. These factors effectively limit the ability of hedge funds to expand the number of brokers they engage with.[4,5,6]

In the context of banking regulation, a repo transaction by a bank lending cash to a hedge fund in exchange for a security used as collateral represents an exposure with credit risk mitigation (CRM) technique. While the collateral helps to reduce credit risk, it simultaneously introduces other types of risk, such as market risk. Consequently, banks are mandated to have robust risk management policies to evaluate the adequacy of margin requirements. Transactions utilizing CRM shall not be subject to higher capital requirements than identical transactions without CRM. For uncollateralized exposures to hedge funds, the standardized approach typically assigns risk weights of 100% or 150% (Basel Committee on Banking Supervision, 2022), and typically somewhat lower when using the internal ratings-based approach. The risk weight associated with the

[4] https://www.aima.org/article/five-key-considerations-when-selecting-a-prime-broker.html

[5] https://hedgelegal.com/prime-brokerage-agreement-negotiation-everything-a-hedge-fund-needs-to-know-part-1/

[6] https://thehedgefundjournal.com/the-balancing-act/

counterparty can be substituted with the risk weight of the collateral, subject to a 20% floor (Basel Committee on Banking Supervision (2020), simple approach). Exemptions to the risk-weight floor are applicable to repo transactions under certain conditions. These conditions include overnight transactions or daily remargining and mark-to-market of both exposure and collateral, and the use of sovereign securities as collateral. Given the nature of the repo transactions observed in our dataset, it is very likely that the majority of these transactions fulfill the exemption requirements. As a result, a risk weight of 10% can be applied. Assuming banks are required to maintain 8% capital to risk-weighted assets, a typical repo transaction of 10 million euros translates into capital requirements of 80,000 euros (10,000,000 $\times$ 0.1 $\times$ 0.08). Regulations currently do not mandate a minimum haircut when hedge funds act as counterparties in repo transactions. However, there is ongoing debate about whether implementing such minimum haircuts should be required (FSB, 2014; Basel Committee on Banking Supervision, 2021).

4 Data and Descriptive Statistics

4.1 Data Sources and Sample Construction

We use data from the *money market* statistical reporting (MMSR)[7], which provides transaction-by-transaction information on the European secured money market segment. The dataset includes the identities of the *lender*, and *borrower* as well as *collateral* and includes contract-specific information such as the haircut.

We restrict our sample to *borrower* classified as hedge funds. In the first step, hedge funds are identified from MMSR lending transactions to Non-MMF investment funds (ESA: S124) and financial auxiliaries (ESA: S126), that engage in economic activities related to 'fund management activities' or 'trusts, funds, and similar entities'. In the second step, these entities are further categorized based on SEC filings in Form ADV. We classify a counterparty as hedge fund if it is explicitly identified as such on the fund-level. If the counterparty is matched on company-level,

[7] https://www.ecb.europa.eu/stats/financial_markets_and_interest_rates/money_market/html/index.en.html

we define it as a hedge fund if hedge fund activities constitute more than 75% of the asset under management on the company-level. Additionally, we require hedge funds to have more than ten transactions and an average monthly volume exceeding €10 million. We also integrate fund-level information about the number of brokers and exposure to Credit Suisse from the Investment Advisor Public Disclosure (IAPD) provided by the SEC. For counterparties identified through the management company, we calculate the number of broker relationship as the average of broker relationships from the associated funds.

To complement *lender* information, we merge bank balance-sheet characteristics from the EU-wide transparency exercise conducted by the European Banking Authority (EBA).[8]

We also incorporate data from the Analytical Credit Database (AnaCredit), which covers the probability of default for a given hedge fund reported by the lender.[9]

Finally, we use the Centralised Securities Database (CSDB) to merge *collateral*-specific information such as ratings and eligibility for Eurosystem operations, as well as return data from Refinitiv. Our sample is restricted to transactions involving fixed income collateral.

4.2 Stylized Facts and Summary Statistics

The average daily transaction volume has more than doubled from 2019 to the end of 2023, with lending to hedge funds now constituting nearly 25% of total bilateral lending (see Figure 1).[10][11] In addition, hedge funds have increasingly diversified their broker relationships over the past years as can be seen in Figure 2. During our sample period, the average number of banking relationships for hedge funds increased from 3.7 in April 2019 to 5.9 in December 2024. Correspondingly, the funding concentration, measured by the Herfindahl-Hirschman Index (HHI), declined from 0.53 to 0.39 over the same period.

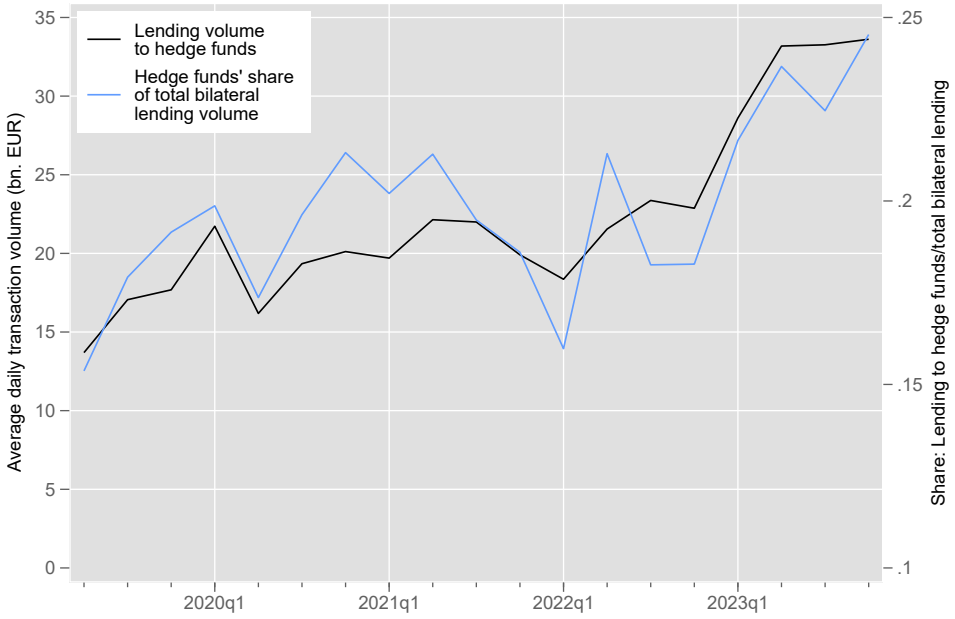
Hedge funds in our sample are larger both at the fund and company level, have more bro-

[8] https://www.eba.europa.eu/risk-and-data-analysis/data/data-analytics-tools

[9] https://www.ecb.europa.eu/stats/ecb_statistics/anacredit/html/index.en.html

[10] In the repo market, banks also function as cash borrowers from hedge funds, effectively acting as securities lenders, while hedge funds primarily borrow securities to establish short positions. During our sample period, the average ratio of banks' secured lending to borrowing is 0.79, indicating that hedge funds used the European repo

Figure 1: **Secured lending to hedge funds**
The graph displays the lending activity of Euro area banks to hedge funds, as well as the proportion of these loans in comparison to the overall bilateral lending volume. The data reflects the average daily lending volume on a quarterly basis, encompassing all transactions reported by MMSR agents from 2019:Q2 until 2023:Q4.



kers, and exhibit greater exposure to Credit Suisse compared to other hedge funds listed in the SEC-filings (ADV and IAPD). The identified hedge funds are almost exclusively domiciled in the Cayman Islands (96%), while the management companies are predominantly located in the United States (64%) and the United Kingdom (14%). Our sample includes 179 hedge funds, each managing, on average, more than $20 billion and engaging with about four broker (Table 1, Panel B). The funds in our sample have an average one-year probability of default exceeding 1.5%, corresponding to a non-investment grade rating B+.[12]

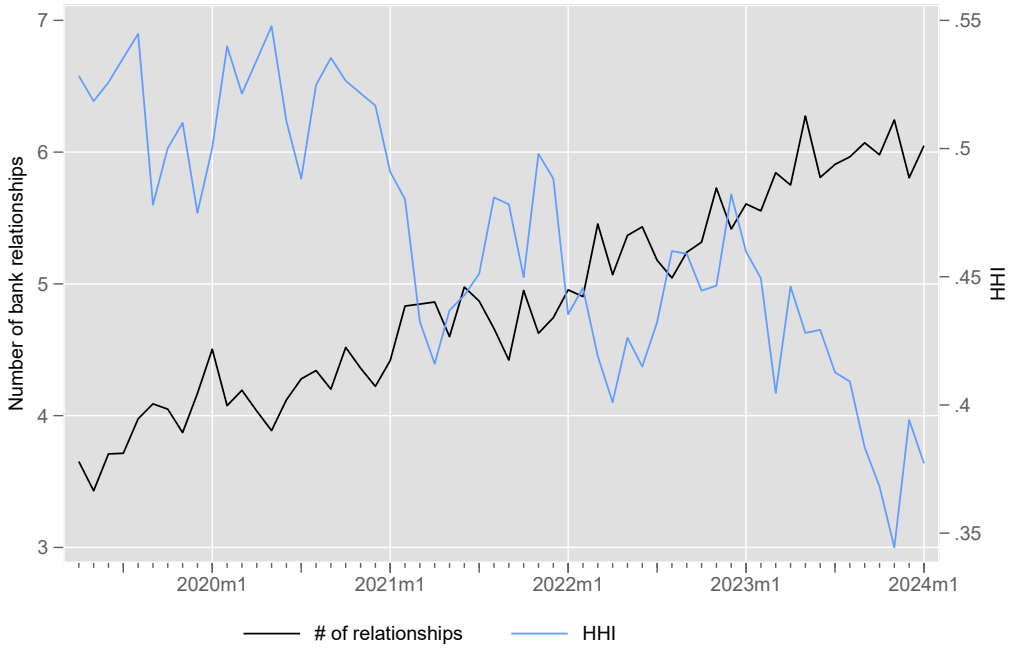
Banks in our sample are larger, more systemically relevant according to Financial Stability Board (FSB) standards, and tend to be less capitalized, with liquidity ratios similar to those of other banks participating in the EBA transparency exercise. Reflecting their business model,

market to establish short positions in European securities to an even greater extent than for financing purposes.

[11] At the start of our sample period, bilateral lending accounts for 31% of total secured lending, rising to 38% by the end of the sample period.

[12] https://www.spglobal.com/ratings/en/research/articles/240328-default-transition-and-recovery-2023-annual-global-corporate-default-and-rating-transition-study-13047827

Figure 2: **Hedge funds' funding structure over time:** The figure depicts the evolution of hedge funds' banking relationships and their funding concentration. For each fund, we calculate the number of banking relationships and the concentration of funding using the Hirschman-Herfindahl Index (HHI) on a monthly basis. We report volume-weighted averages of these funding concentration measures each month. The data encompasses MMSR agents' lending transactions to hedge funds from April 2019 to December 2023.



these banks hold more traded assets and exhibit higher exposure to counterparty credit risk. Data from AnaCredit contextualize the scale of lending to hedge funds, revealing that it constitutes 45% of total lending to the real economy for the average bank in our sample (Table 1, Panel A). Additionally, AnaCredit highlights the dominance of repurchase agreements (98.8%) in bank lending to hedge funds, making the MMSR dataset a suitable laboratory, and providing additional information on haircuts and collateral.

Government bonds are the primary form of collateral in secured lending transactions, accounting for more than 90% in our sample, followed by financial bonds (Figure A1). Nearly 40% of the total collateral is rated as high-grade. Figure A2 provides a breakdown of collateral by country, showing a dominance of euro area countries, including Italy (30%), France (15%), Germany (14%) and Spain (13%).

In Table 2 we present summary statistics on the variation in haircuts. Observations with negative haircuts are excluded from our sample, as these typically indicate cases where repos are used to intermediate collateral (Infante, 2019). The variation in haircuts is most pronounced for speculative-grade or unrated collateral, but it is also evident for medium-low and high grad rated collateral. We normalize haircuts by the average for a given security (column, 2) and even condition on a given day (column, 5), yet we still observe significant heterogeneity in haircut policies.

Table 1: **Summary Statistics - Banks and Hedge Funds**
The table presents summary statistics for lenders and counterparties in 2020. Panel A presents summary statistics for lenders at the bank level, comparing banks in the sample with other banks participating in the EBA transparency exercise. Panel B presents summary statistics for counterparties, comparing hedge funds in the sample with other hedge funds based on SEC filings (ADV and IAPD).

Panel A: Bank	Sample			Reference				
	Mean	SD	*N*	Mean	SD	*N*	t	p-value
Assets (in € bn)	928.16	629.57	14	142.72	211.74	66	8.30	.00
G-SIB Bucket[13]	.79	.97	14	.06	.30	66	5.11	.00
CET1 Ratio	.15	.03	14	.19	.08	66	-1.66	.10
Traded Assets / Total Assets	.15	.03	14	.04	.07	66	4.36	.00
Liquid Assets / Total Assets	.12	.05	14	.15	.10	66	-0.99	.32
CCR / CET1	.28	.16	14	.11	.17	66	3.41	.00
Lending to (Hedge Funds / Economy)	.45	.58	14	.00	.00	66	6.54	.00
Panel B: Hedge Fund	Sample			Reference				
	Mean	SD	*N*	Mean	SD	*N*	t	p-value
Number of Broker Relationships	4.08	2.64	179	1.95	1.90	6,864	16.29	.00
Credit Suisse Exposure (CS)	.58	.50	179	.13	.33	6,864	17.63	.00
AUM (in $ bn, Company)	161.55	190.63	179	23.34	68.62	6,864	24.60	.00
Assets (in $ bn)	20.65	43.94	112	.71	4.29	6,864	29.96	.00

Table 2: **Variation of haircuts: overall and within security**
The table presents summary statistics for the standard deviation in haircuts by rating category and varies the degree of demeaning.

SD (Haircut)	(1)	(2)	(3)	(4)	(5)
		Haircuts demeaned by…			
Rating		security	security-month	security-week	security-day
High Grade	1.08	0.37	0.27	0.25	0.24
Medium-Low Grade	4.57	1.43	0.9	0.86	0.84
Speculative Grade (or NA)	6.33	2.53	1.53	1.45	1.43
Full Sample	5.74	1.59	0.98	0.93	0.91

5 Bargaining power and haircuts

5.1 Empirical Strategy

To test the effect of bargaining power on haircut policies we run the following regression:

$$Haircut_{l(bfct)} = \beta HHI_{ft} + \gamma PD_{bft} + \alpha_{bc\tau} + \nu_t + \varepsilon_{l(bfct)}, \quad (1)$$

where $Haircut_{l(bcft)}$ is the haircut (in percent) applied by bank b for collateral c in a repo transaction with hedge fund f at transaction day t as a function of loan l. The primary variable of interest, denoted as HHI_{ft}, represents the Herfindahl–Hirschman Index (HHI) that quantifies the concentration of hedge funds' bank funding relationships in the previous month, as measured at day t. Furthermore, we control for the probability of default, PD_{bft}, which reflects the likelihood of default for hedge fund f as reported by bank b at day t. Our analysis utilizes a saturated regression framework that incorporates fixed effects denoted by $\alpha_{bc\tau}$, which capture the interactions between banks and collateral within distinct time periods τ. The time periods are granularly defined and can encompass a calendar month, a week, or even a trading day. Essentially, our most saturated regression model examines how haircuts for identical collateral on the same day from the same bank vary in relation to the concentration of hedge funds' funding, while adjusting for the respective probability of default. Throughout all our analyses we cluster standard errors at the bank-fund-collateral level.

5.2 Results

Table 3 presents the estimated outcomes from Equation (3). We begin with simpler models in Specifications (1) to (3), which incorporate only day collateral and bank fixed effects. The results consistently indicate a positive and statistically significant coefficient for the Herfindahl-Hirschman Index (HHI), implying that hedge funds with a more concentrated funding structure,

Table 3: **The effect of funding concentration on haircuts**
This table presents the estimation results, regressing hedge funds' haircut (in percent) on their funding concentration, controlling for their probability of default. Funding concentration is measured by the Herfindahl–Hirschman Index (HHI) of hedge funds' f previous months bank funding relationships at time t; PD_{bft} is the probability of default of hedge funds f reported by bank b at time t. The sample consists of all overnight lending transactions of MMSR reporting agents to hedge funds with fixed income securities as collateral. The sample period is from April 1, 2019, to December 31, 2023. Standard errors are clustered at the bank-fund-security level. t-statistics are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Dependent variable: Haircut	(1)	(2)	(3)	(4)	(5)	(6)
HHI	1.31***	1.28***	1.23***	1.21***	1.23***	1.30***
	(5.77)	(5.76)	(4.78)	(3.27)	(3.03)	(2.60)
PD	18.84***	2.60	9.10*	21.96**	23.74**	24.85*
	(7.36)	(0.80)	(1.72)	(2.40)	(2.13)	(1.81)
Constant	3.13***	3.40***	3.33***	3.14***	3.11***	3.31***
	(24.71)	(28.35)	(21.56)	(11.42)	(9.66)	(8.06)
R^2 (%)	92.8	93.0	94.7	98.0	98.2	96.7
N	450,787	450,787	450,709	449,578	446,519	229,561
Fixed effects:						
Bank	–	✓	–	–	–	–
Security	✓	✓	–	–	–	–
Day	✓	✓	✓	✓	✓	–
Bank × security	–	–	✓	–	–	–
Bank × security × month	–	–	–	✓	–	–
Bank × security × week	–	–	–	–	✓	–
Bank × security × day	–	–	–	–	–	✓

*** p<0.01, ** p<0.05, * p<0.1
(t-statistics in parentheses)

and consequently diminished bargaining power, face higher haircuts. The picture for the probability of default is less clear. Although the sign is consistently positive, suggesting that a higher default probability is associated with higher haircuts, its economic effect and statistical significance varies across the different models. It is noteworthy that even these initial models exhibit a high degree of explanatory power, with an R^2 exceeding 92.7%. This high R^2 value can be attributed to the fact that haircut variations are predominantly driven by characteristics specific to the securities involved. In Specifications (4) through (6), the models are further refined to include bank $\times$ collateral $\times$ time period fixed effects, with the time period granularity being narrowed down from a month to a week, and finally to a trading day. The economic magnitude of HHI remains very similar across all specifications, even for the most saturated model which only exploits variation within bank-collateral-trading day. It is important to note that this most saturated model necessitates at least two distinct transactions involving different funds within the same bank-collateral-day combination, which effectively halves the transaction sample size.

The impact of bargaining power on haircuts is substantial. Specifically taking the estimates of specification (6), an increase in the Herfindahl-Hirschman Index (HHI) equivalent to its interquartile range leads to an increase in the haircut by approximately $0.39 \times 1.30 = 0.51$ percentage points. To provide context, we contrast the aforementioned effect with the economic influence the critical counterparty variable anticipated to be associated with haircuts: the probability of default. This comparison serves to benchmark the relative significance of bargaining power against other determinants that are expected to influence haircut levels. Being most conservative and taking the largest coefficient estimte provided in specification (6), an increase in PD by its interquartile range increases the haircut by approximately $0.0172 \times 24.85 = 0.43$ percentage points, which is even slightly lower than the effect of bargaining power.

5.3 Collateral quality and central bank eligibility

In the subsequent analysis, we explore the variation in the influence of bargaining power on haircuts across different tiers of collateral quality. We focus on the two most saturated specifi-

cations, which account for bank-collateral-week and bank-collateral-day fixed effects. Although the bank-collateral-day specification yields the most precisely identified effects, it comes at the cost of a significantly smaller sample size, which in turn diminishes the statistical power relative to the within-week comparison of haircuts. Table 4 shows the results categorized by the credit rating of the collateral issuer. Across all rating categories, there is a positive relation between HHI and haircuts. Notably, this relationship intensifies as we move from high-grade collateral to medium/low investment grade. Point estimates are even higher for speculative or unrated securities, however the effect is estimated at lower statistical precision. Overall, the results suggest that the effect of bargaining power on haircuts is most pronounced for medium to low investment grade collateral.

Table 4: **The effect of funding concentration on haircuts across collateral quality**
This table repeats the regression from Table 3 for different sub-samples based on the issuer rating of the underlying collateral. The dependent variable is the haircut in percent. Funding concentration is measured by the Herfindahl–Hirschman Index (HHI) of hedge funds' bank funding sources in the previous calendar month. The sample consists of all overnight lending transactions of MMSR reporting agents to hedge funds with fixed income securities as collateral. The sample period is from April 1, 2019, to December 31, 2023. Standard errors are clustered at the bank-fund-security level. t-statistics are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Dep. variable: Haircut	(1)	(2)	(3)	(4)	(5)	(6)
	High grade		Medium to low investment grade		Speculative and not rated	
HHI	0.37***	0.36***	0.86***	0.88***	2.97*	3.14*
	(3.94)	(3.06)	(3.38)	(2.89)	(1.95)	(1.73)
R^2 (%)	99.1	98.3	98.1	96.6	95.9	92.1
N	140,169	66,548	204,797	103,515	110,588	64,974
Controls & fixed effects:						
PD	✓	✓	✓	✓	✓	✓
Day	✓	–	✓	–	✓	–
Bank × security × week	✓	–	✓	–	✓	–
Bank × security × day	–	✓	–	✓	–	✓

Next, we examine in Table 5 the impact of bargaining power on haircuts, considering the role of collateral eligibility for ECB operations. In Panel A, we conduct a simple sample split within the overall sample. Generally, our findings indicate a positive relation between funding concentration

and haircuts across both subsets. This relationship is highly statistically significant for securities eligible for ECB operations, and the economic magnitude of the effect is even greater for non-eligible assets. However, the statistical significance for non-eligible assets is less pronounced.

In Panels B through D, we refine our analysis by accounting for the credit ratings of collateral issuers. Panel A reveals that for high-grade debt, there is a positive relationship between funding concentration and haircuts for both ECB-eligible and non-eligible assets. Notably, the economic impact is more pronounced for non-eligible assets, with a magnitude of 0.88, compared to 0.34 for eligible assets. However, it is important to acknowledge that the subset of non-eligible high-grade debt is relatively small, constituting only about 3% of the overall sample. Panel C indicates that for medium to low investment-grade bonds, the positive correlation between funding concentration and haircuts is confined to ECB-eligible assets. Furthermore, we observe a positive, though statistically weak, association for speculative-grade and non-rated securities that are not eligible for ECB operations.

5.4 Robustness checks

We conducted a series of robustness tests on our baseline regression to ensure the reliability of our findings.

First, we utilize the concentration ratio as an alternative indicator of funding concentration. Specifically, we apply the 1-firm concentration ratio, which captures the market share held by the largest bank within a hedge fund's funding sources. Table A1 shows that the results are almost identical using this alternative funding concentration measure. Taking the estimates from specification (6), increase in the concentration ratio equivalent to its interquartile range leads to an increase in the haircut by approximately $0.40 \times 1.40 = 0.56$ percentage points.

Next, we distinguished between transactions with zero haircuts and those with positive haircuts. For this purpose, we re-estimated Equation (3), introducing a binary indicator that takes the value of one for zero haircuts and zero for positive haircuts. This analysis aims to explore the influence of bargaining power on the probability of obtaining a zero haircut. Furthermore,

Table 5: **The effect of funding concentration on haircuts in relation to central bank eligibility**

This table repeats the regression from Table 3 for different sub-samples based on ECB eligible asset status and issuer rating of the underlying collateral. The dependent variable is the haircut in percent. Funding concentration is measured by the Herfindahl–Hirschman Index (HHI) of hedge funds' bank funding sources in the previous calendar month. The sample consists of all overnight lending transactions of MMSR reporting agents to hedge funds with fixed income securities as collateral. The sample period is from April 1, 2019, to December 31, 2023. Standard errors are clustered at the bank-fund-security level. t-statistics are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Dep. variable: Haircut	(1)	(2)	(3)	(4)
	ECB eligible asset = yes		ECB eligible asset = no	
Panel A: overall sample				
HHI	0.67***	0.68***	2.64**	2.86*
	(5.13)	(4.29)	(1.97)	(1.74)
R^2 (%)	97.8	96.3	96.3	92.4
N	299,082	150,805	157,652	84,306
Panel B: High grade				
HHI	0.35***	0.34***	0.89***	0.88***
	(3.62)	(2.82)	(4.18)	(3.46)
R^2 (%)	96.2	90.5	99.9	99.9
N	130,905	62,297	9,053	4,251
Panel C: Medium to low investment grade				
HHI	0.77***	0.77***	1.42	1.53
	(3.92)	(3.34)	(0.82)	(0.71)
R^2 (%)	97.4	95.8	96.6	92.2
N	152,173	80,731	52,513	22,784
Panel D: Speculative grade and not rated				
HHI	–	–	3.28*	3.49*
			(1.87)	(1.66)
R^2 (%)			95.3	91.2
N			95,439	57,244
Controls & fixed effects:				
PD	✓	✓	✓	✓
Day	✓	–	✓	–
Bank × security × week	✓	–	✓	–
Bank × security × day	–	✓	–	✓

we refined our analysis by rerunning Equation (3) exclusively on the subset of transactions that involve positive haircuts.

The outcomes of these robustness checks are summarized in Table A2. The results from the first two columns indicate a notable decrease in the probability of receiving a zero haircut in repo transactions for hedge funds with a higher concentration of funding sources. Specifically, as shown in specification (2), an increase in the HHI by an amount equal to its interquartile range is associated with a decrease in the probability of a zero haircut by $0.39 \times -0.27 = -0.11$ percentage points. This magnitude is substantial when compared to the baseline probability of receiving a zero haircut, which stands at roughly one-third in our sample. Columns (3) and (4) show that for the sublsample of positive haircuts there a positive and statistically significant coefficient for the HHI, which is substantially larger (1.67) than that of the overall sample (1.27). All in all, this suggest that increased bargaining power not only reduces the size of haircuts but also enhances the probability of receiving a zero haircut.

Our initial analysis concentrated on the overnight segment, which is the most prevalent maturity for secured lending to hedge funds. In Table A3, we broaden our scope to include the entire spectrum of repo tenors, encompassing tom-next, spot-next, and longer durations spanning several weeks or months. To control for repo maturity we include interactions between bank-collateral-week fixed effects and bank-collateral-day fixed effects with predefined maturity buckets. Additionally, in the most saturated model we include interactions for all dates defining a repo transaction, namely bank$\times$collateral$\times$trade date$\times$settlement$\times$maturity date fixed effects. Although the effect is slightly smaller, we find a consistent positive association between funding concentration and haircuts in the extended sample, covering all repo maturities.

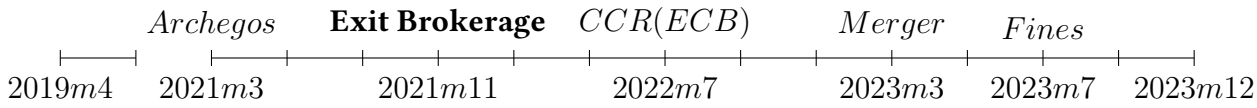
6 Natural experiment: Credit Suisse's exit from the prime brokerage business

In this section, we leverage the exit of Credit Suisse from the prime brokerage business as a quasi-exogenous natural experiment to estimate a causal relationship between bargaining power and risk management. This methodology is akin to the approaches used by Di Maggio, Kermani, and Song (2017) and Gabrieli and Georg (2014), who analyzed the impact of a flagship dealer´s exit in 2008 on intermediation chains in the corporate bond market and liquidity allocation in the interbank market, respectively.

6.1 Institutional Background

Credit Suisse announced its exit from the prime brokerage business on November 4, 2021, following significant losses incurred due to its exposure to Archegos Capital Management. An independent external investigation subsequently documented failures in effective risk management. The final report highlighted key issues, including failures *'by both the first and second lines of defense as well as a lack of risk escalation. In the same business, it also found a failure to control limit excesses across both lines of defense as a result of an insufficient discharge of supervisory responsibilities in the Investment Bank and in Risk, as well as a lack of prioritization of risk mitigation and enhancement measures'*.

Figure 3: **Timeline - Credit Suisse.** The figure shows a timeline of major events related to the exit of Credit Suisse from the prime brokerage business (November 4th 2021) such as the default of Archegos Capital Management in March 2021, counterparty credit risk (CCR) as ECB´s supervisory priority (2022-2024), merger with UBS in March 2023 and fines announced by the Federal Reserve Board and the Prudential Regulation Authority in July 2023.



Archegos Capital Management operated as a family office but employed investment strategies similar to those of hedge funds. By March 2021, Archegos was highly leveraged and exposed to

equity derivatives of ViacomCBS and Disney Inc. When the underlying stock prices declined drastically, Archegos was unable to meet the margin calls from associated banks. Among the largest 15 brokers, almost every second bank had been exposed to Archegos at that time. While some banks managed to unwind their positions with little to no losses, Credit Suisse incurred a substantial loss of approximately $5.5 billion (see Table A4). This loss was nearly six times the bank´s average annual profit over the preceding decade.

The European Central Bank (ECB) identified counterparty credit risk (CCR) as a supervisory priority for the period from 2022 to 2024, noting that *'banks had been increasingly offering capital market services to riskier, leveraged and less transparent counterparties'*. Following a series of on- and off-site inspections, the ECB issued guidelines on sound practices that should be considered beyond mere regulatory compliance.

On July 24, 2023 the Federal Reserve Board and the Prudential Regulation Authority announced fines for Credit Suisse amounting to $268.5 million and £87 million respectively.[14,15] These penalties were imposed due to significant failures in risk management and governance related to the bank´s exposures to Archegos Capital Management.

6.2 Identification Strategy

We leverage the exit of Credit Suisse from the prime brokerage business as a quasi-exogenous natural experiment to estimate a causal relationship between changes in broker composition and counterparty credit risk measures. We hypothesize that hedge funds with pre-existing relationships with Credit will experience lower growth in broker relationships following the announcement of Credit Suisse´s exit from prime brokerage business. This increased broker concentration is expected to result in reduced bargaining power of the hedge fund.

The SEC filings (IAPD) provide detailed broker information, such as the names of brokers, allowing to categorize hedge funds based on their prime broker relationships with Credit Suisse. We define hedge funds as treated if they had an existing prime brokerage relationship with Credit

[14]https://www.federalreserve.gov/newsevents/pressreleases/enforcement20230724a.htm
[15]https://www.bankofengland.co.uk/news/2023/july/the-pra-imposes-record-fine-of-87m-on-credit-suisse

Suisse as of 2020 (CS_f=1, and otherwise 0). Table 6, column one, shows that hedge funds with a relationship to Credit Suisse experienced an 6 percentage points lower growth in broker relationships compared to those without such a relationship. We control for time-invariant fund characteristics and general temporal changes by including year fixed effects. Figure A3 illustrates the lower growth in broker relationships from 2020 to 2023 for hedge funds with pre-existing relationships with Credit Suisse, compared to other hedge funds, across the distribution of the number of broker relationships in 2020. Hedge funds with and without relationships to Credit Suisse did not differ in broker relationship growth until Credit Suisse announced its exit from the prime brokerage business, thereby validating the underlying parallel trend assumption (see Table 6, column two).

Table 6: **Credit Suisse Exit and Broker Relationship Growth**
The sample is a panel at the hedge fund level f from 2018 to 2023 with yearly frequency. $Post_t$ equals 1 after Credit Suisse announced its plan to leave prime brokerage on November 4th 2021 (i.e. from 2021 onwards), and 0 otherwise. CS_f equals 1 if Credit Suisse acts as a broker for hedge fund f as of 2020. Standard errors are clustered at fund level.

Growth of Broker Relationships	(1)	(2)
$Post_t \times CS_f$	-0.06***	
	(-6.98)	
$2018_t \times CS_f$		0.00
		(0.18)
$2019_t \times CS_f$		-0.01
		(-1.15)
$2021_t \times CS_f$		-0.05***
		(-3.22)
$2022_t \times CS_f$		-0.04***
		(-2.64)
$2023_t \times CS_f$		-0.13***
		(-9.22)
R^2 (%)	22.2	22.4
N	35,372	35,372
Fund FE	✓	✓
Year FE	✓	✓
SE Cluster	Fund	

*** p<0.01, ** p<0.05, * p<0.1
(t-statistics in parentheses)

To identify the impact of bargaining power on risk management practices, we estimate the following loan-level specification:

$$Haircut_{l(bfct)} = \beta POST_t \times CS_{f,2020} + \gamma PD_{bft} + \delta_{bfc} + \eta_{bt} + \mu_{ct} + \varepsilon_{l(bfct)}, \quad (2)$$

where $Haircut$ is the dependent variable and reflects the haircut on collateral *c* at date *t* for a loan l provided by bank *b* to hedge-fund *f*. CS_f equals one if Credit Suisse provided brokerage services to a given hedge funds as of 2020, and zero otherwise. $Post_t$ equals one after Credit Suisse announced its exit from the prime brokerage business on November 4, 2021, and zero otherwise. We introduce bank-hedge fund-collateral fixed effects to identify the effects of ex-ante broker composition on haircut policy over time within bank, counterparty and collateral relationships. This set of fixed effects captures, among other aspects, structurally different demand for and supply of funding and services within a given relationship. Additionally, we control for perceived counterparty risk by including the default probability of hedge fund f at date t reported by bank *b*. To further refine our model, we include bank-date and collateral-date fixed effects to control for time-varying characteristics at the bank and collateral levels.

6.3 Results

We present our main results in Table 7, highlighting significantly higher haircuts for hedge funds with pre-existing relationships with Credit Suisse after Credit Suisse announced its exit from prime brokerage business. Specifically, haircuts increased by 0.49 percentage points within the same bank and hedge fund relationship using identical collateral (see column (3)). In contrast, counterparties without such a prior relationships did not experience any increase in haircuts following the announcement. By including security-date fixed effects in column (5), we restrict our sample to loans with collateral that is posted more than once on a given date. In column (6), we also incorporate bank-date fixed effects to control for unobserved bank-specific changes over

Table 7: **Effect of Credit Suisse Exit on Haircut**
This table presents the estimation results based on equation 2, regressing hedge funds' haircut (in percent) on their exposure to Credit Suisse, controlling for their probability of default. Exposure to Credit Suisse, CS_f, equals 1 if Credit Suisse acts as a broker for hedge fund f as of 2020, and 0 otherwise. $POST_t$ equals 1 after Credit Suisse announced its plan to leave prime brokerage on November 4th 2021, and 0 otherwise. PD_{bft} is the probability of default of hedge funds f reported by bank b at time t. The sample consists of all overnight lending transactions of MMSR reporting agents to hedge funds with fixed income securities as collateral. The sample period is from April 1, 2019, to December 31, 2023. Standard errors are clustered at the bank-fund-security level. t-statistics are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Dep. Variable: Haircut	(1)	(2)	(3)	(4)	(5)	(6)
$POST \times CS$	0.35***	0.36**	0.49**	0.47**	0.29**	0.34**
	(2.73)	(2.55)	(2.28)	(2.28)	(2.09)	(2.14)
POST	-0.17**	-0.12	-0.08			
	(-2.09)	(-1.46)	(-1.39)			
Constant	4.69***	4.45***	4.48***	4.47***	4.45***	4.61***
	(37.87)	(27.21)	(22.63)	(22.16)	(88.80)	(64.53)
R^2 (%)	94.9	95.3	97.3	97.4	98.3	98.3
N	356,063	356,061	355,840	355,840	204,994	204,299
Controls & fixed effects						
PD	✓	✓	✓	✓	✓	✓
Bank	✓					
Counterparty	✓					
Security	✓	✓				
Bank x counterparty		✓				
Bank x counterparty x security			✓	✓	✓	✓
Day				✓		
Security x day					✓	✓
Bank x day						✓

time. The coefficient of interest in our most saturated specification remains very similar to that in the least restrictive model reported in column (1).

Next, we differentiate between transactions with zero haircuts and those with positive haircuts, as shown in Table A5. We introduce a binary indicator that takes the value of one for zero haircuts and zero for positive haircuts, and we estimate the effect of exposure to Credit Suisse on the likelihood of obtaining zero haircuts. Our findings in column (1) to (3) indicate that hedge funds with greater exposure to Credit Suisse are less likely to secure zero haircuts. Additionally, we refine our analysis by focusing exclusively on transactions with positive haircuts in column (4) to (6), and the results remain consistent with our baseline findings.

Finally, we examine whether the effect is most pronounced for hedge funds with fewer broker relationships. We define broker relationships $Relationships_{f,2020}$, as the number of existing relationships in 2020. Table 8 presents the results for a sample split using a threshold of up to five pre-existing relationships. The findings are concentrated in the subsample of hedge funds with a relatively low number of broker relationships. Columns (1) to (3) indicate that hedge funds with fewer broker relationships are significantly affected. In contrast, columns (4) to (6) suggest that hedge funds with many broker relationships do not appear to be significantly affected.

6.4 Robustness Checks

We present robustness checks in the appendix, detailed in Table A6. First, columns (1) and (2) show that there is no significant pre-treatment effect in the period leading up to the announcement. Second, to rule out the influence of confounding events, we restrict our sample to a short post-announcement period ending in June 2022, as shown in columns (3) and (4). This period excludes the European Central Bank´s monetary policy tightening, which started with the first rate change on July 27, 2022. The change in monetary policy could potentially bias our results from both the supply and demand side. Supply could be differentially affected if brokers of Credit Suisse related hedge funds had different sensitivities to monetary policy changes. Additionally, hedge funds themselves might experience heterogeneous changes in demand, leading to bias

Table 8: **Effect of Credit Suisse Exit on Haircut - Broker Relationships**
This table presents the estimation results based on equation 2, regressing hedge funds' haircut (in percent) on their exposure to Credit Suisse and the number of hedge funds' broker relationships, controlling for their probability of default. The sample is split by the number of hedge funds' broker $Relationships_{f,2020}$ as of 2020 into hedge funds with up to 5 in column (1) to (3) compared to hedge funds with more than 5 pre-existing broker relationships in column (4) to (6). Exposure to Credit Suisse, CS_f, equals 1 if Credit Suisse acts as a broker for hedge fund f as of 2020, and 0 otherwise. $POST_t$ equals 1 after Credit Suisse announced its plan to leave prime brokerage on November 4th 2021, and 0 otherwise. PD_{bft} is the probability of default of hedge funds f reported by bank b at time t. The sample consists of all overnight lending transactions of MMSR reporting agents to hedge funds with fixed income securities as collateral. The sample period is from April 1, 2019, to December 31, 2023. Standard errors are clustered at the bank-fund-security level. t-statistics are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Dep. Variable: Haircut	(1)	(2)	(3)	(4)	(5)	(6)
Relationships:		up to 5			more than 5	
$POST \times CS$	0.59***	1.91**	3.11***	0.38	0.06	0.06
	(2.87)	(2.04)	(6.55)	(1.12)	(1.35)	(1.60)
R^2 (%)	96.7	97.2	97.2	97.1	98.6	98.6
N	159,593	97,435	96,435	196,247	92,641	91,767
Controls & fixed effects						
PD	✓	✓	✓	✓	✓	✓
Bank x counterparty x security	✓	✓	✓	✓	✓	✓
Day	✓			✓		
Security x day		✓	✓		✓	✓
Bank x day			✓			✓

if correlated with exposure to Credit Suisse. Our findings remain robust with this short post-announcement period. In columns (5) and (6), we control using the fund-time specific probability of default instead of the respective probability of default reported by the bank. Finally, in columns (7) and (8), we employ triple clustering at the bank, fund, and at security levels, instead of single clustering at the bank-fund-security level. This approach yields results that are statistically more significant compared to our baseline clustering in Table 7, columns (5) and (6).

As a final robustness check, we restrict our sample to hedge funds that are identified on the fund level. This selection reduces the sample size from 179 to 112 counterparties, but allows for a more precise identification of exposure to Credit Suisse. The results, presented in Table A7, become economically more significant. Additionally, we use $CS\text{-}share_f$, defined as the number of Credit Suisse broker divided by the total number of brokers for a given fund f as of 2020. The results in columns (4) to (6) indicate that hedge funds with an ex-ante more concentrated exposure to Credit Suisse face stronger haircut increases following its exit.

7 Adequacy of haircuts

We now examine whether the haircuts demanded by banks are adequate when judged by standard value-at-risk models. To examine this question we run the following regression

$$\begin{aligned}\mathbb{1}(Haircut_{bfct} < Haircut^m_{ct}) = \beta HHI_{ft} + \gamma PD_{bft} \\ + \alpha_{bc\tau} + \nu_t + \varepsilon_{bfct},\end{aligned} \tag{3}$$

where the dependent variable is defined by a binary indicator, which is set to one if the haircut $Haircut_{bcft}$, applied by bank b to collateral c in a repurchase agreement with fund f on day t, is lower than the model-predicted haircut $Haircut^m_{ct}$ for the same collateral and day, as determined by model m. To calculate these model-implied haircuts, we employ various value-at-risk (VaR) models at distinct confidence intervals.

Initially, we utilize the historical approach to identify the empirical 1st, 5th, and 10th per-

centiles of the collateral's return distribution over the preceding 12 months. This method provides a non-parametric estimate of the VaR based on actual historical returns. Subsequently, we estimate the conditional variance using two parametric methods: the Exponentially Weighted Moving Average (EWMA) and the Generalized Autoregressive Conditional Heteroskedasticity (GARCH)(1,1) model. By forecasting the one-step-ahead conditional variance with these methods, we can compute the VaR at various confidence levels under the assumption that returns follow a normal distribution. These calculated VaRs serve as the benchmarks for the model-implied haircuts against which the actual haircuts applied in repo transactions are compared.

Table 9 presents the findings from our analysis. Across all employed methods and at every conventional VaR confidence level, we consistently observe a negative coefficient for the Herfindahl-Hirschman Index (HHI). This suggests that an increase in funding concentration, which implies diminished bargaining power, is related to a decreased probability of the haircut being insufficient. The magnitude of the coefficients is relatively stable across different models and also varies only little for different confidence levels. For instance, considering the results from specification (6) in Panel B, an increase in HHI corresponding to its interquartile range is associated with a reduction of $0.39 \times 0.27 = 0.11$ percentage points in the probability of an inadequate haircut at the 5% confidence level, Similarly, at the more stringent 1% confidence level, the likelihood of an inadequate haircut decreases by $0.39 \times 0.25 = 0.10$ percentage points.

Our analysis further reveals that an increased probability of default relates to lower likelihood of the applied haircut being insufficient. However, this relationship is not statistically significant in all our model specifications. Overall, the overarching evidence of Table9 suggests that bargaining power substantially elevates the risk of insufficient haircuts according to standard value-at-risk models.

In Table 10, we explore the influence of bargaining power on the probability of encountering inadequate haircuts, with a focus on different rating categories and their eligibility for European Central Bank (ECB) operations. Given the consistency of results across various models, we focus on the findings derived from a GARCH model at a 5% confidence level. Panel A highlights that

the risk of inadequate haircuts, as affected by bargaining power, is particularly significant for securities rated as medium to low investment grade. In Panel B, we further dissect these rating groups based on their eligibility for ECB operations. The analysis reveals that insufficient haircut levels due to bargaining power is a concern in particular for ECB-eligible securities.

Table 9: **The effect of funding concentration on the likelihood if insufficient haircuts**
The dependent variable is a dummy variable that equals one if a given haircut is deemed insufficient based on the chosen value-at-risk model and confidence level, and zero otherwise. The main explanatory variable is funding concentration, which is measured by the Herfindahl–Hirschman Index (HHI) of hedge funds' bank funding sources in the previous calendar month. PD is the probability of default of fund f reported by bank b at date t. To determine the VaR, we employ the historical method in specifications (1) and (2), the Exponentially Weighted Moving Average (EWMA) in specifications (3) and (4), and a GARCH (1,1) model in specifications (5) and (6). Panel A to C vary with regard to different VaR confidence levels. The sample consists of all overnight lending transactions of MMSR reporting agents to hedge funds with fixed income securities as collateral. The sample period is from April 1, 2019, to December 31, 2023. Standard errors are clustered at the bank-fund-security level. t-statistics are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)	(4)	(5)	(6)
	Historical		EWMA		GARCH	
Panel A: Dependent variable: Insufficient haircut (VaR 1%)						
HHI	-0.20***	-0.21***	-0.22***	-0.23***	-0.24***	-0.25***
	(-4.14)	(-3.58)	(-3.42)	(-2.99)	(-4.10)	(-3.60)
PD	-1.53	-1.36	-1.72**	-1.59	-0.82	-0.67
	(-1.49)	(-1.13)	(-2.00)	(-1.58)	(-1.03)	(-0.71)
R^2 (%)	96.8	94.7	95.8	94.4	94.5	94.4
N	305,400	157,544	305,887	157,556	325,490	168,933
Panel B: Dependent variable: Insufficient haircut (VaR 5%)						
HHI	-0.24***	-0.24***	-0.24***	-0.25***	-0.26***	-0.27***
	(-3.37)	(-2.90)	(-3.74)	(-3.24)	(-4.21)	(-3.65)
PD	-2.50**	-2.36**	-2.18**	-2.03*	-1.12	-1.00
	(-2.54)	(-2.05)	(-2.32)	(-1.84)	(-1.39)	(-1.05)
R^2 (%)	96.4	93.7	95.8	93.7	94.4	93.4
N	305,400	157,544	305,887	157,556	325,597	168,936
Panel C: Dependent variable: Insufficient haircut (VaR 10%)						
HHI	-0.29***	-0.30***	-0.27***	-0.28***	-0.28***	-0.28***
	(-4.13)	(-3.57)	(-4.11)	(-3.55)	(-4.40)	(-3.84)
PD	-3.09***	-3.03**	-3.11***	-2.97**	-2.14**	-2.10**
	(-2.93)	(-2.45)	(-2.98)	(-2.45)	(-2.46)	(-2.05)
R^2 (%)	96.1	93.1	95.5	93.0	94.8	93.2
N	305,400	157,544	305,887	157,556	325,651	168,939
Fixed effects:						
Day	✓	–	✓	–	✓	–
Bank × security × week	✓	–	✓	–	✓	–
Bank × security × day	–	✓	–	✓	–	✓

Table 10: **The adequacy of haircuts in relation to the quality of collateral and its eligibility for central bank operations**

The dependent variable is a binary indicator that takes the value of one if a particular haircut is considered inadequate according to the selected value-at-risk (VaR) model and confidence level, and zero otherwise. The primary explanatory variable is funding concentration, which is measured using the Herfindahl–Hirschman Index (HHI) based on the hedge funds' bank funding sources from the preceding calendar month. To calculate the VaR, we utilize a GARCH (1,1) model with a confidence level of 5%. Panel A distinguishes between the ratings of collateral issuers, while Panel B differentiates based on the ECB eligibility status within the medium to low investment-grade collateral category. The sample consists of all overnight lending transactions of MMSR reporting agents to hedge funds with fixed income securities as collateral. The sample period is from April 1, 2019, to December 31, 2023. Standard errors are clustered at the bank-fund-security level. t-statistics are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Dep. variable: Insuff. haircut	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Insufficient haircut (VaR 5%, GARCH) across rating groups						
	High grade		Medium to low investment grade		Speculative and not rated	
HHI	-0.12	-0.12	-0.38***	-0.38***	-0.04	-0.04
	(-1.23)	(-0.93)	(-3.90)	(-3.40)	(-1.35)	(-1.32)
R^2 (%)	95.8	93.4	91.0	89.2	84.4	88.7
N	101,656	43,691	140,770	71,006	82,314	54,191
Fixed effects:						
Day	✓	–	✓	–	✓	–
Bank × security × week	✓	–	✓	–	✓	–
Bank × security × day	–	✓	–	✓	–	✓
Panel B: Insufficient haircut (VaR 5%, GARCH) medium to low investment grade						
	ECB eligible asset = yes		ECB eligible asset = no			
HHI	-0.42***	-0.41***	-0.02	-0.02		
	(-3.83)	(-3.33)	(-0.93)	(-0.79)		
R^2 (%)	89.8	87.0	86.4	88.2		
N	104,541	50,846	36,165	20,160		
Fixed effects:						
Day	✓	–	✓	–		
Bank × security × week	✓	–	✓	–		
Bank × security × day	–	✓	–	✓		

8 Conclusion

The default of Archegos Capital Management in 2021 illuminated critical vulnerabilities in the financial system, particularly concerning the management of counterparty credit risk (CCR). The European Central Bank's decided to designate CCR as a supervisory priority from 2022 onwards. Enhanced regulatory scrutiny and risk management frameworks are crucial in mitigating systemic risks posed by interconnected financial entities, especially those with significant leverage and opacity.

Our study examines these dynamics through the lens of secured lending transactions revealing insights into how bargaining power affects risk management practices. Our findings show that hedge funds with a more diversified funding structure face lower haircuts in repo transactions, indicative of their stronger bargaining power. The exit of Credit Suisse from the prime brokerage business allows us to identify the relationship between bargaining power and risk management practices. We find that stronger exposed hedge funds face higher haircuts after the event.

Benchmarking haircuts with standard value-at-risk models suggest haircuts to be systematically underestimated when hedge funds bargaining power is high. This is the case in particular for ECB eligible collateral, stressing the potential implications for both financial stability and monetary policy.

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ONLINE APPENDIX

Figure A1: **Collateral - Breakdown by Rating and Issuer Type**
The figure illustrates the collateral used in secured lending activities of Euro area banks to hedge funds. Hedge funds are categorized based on SEC filings in Form ADV. The figure plots the breakdown by rating (High-Grade vs. Non-High-Grade) and issuer type (Financial, Government, Other) based on the nominal amount of posted collateral for the sample period 2019:Q2 until 2023:Q4.

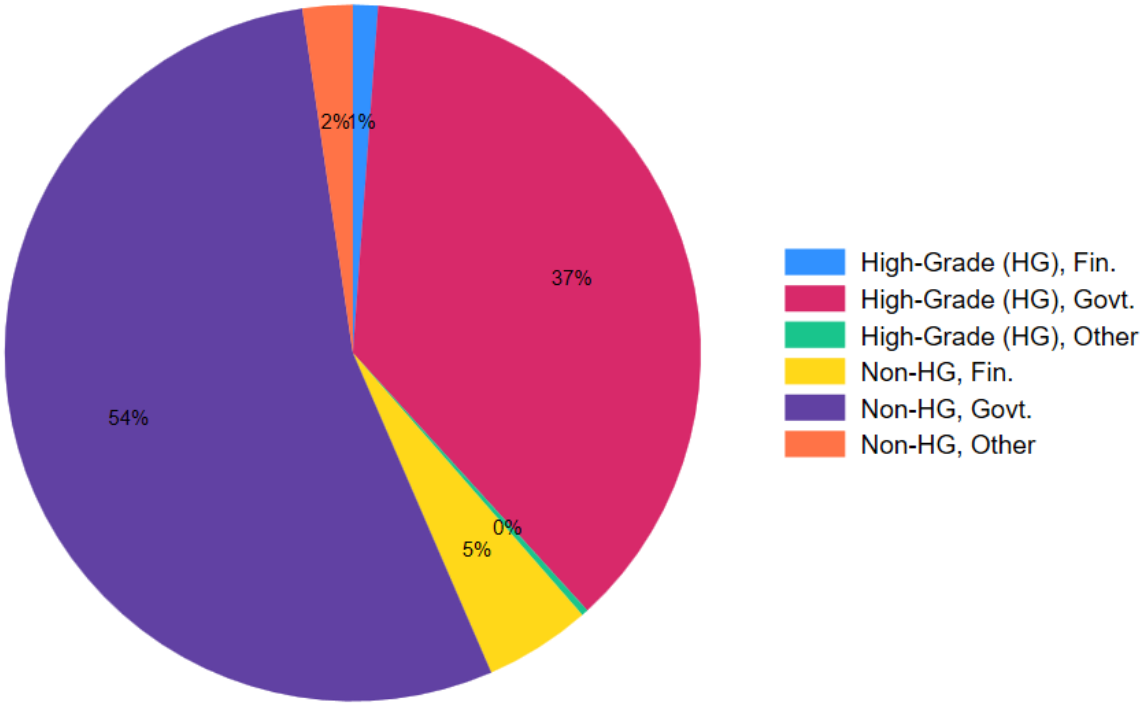

Figure A2: **Collateral - Breakdown by Country**
The figure illustrates the collateral used in secured lending activities of Euro area banks to hedge funds. Hedge funds are categorized based on SEC filings in Form ADV. The figure plots the breakdown by country based on the nominal amount of posted collateral for the sample period 2019:Q2 until 2023:Q4.

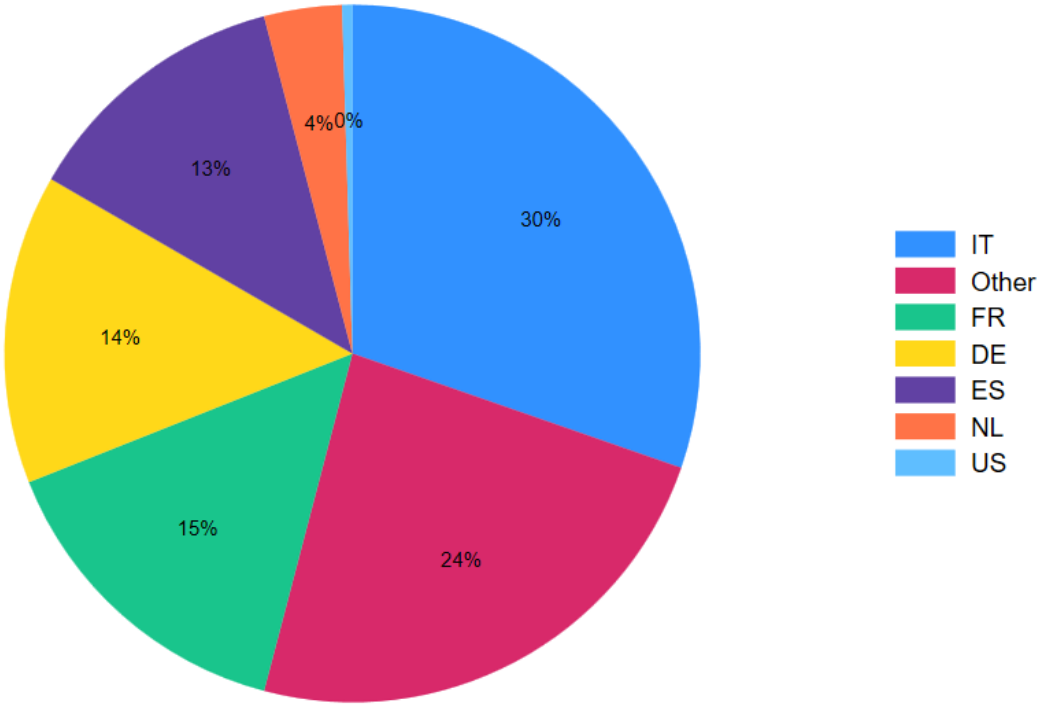

Figure A3: **Growth of Broker Relationships.** The figure shows a binned scatter for the hedge funds' number of broker in 2020 and the growth in broker relationships until 2023. Hedge funds with a broker relationship to Credit Suisse in 2020 is shown in red and compared to hedge funds without such a relationship shown in blue. Source: SEC-filings (ADV and IAPD).

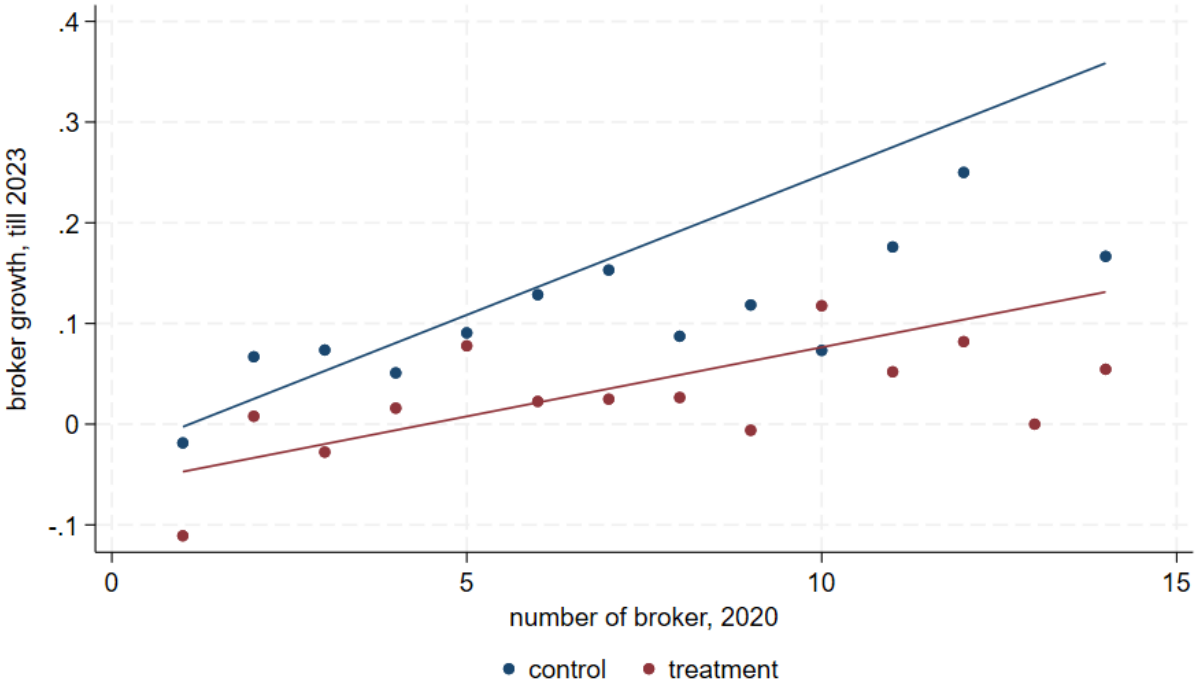

Table A1: **The effect of funding concentration on haircuts: alternative funding concentration measure**

This table replicates the regression analysis from Table 3, employing the concentration ratio as an alternative metric for funding concentration. The dependent variable is the haircut, expressed as a percentage. CR_1 denotes the 1-firm concentration ratio, which reflects the market share of the largest bank among the funding sources from the preceding calendar month. The sample consists of all overnight lending transactions of MMSR reporting agents to hedge funds with fixed income securities as collateral. The sample period is from April 1, 2019, to December 31, 2023. Standard errors are clustered at the bank-fund-security level. t-statistics are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Dependent variable: Haircut	(1)	(2)	(3)	(4)	(5)	(6)
CR_1	1.36***	1.39***	1.28***	1.29***	1.31***	1.40***
	(5.85)	(6.05)	(5.02)	(3.52)	(3.28)	(2.80)
PD	18.77***	1.99	8.36	21.17**	22.97**	24.08*
	(7.32)	(0.61)	(1.58)	(2.33)	(2.08)	(1.77)
Constant	2.98***	3.23***	3.19***	2.98***	2.95***	3.13***
	(19.71)	(23.18)	(18.85)	(10.19)	(8.65)	(7.14)
R^2 (%)	92.8	93.0	94.7	98.0	98.2	96.7
N	450,787	450,787	450,709	449,578	446,519	229,561
Fixed effects:						
Bank	–	✓	–	–	–	–
Security	✓	✓	–	–	–	–
Day	✓	✓	✓	✓	✓	–
Bank × security	–	–	✓	–	–	–
Bank × security × month	–	–	–	✓	–	–
Bank × security × week	–	–	–	–	✓	–
Bank × security × day	–	–	–	–	–	✓

*** p<0.01, ** p<0.05, * p<0.1
(t-statistics in parentheses)

Table A2: **The effect of funding concentration on haircuts: zero vs. positive haircuts**
This table repeats the regression from Table 3, differentiating between zero and positive haircuts. The dependent variable in columns (1) and (2) is a dummy variable that equals one if a given haircut is zero, and zero otherwise. The dependent variable in columns (3) and (4) is the haircut percentage for the sample with positive haircuts. Funding concentration is measured by the Herfindahl–Hirschman Index (HHI) of hedge funds' bank funding sources in the previous calendar month. The sample consists of all overnight lending transactions of MMSR reporting agents to hedge funds with fixed income securities as collateral. The sample period is from April 1, 2019, to December 31, 2023. Standard errors are clustered at the bank-fund-security level. t-statistics are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)	(4)
Dep. Variable:	**𝟙(Haircut = 0)**		**Haircut**	
Sample:	*full*		*Haircut > 0*	
HHI	-0.26***	-0.27***	1.59***	1.67**
	(-4.75)	(-4.06)	(2.64)	(2.27)
R^2 (%)	95.5	91.9	97.8	95.7
N	446,519	229,561	300,210	153,342
Controls & fixed effects:				
PD	✓	✓	✓	✓
Day	✓	–	✓	–
Bank × security × week	✓	–	✓	–
Bank × security × day	–	✓	–	✓

Table A3: **The effect of funding concentration on haircuts: extended sample of all repo maturities**

This table extends the regression analysis from Table 3 to encompass all repo maturities. The dependent variable the haircut, expressed as a percentage. Funding concentration is measured by the Herfindahl–Hirschman Index (HHI) of hedge funds' bank funding sources in the previous calendar month. The dataset comprises transactions between MMSR reporting agents and hedge funds involving fixed income securities as collateral, across all repo maturities. The specifications vary in terms of the fixed effects employed. Specifications (1) and (2) adjust for repo maturity by incorporating interactions between bank-collateral-week fixed effects and bank-collateral-day fixed effects with predefined maturity buckets. Week and day correspond to the trade date of the transaction. Specification (3) represents the most saturated model, controlling within a bank-collateral pair for all dates defining a repo transaction, namely transaction, settlement, and maturity date. The sample period is from April 1, 2019, to December 31, 2023. Standard errors are clustered at the bank-fund-security level. t-statistics are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Dependent variable: Haircut	(1)	(2)	(3)
HHI	0.65**	0.85**	0.87**
	(2.35)	(2.24)	(2.23)
R^2 (%)	99.2	98.0	97.9
N	603,751	313,825	305,191
Controls & fixed effects:			
PD	✓	✓	✓
Day	✓	–	–
Bank × security × week × maturity bucket	✓	–	–
Bank × security × day × maturity bucket	–	✓	–
Bank × security × trade date × settlement date × maturity date	–	–	✓

Table A4: **Largest Broker to Hedge Funds:** *Volume* is the sum of banks' customer (hedge funds) assets in $ bn. *Count* shows the number of hedge funds for a given bank. *Size* shows the average hedge fund size for a given bank in $ bn. *Exposure* equals *yes* in case of a relationship to Archegos prior to its default. *Loss* expresses the bank-specific loss incurred after the default of Archegos. The largest 20 broker represent about 90% of the market. Information are based on SEC filings (ADV and IAPD) in 2020 and public sources for exposure to Archegos.

Rank	Bank Name	Broker Segment		Hedge Fund	Archegos	
		Volume ($ bn)	Count	Size ($ bn)	Exposure	Loss
1	Barclays	5,739	656	8.75		
2	Morgan Stanley	5,195	2,162	2.40	yes	$911m
3	Citigroup	4,888	778	6.28		
4	Credit Suisse	4,452	1,092	4.86	yes	$5.5bn
5	Goldman Sachs	4,626	2,363	1.96	yes	~ 0
6	J.P. Morgan	4,623	1,562	2.96		
7	UBS	3,481	841	4.14	yes	$861m
8	ING	3,401	1,083	3.14		
9	Deutsche Bank	3,101	645	4.81	yes	~ 0
10	Merrill Lynch	2,631	328	8.02		
11	BNP Paribas	1,983	347	5.72		
...						
14	Wells Fargo	805	361	2.23	yes	~ 0
15	Nomura	705	54	13.05	yes	$2.9bn
...						
20	Société Générale	405	37	11.0		

Table A5: **Effect of Credit Suisse Exit on Haircut: zero vs. positive haircuts**

This table presents the estimation results based on equation 2, differentiating between zero and positive haircuts. The dependent variable in columns (1) to (3) is a dummy variable that equals one if a given haircut is zero, and zero otherwise. The dependent variable in columns (4) and (6) is the haircut percentage for the sample with positive haircuts. Exposure to Credit Suisse, CS_f, equals 1 if Credit Suisse acts as a broker for hedge fund f as of 2020, and 0 otherwise. $POST_t$ equals 1 after Credit Suisse announced its plan to leave prime brokerage on November 4th 2021, and 0 otherwise. PD_{bft} is the probability of default of hedge funds f reported by bank b at time t. The sample consists of all overnight lending transactions of MMSR reporting agents to hedge funds with fixed income securities as collateral and covers all observations in column (1) to (3), but only observations with haircuts greater than zero in column (4) to (6). The sample period is from April 1, 2019, to December 31, 2023. Standard errors are clustered at the bank-fund-security level. t-statistics are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. Variable:	**1(Haircut = 0)**			**Haircut**		
Sample:	*full*			*haircut > 0*		
$POST \times CS$	-0.07***	-0.16**	-0.16**	0.49**	0.40*	0.44*
	(-3.26)	(-2.53)	(-2.29)	(2.33)	(1.68)	(1.77)
Constant	0.33***	0.43***	0.45***	6.39***	6.76***	7.05***
	(17.31)	(12.00)	(6.82)	(21.91)	(73.47)	(43.74)
R^2 (%)	95.2	97.1	97.2	97.0	97.7	97.7
N	355,840	204,994	204,299	258,478	138,166	137,187
Controls & fixed effects						
PD	✓	✓	✓	✓	✓	✓
Bank x counterparty x security	✓	✓	✓	✓	✓	✓
Day	✓			✓		
Security x day		✓	✓		✓	✓
Bank x day			✓			✓

Table A6: **Effect of Credit Suisse Exit on Haircut - Robustness**

This table presents the estimation results based on equation 2, regressing hedge funds' haircut (in percent) on their exposure to Credit Suisse, controlling for their probability of default. Exposure to Credit Suisse, CS_f, equals 1 if Credit Suisse acts as a broker for hedge fund f as of 2020, and 0 otherwise. $POST_t$ equals 1 after Credit Suisse announced its plan to leave prime brokerage on November 4th 2021, and 0 otherwise. PRE_t equals 1 in the three months period before Credit Suisse announced its plan to leave prime brokerage on November 4th 2021, and 0 otherwise. PD_{bft} is the probability of default of hedge funds f reported by bank b at time t. In column (5) and (6) the probability of default, PD_{ft}, is the average probability of default of hedge funds f reported by all banks lending to hedge fund f at time t. The sample consists of all overnight lending transactions of MMSR reporting agents to hedge funds with fixed income securities as collateral. The sample period is generally from April 1, 2019, to December 31, 2023 but ends June 30, 2022 in column (3) and (4). Standard errors are generally clustered at the bank-fund-security level but at the bank, fund, and security level in column (7) and (8). t-statistics are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dep. Variable: Haircut	**pre trend**		**confounding events**		**average PD**		**clustering**	
$POST \times CS$	0.32**	0.38**	0.19*	0.24**	0.34**	0.36**	0.29**	0.34**
	(2.15)	(2.20)	(1.79)	(2.05)	(2.37)	(2.31)	(2.68)	(3.02)
$PRE \times CS$	0.07	0.09						
	(0.58)	(0.64)						
R^2 (%)	98.3	98.3	98.1	98.1	98.3	98.3	98.3	98.3
N	204,994	204,299	118,526	118,005	204,994	204,299	204,994	204,299
Controls & fixed effects								
PD	PD_{bft}	PD_{bft}	PD_{bft}	PD_{bft}	PD_{ft}	PD_{ft}	PD_{bft}	PD_{bft}
Bank x counterparty x security	✓	✓	✓	✓	✓	✓	✓	✓
Security x day	✓	✓	✓	✓	✓	✓	✓	✓
Bank x day	-	✓	-	✓	-	✓	-	✓

Table A7: **Effect of Credit Suisse Exit on Haircut - Fund Exposure**
This table presents the estimation results based on equation 2, regressing hedge funds' haircut (in percent) on their exposure to Credit Suisse, controlling for their probability of default. Exposure to Credit Suisse in column (1) to (3), $CS(fund)_f$, equals 1 if Credit Suisse acts as a broker for hedge fund f as of 2020 at the fund-level, and 0 otherwise. Exposure to Credit Suisse in column (4) to (6), $CS\text{-}share(fund)_f$, equals one divided by the total number of broker for hedge fund f if Credit Suisse acts as a broker for hedge fund f as of 2020 at the fund-level, and 0 otherwise. $POST_t$ equals 1 after Credit Suisse announced its plan to leave prime brokerage on November 4th 2021, and 0 otherwise. PD_{bft} is the probability of default of hedge funds f reported by bank b at time t. The sample consists of all overnight lending transactions of MMSR reporting agents to hedge funds with fixed income securities as collateral. The sample period is from April 1, 2019, to December 31, 2023. Standard errors are clustered at the bank-fund-security level. t-statistics are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Dep. Variable: Haircut	(1)	(2)	(3)	(4)	(5)	(6)
$POST \times CS(fund)$	1.24**	1.16***	1.90***			
	(2.87)	(2.04)	(6.55)			
$POST \times CS\text{-}share(fund)$				4.36**	3.94**	6.03**
				(2.37)	(2.36)	(2.27)
R^2 (%)	96.9	97.9	97.9	96.8	97.9	97.9
N	253,484	142,447	141,498	253,484	142,447	141,498
Controls & fixed effects						
PD	✓	✓	✓	✓	✓	✓
Bank x counterparty x security	✓	✓	✓	✓	✓	✓
Day	✓			✓		
Security x day		✓	✓		✓	✓
Bank x day			✓			✓