Intermediation, Pricing, and Hedging in OTC Markets: Equity Total Return Swaps

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Abstract

I present a simple theoretical framework for pricing and hedging equity total return swaps and test the model's predictions using novel, transaction level data. I find that swap spreads are based on a dealer's financing cost when the dealer's net swap exposure is positive but that the spread is determined by the short-selling cost of the reference security when the dealer's net exposure is negative. I also show that dealers hedge their exposure fully, first, by matching long and short trades internally and, second, by trading the underlying security. Dealers offer lower spreads on trades that reduce their net exposure, i.e., contribute to hedging the overall position. Using a natural experiment, I show that reduced competition between dealers leads to higher spreads.

Keywords: Total return swaps, brokerage, intermediation

JEL Classification: G12, G14, G24

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1 Introduction

A large share of trading takes place in over-the-counter (OTC) markets, where institutions can fulfill large block trades, arrange bespoke derivatives contracts, or trade otherwise illiquid or non-exchange traded securities. OTC markets are an understudied segment of the broader financial markets, and little is understood about the pricing of OTC trades and the frictions that affect this segment of the market.

In this paper, I examine how dealers set spreads – i.e., their profit margins – on OTC trades; how the spreads depend on the competitive dynamics in the market; and how dealers hedge the resulting exposure from these trades. I present a simple theoretical model that yields hypotheses relating to dealers' behavior and empirically test these hypotheses using novel regulatory data.

To examine OTC trades, I focus on equity total return swap (TRS) contracts. Equity TRS contracts are traded over the counter between investors and dealers and are structured to deliver the return of the target security or basket to one party in exchange for the return of a fixed rate – plus a margin – to the opposing party in the transaction. Traders can use TRS contracts to achieve both long and short exposure to the underlying security, giving rise to divergent hedging needs for the dealer that intermediates the trade or produces the required exposure.

Equity TRS volumes have grown remarkably in recent years as traders seek to gain off-balance sheet exposure to securities and as leveraged investment funds have proliferated.[1] Large TRS trades have, moreover, been related to the recent collapse of a $35 billion hedge fund and the ensuing increased scrutiny of swap dealers.[2]

I specifically study equity TRS contracts to understand OTC market trading and trade pricing because I can theoretically establish a baseline, competitive market spread level that depends on a dealer's net exposure to the swap's reference asset, the dealer's financing cost, and the short-selling cost of the reference asset. The baseline model establishes how dealers should hedge their swap exposure and allows me to examine deviations from the baseline pricing spreads. This model enables me to study how competitive dynamics affect pricing and spreads in OTC markets.

When a trader seeks to obtain positive exposure to a reference asset, they can buy this from a dealer, who is said to "sell" a swap, leaving the dealer exposed to long swaps. Similarly, if a trader

[1] Most U.S. based leveraged mutual funds gain their exposure through swap trades, as opposed to taking on leverage to buy or sell their target securities.

[2] See Archegos; CFTC 2022; Armstrong 2021.

wants negative exposure to an asset (akin to a short sale), they can obtain it from a dealer, who is then the swap buyer. This exchange gives the dealer exposure to short swaps.

The baseline model predicts that when a dealer has sold (bought) swaps and has a resulting positive (negative) exposure to a security, the dealer will hedge by buying (short selling) the security unless they can internally offset the exposure by matching demand from traders seeking the opposite exposure. This relationship establishes a floor level to swap spreads: When the dealer has an unmatched net-long exposure, the dealer's competitive swap spread on long transactions is determined by the *dealer-specific* financing cost in excess of the market risk-free benchmark, and their competitive spread on short transactions is the *negative* of their financing cost. When a dealer has a net-short exposure, the competitive spread on short swaps is the *asset-specific* short-selling cost, and the competitive spread on long swaps is the negative of the short-selling cost. In less competitive markets, dealers will, naturally, be able to charge margin rates that are above this spread.

The intuition behind the negative minimum spreads for short swaps (when the dealer has a positive net exposure, or long swaps when their net exposure is negative) is simple: The dealer tries to attract other traders to take positions on the smaller swap leg to net out the exposure internally, thus avoiding the need to hedge by trading in the spot markets (at higher cost). These predictions – in particular regarding the swap spreads when the dealer's net notional is positive – are in line with Sun et al. (1993), who use proprietary data to find that the dealers' credit quality drives the spreads they charge swap counterparties.

Notably, given the asymmetric hedging strategies in which dealers must engage – buying the security if they have sold positive exposure and short selling it if they have sold negative exposure – gives rise to asymmetric effects. Buying a security is simple and does not necessarily increase the dealer's leverage. However, short selling a security is often more complex and exposes the dealer to various risks associated with it (see, for example, Engelberg et al. (2018)).

Using newly available regulatory data, I first establish that, on average, dealers' swap pricing follows the predictions from the model: When a dealer has positive exposure to a swap, long swap spreads are, on average, positive but insensitive to a dealer's notional exposure to a swap asset, whereas short swap spreads are negative. Conversely, when a dealer has negative exposure to a swap, short swap spreads are positive and higher than long swap spreads.

I find that in more competitive OTC markets – measured either by the number of dealers active in the specific asset or by market concentration – swap spreads are lower, consistent with the baseline model. In less competitive markets, dealers are able to extract economically abnormal margins akin to monopoly rents. I also find that the effect of competition is stronger on the short leg of the swaps: More competition decreases average spreads more steeply on short swaps, whereas the effect is economically insignificant for long swaps.

Next, I examine dealers' hedging behavior. First, the number of transactions they have in the *opposite* direction of their net exposure – i.e., short trades when they are net long and vice versa – increases with their exposure. Second, in line with predictions from the model, dealers charge lower fees to new clients that trade in the *opposite* direction to their existing exposure. This finding indicates that dealers seek to net out their exposure internally. Using 13F institutional holdings reports, I also find that dealers' holdings of the swap reference assets move in conjunction with their net exposure in the swaps: Dealers hedge the part of their exposure that is not netted internally by trading in the cash markets.

Finally, I study a quasi-natural experiment in which a dealer exits the market. The experiment gives a reasonably exogenous variation to the remaining market participants, and enables me to study the effect of competition on the swaps market. I find that spreads on short swaps that the exiting investment bank used to intermediate increase by 25-54 basis points. This amounts to 51-115% of the average short swap spread. The increase in long swap spreads is, in contrast, smaller and statistically insignificant in most specifications. This finding is, once again, consistent with long swaps being more competitively priced in general and easier or less risky for dealers to hedge than short swaps.

I find that most dealers hold a net exposure close to zero, regardless of their directional swap exposures. This finding supports the idea that dealers attract more short (long) swap traders when they hold substantial long (short) swap exposure. Further evidence of this can be seen in the number of swap counterparties of a dealer, which displays a V-pattern: The number of both long and short swap counterparties increases for a dealer when the dealer's net notional exposure deviates from zero.

The empirical tests in this article rely on swap trading by mutual funds. These data are reported in the quarterly N-PORT filings that all U.S. mutual funds must submit to the Securities and Exchange Commission (SEC). These data report, for each swap transaction, the underlying security, the swap counterparty (dealer) identity, the notional amount of the swap, the swap spread, and the benchmark rate for the contract. The data thus provide a detailed quarterly account of each dealer's exposure to any asset, as well as the transaction level and average swap spreads from each dealer-asset pair.

These data allow me to study trading in OTC markets in detail and – importantly – to inspect the deviation from a competitive market pricing, thus facilitating an analysis of the cost that institutions face in OTC trading. However, the data explicitly omit swap trading by potentially more informed market participants such as hedge funds. While hedge funds and other institutions that are not required to report Form N-PORT are likely to constitute an important part of the derivatives market, focusing on mutual funds arguably leaves out information aspects that would affect derivatives pricing. This narrower approach helps us understand how OTC market spreads are set in the absence of information and signaling frictions that are more likely to arise from informed orders.

2 Literature

Prior literature has largely focused on interest rate swaps. Duffie and Huang (1996) and Cooper and Mello (1991), for example, both develop models that incorporate default risk for both swap counterparties. Duffie and Huang (1996) finds analytically that in valuing a swap, cash flows should be discounted using the discount rate of the counterparty for whom the swap is currently out of the money. Cooper and Mello (1991), moreover, explicitly leave open the empirical examination of the model. Liu et al. (2006) study both the roles of default and liquidity risk in interest rate swap spreads, concluding that, on average, the default risk component contributes more to the credit spread than liquidity risk does. Lou (2023) develops a TRS pricing model demonstrating that the buyer and seller have different fair values for the swap due to their differing discount rates, suggesting clear gains from trade. Prior literature has thus largely focused on swap valuation from the perspective of finding the correct present value. In contrast, this paper sheds light on how swaps and other OTC trades are *priced* – in other words, what the cost is that counterparties charge to deliver a swap contract.

However, once collateralization for swaps became widespread, market practice began to view swap trades as essentially free of counterparty default risk (see Tuckman and Serrat (2022)). Collin-Dufresne and Solnik (2001) argue that swap *contracts* are default free thanks to collateralization and marking-to-market and show that fixed income swap *rates* should capture the expected deterioration of bond issuers' credit quality. Similarly, Johannes and Sundaresan (2007) provide a theory of swap valuation with marking-to-market and collateralization, showing empirically that market swap rates are consistent with costly collateral usage. Along similar lines, Arora et al. (2012) find that counterparty credit risk is priced in the credit default swap (CDS) market but that the effect is extremely small and consistent with full collateralization of the swap trades. Similarly, He (2000) departs from the traditional view that counterparty credit risk drives swap spreads, instead emphasizing three key factors: short-term financing spreads, the liquidity premium of government bonds, and the risk premium for holding long-term bonds or swaps.

Empirical research has, like theoretical analysis, focused on fixed income and interest rate swaps. Jermann (2019) observes that fixed rates for long-term swaps have largely been below Treasury rates since 2008 and shows analytically that this trend is consistent with arbitrage frictions and arises due to costs of holding bonds. Similarly, Klingler and Sundaresan (2019) examine the persistent negative spread of U.S. 30-year interest rate swaps since September 2008, offering a demand-driven explanation. They attribute the phenomenon to the preference among pension plans to receive fixed payments in 30-year interest rate swaps, rather than using leveraged bond positions, to hedge long-term liabilities. Osler et al. (2016) study OTC foreign exchange trading and find that adverse selection plays a role in the determining bid-ask spreads, with more sophisticated traders obtaining narrower spreads.

While equity total return swaps function similarly – exchanging one rate of return for another, although in the case of equity TRSs both rates are often variable – little research has focused on them. This omission is particularly important given the rise in equity TRS usage by traders to achieve leverage or undisclosed ownership in companies. Moreover, prior research has focused on the pricing of a single swap contract in isolation, whereas I present a model where dealers take into account their *entire* swap *portfolio* on an asset when setting the spreads for *individual* swap contracts. This aspect is consistent with empirical observations of equity TRS spreads in this article.

3 Total Return Swaps

3.1 Uses of TRS contracts

Most securities that underlie total return swaps – whether they are single stocks or stock indices – have spot or futures market alternatives that traders can use to gain exposure.[3] There are, however, three broad reasons why traders might instead use TRS contracts: to gain leverage, to circumvent leverage restrictions, or to avoid disclosure requirements.

First, a TRS contract allows traders to gain exposure to some desired notional amount of the underlying asset while requiring them to post only a small amount of collateral with the counterparty. This feature can avoid Reg T margin limits. For example, hedge funds may gain far greater leverage than the 50% of total assets allowed by Reg T through swaps: A TRS contract may require no initial capital outlay from either party as long as they are reasonable creditworthy and any gains and cash flows are settled on a daily basis.

Second, mutual funds are generally limited in their capacity to take outright leverage to trade. To circumvent this restriction, they can enter TRS contracts with dealers, as these are considered normal derivatives positions and not outright leverage.

Third, informed traders may prefer TRS contracts over direct investments in the target company, as disclosure of swaps, the resulting exposure, and the effective control were not required in 13D filings with the SEC until 2023. In fact, in 2008, the SEC explicitly advised that total return swaps did not need to be disclosed in 13D filings[4] but changed this guidance in 2023 following the collapse of Archegos.[5] This exposure-without-disclosure aspect of TRS has been exploited by, e.g., Shaeffler AG in its takeover of Continental in 2008, in which it had entered TRS contracts with Merrill Lynch giving it effective control over 28% of Continental's shares.[6] Similarly, in the U.S., The Children's Investment Fund used TRS contracts in its proxy battle with CSX Corporation.[7]

Traders seeking leveraged or undisclosed exposure against a security may have limited options

[3]Each swap, naturally, needs a reference asset or index, but many indexes cannot be directly traded, as, for example, they may not have index futures.

[4]https://corpgov.law.harvard.edu/wp-content/uploads/2008/06/sec-staff-advises-that-13d-disclosure-requirements-do-not-extend-to-total-return-equity-swaps.pdf

[5]https://www.sec.gov/news/press-release/2023-219.

[6]Pütz and Berwin 2008; Saltmarsh 2008

[7]Although The Children's Investment Fund was later found to be in violation of disclosure requirements relating to its swap position, the U.S. District Court declined to take a stance on more broadly requiring disclosure of such contracts in 13D and other filings. See Solomon (2011).

depending on the types of instruments available to them. Moreover, even if they are able to trade on margin, their exposure is limited to twice their net assets due to SEC Regulation T. Traders therefore increasingly turn to TRS contracts, wherein they receive (if they seek long exposure; or pay if they seek short exposure) the return of an asset for a given notional investment amount and pay (receive) a fixed rate to (from) the swap dealer. This function helps traders generate larger leveraged positions, thereby circumventing the Reg T leverage limitations.

3.2 Structure and function of TRS

In a total return swap, the swap buyer will receive the return of a reference asset – for example, a stock or stock market index – and pay the swap seller (typically a large investment bank or broker-dealer) some benchmark interest rate (typically SOFR, the overnight bank financing rate, or the one-month Treasury yield) and a swap spread. The swaps have a zero value at the the onset and often require minimal initial collateral to be posted, although they are subject to daily variation margin. In effect, the swap buyer will receive the daily returns of the reference asset in exchange for the return of a fixed income asset.

In a typical trade, a swap buyer might request the return of the S&P 500 Index on a notional of $50 million and pay the secured overnight financing rate (SOFR) + 45 basis points. If the asset increases in value, the swap buyer will receive the return net of the fixed income return; if the asset decreases in value, she will pay the swap seller the negative return of the asset in addition to the fixed income return.

Symmetrically, a trader who seeks a short position on a reference asset will *receive* the fixed income return (benchmark + spread) plus the negative returns of the reference asset.

A dealer can replicate the cash flows to the swap buyer by borrowing money and investing in the reference security or basket. The dealer's profit from the swap thus comes from the spread she charges the trader. Similarly, if the dealer enters a short TRS with a trader, she can hedge it by short selling the security and investing the proceeds at the risk-free rate. The efficiency of the trade can increase from the dealer's perspective if she can find two traders seeking opposite exposure to the same asset: In this case, the dealer acts as an intermediary, transferring returns from one investor to the other, while capturing a spread without having to hedge the transactions individually. For an overview of different swaps and their functioning, see Goodman and Fabozzi

(2005).

4 Baseline pricing model

4.1 Hedging and pricing swaps

In a long (short) TRS, a trader will contract with a dealer to receive (deliver) the return R of a specified asset or index on a nominal amount N on the swap expiry date and deliver (receive) a pre-defined interest rate r on that same nominal N. The dealer will charge a spread s. The dealer can hedge the exposure by taking a long (short) position in the reference asset and earn a profit equal to the spread net of her hedging costs. The profit of a dealer that has nominal amounts N_L and N_S of long and short swap exposure and takes hedging positions of H_L and H_S to cover the risk can thus be expressed as:

$$\begin{aligned} \Pi = &-N_L \times (R - (r + s_L)) + H_L \times ((1 + R) - (1 + r + c_L)) \\ &+ N_S \times (R - (r - s_S)) - H_S \times ((1 + R + c_S) - (1 + r)), \end{aligned} \tag{1}$$

where s_L and s_S are the spreads the dealer charges for long and short swaps, and c_L and c_S are the financing costs for long and short swap hedging, respectively. Importantly, as the dealer hedges a long swap by *borrowing* cash, c_L is the dealer's credit spread over the risk-free rate, i.e., their financing cost. c_S is the asset-specific short-selling or security borrowing cost.

The first line of Equation 1 shows the dealer's profit from selling N_L units of long swaps at a spread s_L and hedging H_L units at a cost of c_L. The second line of the equation shows the dealer's profit from selling N_S units of short swaps at a spread of s_S and hedging H_S units at a cost of c_S. Note that the profit is expressed in terms of spreads that the dealer receives, as opposed to expressing the spread on the short swap leg as a spread that the dealer pays to her counterparty. The spreads s_L and s_S can be negative.

Assume that the dealer is risk neutral and receives take-it-or-leave-it offers for swap contracts from traders. Also assume that the dealer bears a cost γP^2 for holding a net position P in the reference asset. The dealer maximizes the objective function $O(H_L, H_S)$ with respect to the hedging amount H_L and H_S for long and short swaps:

$$O(H_L, H_S) = \Pi - \gamma P^2, \text{ subject to} \tag{2}$$

$$P = (H_L - N_L) - (H_S - N_S), \tag{3}$$

$$H_L \geq 0,\ H_S \geq 0 \tag{4}$$

From this, two possible outcomes arise depending on the dealer's net exposure $N_L - N_S$:

1. $N_L - N_S > 0$: $H^*_{L+} = N_L - N_S + \frac{E(R)-r-c_L}{2\gamma}$, and $H^*_{S+} = 0$.
2. $N_L - N_S < 0$: $H^*_{L-} = 0$, and $H^*_{S-} = N_S - N_L - \frac{E(R)-r-c_S}{2\gamma}$.

If the dealer's penalty from holding a non-zero exposure P against the swap asset is sufficiently high ($\gamma \to \infty$),[8] the expressions for non-zero hedging simplify to $H^*_{L+} = N_L - N_S$ and $H^*_{S-} = N_S - N_L$: The dealer only hedges the residual exposure that is not matched internally.

The intuition for this hedging strategy is simple: When a dealer has larger long swap exposure than short swap exposure, all of her short exposure is effectively hedged by the long swaps. The long swaps, however, are not fully hedged, and the dealer needs to hedge the remaining unmatched $N_L - N_S$.

Given these outcomes, s_L and s_S can be solved by finding the value that makes the marginal profit for an additional unit of exposure $N_L,\ N_S$ weakly greater than zero.

$$\text{When } N_L - N_S > 0 : s_L \geq c_L \text{ and } s_S \geq -c_L. \tag{5}$$

$$\text{When } N_L - N_S < 0 : s_L \geq -c_S \text{ and } s_S \geq c_S. \tag{6}$$

Several observations can be drawn from the theoretical framework. First, the (minimum) swap spreads depend on the dealer's exposure to the asset: If the dealer has net long exposure, the spread is *dealer specific* and depends on the dealer's financing cost, whereas if the dealer has net short exposure, they need to short sell the underlying to hedge, and the spread will be *asset specific* and depend on its short-selling cost.

[8] This is equivalent to the dealer having a binding constraint on the dealer's position: $P = (H_L - N_L) - (H_S - N_S) = 0$.

Naturally, the swap spreads will be closer to the competitive baseline when competition between dealers is higher. The expectation is, therefore, that swap spreads will trend downward when competition increases.

This observation yields the first empirical prediction:

Hypothesis 1. *When $N_L - N_S > 0$, the swap spread will depend on the dealer's financing cost, and when $N_L - N_S < 0$, the spread will depend on the short-selling cost of the underlying security.*

The intuition of this proposition is simple: When the dealer has a positive net exposure, any additional long exposure will bring in a spread s_L but must be hedged at a cost of c_L, which equals the dealer's financing margin. In contrast, any additional unit of short swap exposure in this case will, again, earn the dealer the spread s_S but will also allow the dealer to hedge one unit *less* on the long side. The same applies if the dealer has a negative net swap exposure: Any additional unit of long exposure will then allow the dealer to short sell one unit less ("earning" the opportunity cost of c_S), while an additional unit of short exposure will cost the dealer c_S in additional hedging.

This outcome also reflects dealers' preference to internalize risk rather than hedging each swap leg individually: Hedging the long and short legs individually would duplicate positions, incurring additional cost. The negative spread on short (long) swaps when the dealer's net exposure is positive (negative) is also an incentive for traders to help the dealer to internalize their exposure.

In a strict sense, the spreads will satisfy inequalities 5 and 6: The swap spreads will never be *below* c_L and $-c_L$ for long and short swaps when the dealer's net notional exposure is positive. The fees can be expected to be closer to the equality when competition among dealers is higher or when swap traders have a stronger negotiating position. This can occur, e.g., when there are more dealers trading swaps on a given asset or when exchange-based derivatives on the asset are more available.

Additionally, there is a discontinuity in swap spreads at zero net notional, $N_L - N_S = 0$, when a dealer's hedging need switches from short selling to holding a long position in the reference asset. This observation yields the second empirical prediction:

Hypothesis 2. *Swap fees will exhibit a discontinuity at 0 net swap exposure, with a step up in long swap spreads and a step down in short swap spreads at 0.*

Since the dealer will seek to hold a net zero position against the underlying, the model yields a prediction on dealer hedging:

Hypothesis 3. *A dealer's total hedging $H_T = H_L - H_S$ will be proportional to their net exposure: $H_T = N_L - N_S$.*

In other words, a dealer will buy the asset in the amount of their net exposure and short sell it to that amount if the net exposure is negative. This relationship links dealers' swap exposure to their holdings of the underlying asset: Dealers with large long exposure will hold larger positions in the underlying security.

Dealers' hedging need is also reflected in the swap spreads they charge new clients: When a dealer has an existing net long (short) exposure, they are likely to charge lower spreads on new short (long) swaps, as these help to net out the exposure internally without the need to hedge in the open markets. A corollary of this tendency is that new swap transactions that *increase* a dealer's net exposure will be charged *higher* spreads.

Hypothesis 4. *A dealer will charge lower (higher) spreads on new transactions that help net out (increase) their exposure.*

4.2 Multiple dealers

The baseline pricing model discussed above describes a single dealer's hedging and pricing in the TRS market. Since total return swaps on a given asset are, in essence, commoditized products, no single dealer is likely to be able to differentiate in the substance of the product; hence, the basic idea of Bertrand price competition can be applied to the market.

Following this logic, swap spreads should tend toward competitive pricing when competition between dealers in the swap market for a given asset increases. An important caveat to this notion is, of course, that when dealers do not face the same marginal cost of production, the price should tend toward that of the second-lowest cost producer(s), with the lowest-cost dealer(s) charging $\bar{c_L} - \epsilon$, where $\bar{c_L}$ is the credit spread of the second-lowest cost dealer(s). The low-cost dealers would, in this case, capture the entire market if there are no other factors that, for example, limit a trader's exposure to a single counterparty.

5 Data

I obtain transaction-level data from regulatory filings that U.S. mutual funds must submit to the SEC. The N-PORT filings identify all outstanding swap positions held by mutual funds, as well as the swap spreads, reference rates, notional amounts, and counterparties (dealers). The N-PORT filings identify dealers by name and legal entity identifier (LEI). I map each dealer's LEI to the parent company using the LEI mapping file available from the Global Legal Entity Identifier Foundation (GLEIF).[9]

The N-PORT sample consists of 211,560 transactions between 820 funds and 41 swap dealers (identified at the parent company level) on 10,500 unique assets from the fourth quarter of 2019 to the first quarter of 2024. These match into 18,233 unique dealer-asset pairs and 89,432 quarterly dealer-asset observations. In 14,421 dealer-asset quarters, the dealer has exposure to both sides of the trade, whereas dealers have exposure only to the long (short) leg in 39,295 (35,716) cases.

I collect stock market data (trading volume, price, bid-ask, etc.) from CRSP, option implied volatilities from OptionMetrics, and short interest from Compustat. I am able to map these to 4,349 unique swap underlying assets (129,753 trades). The remainder of swap assets are either foreign securities or index swaps that do not map to a unique CUSIP identifier. I exclude volatility and variance swaps from the sample.

I obtain N-CEN filings, which provide descriptive information about U.S. mutual funds, as well as the 13F Institutional Holdings reports from the SEC. The latter enable me to match a dealer's holdings in a given swap reference asset to her swap exposure: Often, dealers' asset holdings are submitted in so-called combination filings, which report the holdings at the parent or holding company level. The raw filings at the SEC enable me to map dealer names to the holding company-level 13F reports through the "List of Other Included Managers" in each filing.[10]

I obtain credit spreads for a subset of swap dealers from LSED Data and Analytics (formerly Refinitiv) to proxy for their financing cost.

I use the Markit Securities Finance data to estimate short-selling fees for each underlying security. The Markit sample extends from 2019 to 2021.

[9] The GLEIF file that identifies company-parent-ultimate parent relationships is available at https://www.gleif.org/en/lei-data/gleif-golden-copy/download-the-golden-copy/.

[10] For example, neither *J.P. Morgan Securities LLC* nor *JPMorgan Chase Bank, N.A.* directly report their holdings; instead, the two dealers' institutional holdings are reported by *JPMORGAN CHASE & CO.*

Table 1 presents descriptive statistics at the dealer-asset level.

Most dealers hold relatively close to zero net notional exposure against the swap target: While the average net notional held by a dealer is \$17.27 million, the median is only \$10 thousand. The 10th and 90th percentiles are -\$2.08 million and \$8.29 million, respectively; the distribution of notional exposure is highly right skewed. Similar patterns can be observed for long and short notional exposures.

Two observations are indicated by the distribution of dealers' net exposure. First, the average and median are both close to zero, consistent with dealers aiming to match long and short exposure internally. Second, the distribution is right skewed, with some dealers having large positive net exposure. These observations are consistent with the typically larger demand for long swap exposure faced by dealers.

A similar conclusion can be drawn from Figure 1 Panel (a), which plots dealer-asset level net notional against the market aggregate net notional in the asset. Most dealer-asset observations are close to zero on the horizontal axis. The figure also shows that most dealers' net exposure corresponds to the market aggregate exposure: Few dealers hold a negative (positive) net swap exposure in an asset if the market aggregate swap exposure is positive (negative).[11]

Figure 1 Panel (b) plots dealers' long and short notional against the total long notional in the market. The figure provides two observations: First, a substantial proportion of dealers have both long and short exposure. Second, despite many dealers having exposure in both directions, the long exposure generally dominates in magnitude, and most dealer-asset pairs with zero net notional exposure occur at relatively low directional exposures.

Dealers receive long (short) swap spreads of 0.27% (0.34%), on average. Notably, dealers earn positive spreads on both long and short swaps, on average.

The number of long swap transactions is, on average, slightly higher than that of short swaps.

[11] This is clear from the locations of most observations in the top-right and bottom-left quadrants of the figure.

6 Swap spreads

6.1 Baseline model and swap spread discontinuity

The first baseline prediction of the model is that swap spreads depend on a dealer's net notional exposure, i.e., the exposure that the dealer is unable to match internally: When the dealer faces a positive net exposure, she will set long (short) spreads at or above the level of (the negative of) her financing cost; in contrast, when she faces a net negative exposure, she will set short (long) spreads at or above the (negative of the) short selling cost of the reference asset. Setting spreads this way to match her hedging cost ensures that the dealer makes a positive economic profit on her overall position.

Figure 2 Panel (a) plots average dealer-level long and short swap spreads against the dealer's net exposure on the asset. The figure displays a clear discontinuity at zero net exposure: At negative net exposures, short swap spreads are markedly higher than at positive net exposures. The opposite holds for long swap spreads. The effect is even clearer in Panel (b), which normalizes the dealer's exposure against the asset.[12] The figure and the discontinuity it displays is consistent with Hypothesis 2 of the model and supports the idea that swap spreads are determined either by the dealer's financing cost (if she has a positive net-exposure) or by the short-selling cost of the underlying asset (if she has a negative net-exposure). Section 6.2 formally tests Hypothesis 1 from the model.

The model also predicts that long and short swap spreads are negatively correlated if dealers adjust the spread to attract traders on the side of the trade with a smaller notional exposure. The dealer's aim is to net out her exposure internally without having to hedge the excess exposure by trading the reference asset. The unconditional correlation between long and short swap spreads at the dealer-asset level is approximately -0.68.

6.2 Spreads: Dealers' financing cost or short-selling cost

Hypothesis 1 of the model predicts that the competitive level of spreads should only depend on a dealer's financing cost when the dealer's net exposure is positive, depending instead on the short-selling cost of the swap target asset when the net exposure is negative. As a result, swap spreads

[12] The normalization is based on the asset-level exposures and finds $Norm.NetExp_{d,a,t} = NetExp/\sigma_a$, where σ_a is the standard deviation of dealers' net exposure against asset a.

should be mostly explained by dealer-level explanatory variables when the dealer holds a positive net notional on a given asset and mostly explained by asset-level variation when the dealer faces a negative net notional.

However, the relationship between the dealer's financing and short-selling costs and the swap spread is close only when the dealer sets the spread at the competitive level, i.e., when the dealer cannot extract monopoly rents in the market. If the dealer has market power, she will set spreads at higher levels. In this case, the observed swap spreads are unlikely to respond directly to changes in credit default spreads or short-selling costs. In contrast, spreads should be set closer to the competitive levels when dealers face higher competition, e.g., through lower market concentration.

To test this supposition, I split assets by their Herfindal-Hirschman index (HHI) into two groups and regress long and short swap spreads separately across the groups on dealers' six-month credit default swap (CDS) spreads and the short-selling cost for securities. Moreover, the model states that swap spreads depend on a dealer's financing cost when the dealer has a positive net notional exposure and on the short-selling cost of the reference asset when the dealer's exposure is negative. To account for this, I estimate the regression separately for dealer-asset pairs with positive and negative net notional:

$$spread_{b,a,t} = \beta_1 CDS_{b,t} + \beta_2 shortcost_{a,t} + \alpha_{b,a} + \alpha_t \tag{7}$$

I also include dealer×asset and calendar quarter fixed effects. The dealer×asset fixed effects capture any dealer-asset-specific variation in spreads, e.g., due to dealer specialization. The calendar quarter fixed effects capture general time variation in swap spreads, e.g., that caused by interest rate policy or market conditions.

Table 2 presents the results. Panel (a) presents the regressions for low-HHI swaps, i.e., when competition between dealers is high, and Panel (b) presents the results for high-HHI swaps. Outcomes for dealer-asset observations with positive notional exposure are shown in Columns (1)-(4) and those for negative notional exposure in Columns (5-8).

The model asserts that long swap spreads react positively and short swap spreads negatively to CDS spreads when the dealer has a positive net notional exposure against the asset. This is indeed the case in Panel (a): The coefficient on CDS spread is positive and highly statistically significant for long swaps. For short swaps, the point estimates are negative, as predicted by the model, but are not statistically significant. The coefficients on the stock borrowing fee are statistically insignificant when dealers have positive net exposure, indicating that spreads do not load on the short selling fee at that time.

Similarly, the coefficients align with the model when dealers have negative net exposure: Short swap spreads vary positively and long swap spreads negatively with the stock borrowing fee when dealers have negative exposure to the asset (Columns (5)-(8)).

The results presented in Panel (b) of Table 2 align with dealers' exercise of market power when the HHI is high: Long swap spreads do not vary with CDS spreads or borrowing fees when dealers have positive notional exposure. However, both long and short swap spreads vary positively with the borrowing fee when dealers have negative notional exposure, indicating that dealers may pass variations in short-selling costs to clients.

These findings, together with Figure 2 discussed in Section 6.1, support the model's prediction that swap spreads are determined by a dealer's financing cost when the dealer's net notional exposure is positive and at the asset level when the net notional exposure is negative.

6.3 Dealer competition

The baseline model describes the market when there is only one dealer, establishing that the perfectly competitive level of swap spreads is given by the hedging cost faced by the dealer. When a dealer has a positive (negative) net exposure to swaps, she needs to buy (short sell) the reference asset to be hedged. It follows that the competitive level of long swap spreads is given by a dealer's financing cost, whereas the short swap spread is the negative of this cost. Similarly, when a dealer has a negative exposure, the competitive level for the spread on short swaps is given by the short-selling cost of the reference asset, while the long spread is the negative of this cost.

However, these descriptions represent the *lower* bounds for spreads: When dealers face less competition or have more market power, they are able to charge spreads higher than the competitive level.

To test this point, I regress the spread on long and short swaps on variables that measure the level of competitiveness in the swap market:

$$spread_{a,t} = \beta \; competition_{a,t} + \alpha_a + \alpha_b, \tag{8}$$

where $competition_{a,t}$ is either the number of dealers active in the swap market for the reference asset or the HHI for the swaps in the asset. I compute the HHI for each asset-quarter observation based on the total gross notional of swaps outstanding for that asset in the quarter.

Table 3 presents the results: Panel (a) proxies the level of competition by the number of dealers active in the asset's swap market, while Panel (b) proxies the level of competition by the HHI. In both panels, specifications (1)-(2) show the unconditional effect, whereas specifications (3)-(4) reflect dealers with a negative net notional exposure. Specifications (5)-(6) show the results for dealers with a positive net exposure.

Swap spreads should, across the board, decrease with competition, i.e., when the number of dealers is high or when HHI is low. Indeed, in both Panels (a) and (b), short swap spreads decrease or have a statistically insignificant relation with competition in specifications (1) and (3). Specification (5) shows the inverse relation in both panels (although the effect is small and insignificant in Panel (b)): In this case, short spreads seem to be *increasing* with competition. This specification corresponds to a situation in which the dealer has a negative net notional exposure.

This counterintuitive finding may therefore be due to endogeneity: When dealers have large negative (positive) net notional exposures, it is also likely that the overall exposure in the market is negative (positive) (see Figure 1), which reflects the high demand for short (long) exposure in the reference asset. Accordingly, it is plausible that a large number of dealers also reflects high demand for swaps, thus correlating positively with swap spreads.

Long swap spreads may suffer from endogeneity issues, as described above: In specifications (2), (4), spreads increase with competition. However, in specification (6), long swap spreads decrease with competition. Indeed, Specification (6) corresponds to a situation in which the dealer has a *negative* net notional exposure, likely making them compete harder for additional *long* swap exposure.

While the simple experiment above suggests the relation between swap spreads and the competition, it is likely that the analysis suffers from endogeneity. Section 8 aims to address this issue by studying a natural experiment in which a dealer exits the market due to an exogenous shock.

7 Hedging by dealers

7.1 New client trades

Hypothesis 4 of the the pricing model presented in Section 4 predicts that dealers, in the first instance, try to hedge their exposure by seeking trades in a direction opposite to their prevailing exposure: When a dealer has a positive exposure, she will first attempt to attract traders that seek a *negative* exposure so that the exposure from the trades cancels out internally, enabling her to capture a spread from both traders.

This assertion suggests that a dealer should offer lower spreads on new short (long) swaps if she holds an existing positive (negative) net exposure. However, it is not evident that a dealer would discourage new trades that *increase* her exposure: As long as a dealer can charge a spread that more than compensates her for the hedging cost, any new trades will be profitable, so discouraging them by charging higher spreads does not follow in the same way as lower spreads for hedging trades do.

To test this, I identify new trades for a dealer in a given asset by identifying new counterparties trading with the dealer in a given asset each quarter. To determine whether they increase or decrease a dealer's exposure against the reference asset, I examine the direction of the trade (long vs. short) and the dealer's net exposure in the previous quarter: If the new trade is in the opposite direction than the dealer's prior net exposure, I assign the trade as a "hedging" trade. I then regress long and short swap spreads on the indicator variable for new trades.

I estimate the regression at the dealer (b), counterparty (c), asset (a) level:

$$spread_{b,c,a,t} = newtrade_{b,c,a,t} \times hedge_{b,c,a,t} + newtrade_{b,c,a,t} + hedge_{b,c,a,t} + \alpha_{b,a,t} \tag{9}$$

The dealer-asset-time fixed effects in the specification absorb any time-varying dealer-asset aspects. Moreover, the triple-interacted fixed effects ensure that the identification is within a dealer-asset pair in a given quarter: The coefficients therefore identify the effect of new trading relationships, whether trades contribute to hedging, and whether the *new trades* are *hedging trades*.

Table 4 presents the results. First, new trades are, on average, charged higher spreads than existing trades (although the effect is not economically or statistically significant for short spreads): Long spreads are approximately 7.4 to 9.1 basis points higher for new trades. The effect of new trades is positive but statistically insignificant for short swaps, ranging from 0.8 to 2.2 basis points. Most importantly, the interaction between new trades and hedge trades shows that short spreads are approximately 6.3 and long spreads 7.8 basis points lower than for other trades when the new trades hedge the dealer's existing exposure.

This result supports Hypothesis 4 from the model: Dealers entice traders to enter into new TRS trades that help hedge their positions by offering lower spreads.

7.2 Dealers' stock holdings

The model in Section 4 predicts that dealers seek to fully hedge their net exposure against the reference asset. To test this claim, I map dealers' swap exposure to their direct holdings in the reference asset. I do this by matching dealer identities to 13F institutional holdings reports for the swaps whose reference assets are identifiable with a CUSIP in the N-PORT data.

Hypothesis 3 states that a dealer's total hedging in the reference asset is proportional to their net exposure. In short, dealers will first match long and short demand in an asset internally and then hedge only their residual net exposure by trading the reference asset. The trading in the reference asset is, however, proportional to the dealer's net exposure: Changes in net exposure will be reflected in the dealer's holdings in the reference asset.

To test this, I find the share-equivalent of notional by dividing the dealer's net exposure (which is measured in dollars) to a reference asset by the share price of the asset and relate the number of shares held by a dealer to this figure.

I regress the change in dealer holdings over which they hold sole voting authority in each asset on the change in their net swap exposure:

$$\Delta 13\text{F holdings}_{b,a,t} = \Delta\text{Net exposure}_{b,a,t} + X_{b,a,t}, \tag{10}$$

where $X_{b,a,t}$ is a vector of fixed effects at the dealer, stock, and time levels.

Table 5 presents the results. In any specification, a one-unit change in a dealer's exposure against an asset leads to a 0.70-0.75 unit change in the number of shares held by the dealer. Importantly, the coefficients are not statistically different from 1.0: I cannot reject the hypothesis that dealers vary their asset holdings 1-for-1 when their exposure changes.

This result supports Hypothesis 3, which states that dealers will seek to fully hedge their exposure to TRS contracts.

8 Natural experiment

The evidence presented earlier is consistent with the hypotheses derived from the model. However, it is difficult to fully omit any possibility of endogeneity, especially when testing for the effects of competition on swap spreads. To omit these issues, I turn to a natural experiment that is driven by a large loss by a major swap dealer and that dealer's subsequent market exit.

On March 26, 2021, Archegos (a family office with $36 billion of assets at its largest[13]) collapsed after it failed to satisfy margin calls from its trading counterparties. This failure is attributed primarily to the fund's large bets on a small number of companies via TRS contracts with six large investment banks. One of the banks, Credit Suisse, incurred approximately $5.5 billion in losses following the fund's failure and formally announced its exit from the U.S. prime brokerage market on November 4, 2021 as a part of its restructuring plan.[14] Prior to this, Credit Suisse's total net notional exposure had amounted to approximately 11% of the total market.

However, prior to the dealer's complete market exit, Credit Suisse reduced its presence in swap intermediation immediately following the Archegos collapse and the resulting losses in the second quarter of 2021: Its gross notional in short (long) swaps fell by 82% (55%). The bank did not publicly announce its intention to the prime brokerage market until November 4th, 2021.[15]. However, there was no change in the bank's swap exposure around this date, and it completely exited the swap market in the fourth quarter of 2022, when its long and short swap notional went to zero. Figure 4 Panel (a) shows the evolution of Credit Suisse's swap exposure over time.

The bank's timeline for exit thus yields two distinct treatment dates: First, in the second quarter of 2021 when the bank exits most of its short swaps and more than half of its long swaps, and second, in the fourth quarter of 2022 when the bank entirely exits the market and its outstanding

[13] https://www.bloomberg.com/features/2024-bill-hwang-archegos-collapse-timeline/
[14] See Walker 2021; Credit Suisse 2021.
[15] Credit Suisse (2021)

swap notional falls to zero.

In March 2023, UBS, another Swiss investment bank, announced that it would acquire Credit Suisse, which was completed in June 2023. However, the combined entity did not recover the swap volume that Credit Suisse had lost in Q2 2021 and Q3 2022: Figure 4 Panel (b) shows UBS's swap exposure over time. The bank shows no sharp changes in its swap notional exposure around Credit Suisse's market exit. This consistency ensures that there was an effective market exit by a dealer and that the volume was not absorbed by the eventual acquirer bank. Figure A.2 in the Appendix displays the swap notional evolution of six other major investment banks (of these, Deutsche Bank, Goldman Sachs, Morgan Stanley, and Nomura were also counterparties to Archegos).

The natural experiment around Credit Suisse's exit from the market is similar to Di Maggio et al. (2017), who study the market for corporate bonds following the collapse of Lehman Brothers in 2007. Di Maggio et al. (2017), however, consider the intermediation chains in the bond market, whereas the focus of this paper is on the cost of swap trading.

To test whether Credit Suisse's market exit affected swap spreads, I identify reference assets (the "Treated" group) on which Credit Suisse had outstanding swaps in 2021Q1 and 2022Q3, i.e., the quarters preceding the large reductions in Credit Suisse's swap exposure. I then regress swap spreads on the $Treated_a$ indicator variable, which takes a value of one if the asset is treated, a post-treatment indicator variable, and the interaction of the two. The main coefficient of interest is that on the interaction term: The coefficient will show how swap spreads changed for the affected assets following a dealer's exit.

$$spread_{b,a,t} = \beta_1 \, Treated_a \times Post_t + \beta_2 \, Treated_a + \beta_3 \, Post_t + \alpha_b \tag{11}$$

Table 6 presents the results: Panels (a) and (b) show the study effects on treatment after 2021Q1 and 2022Q3, respectively. Specifications (1)-(2) show treatment effects for any asset in which Credit Suisse was active before the exit (after 2021Q1 and 2022Q3, respectively). Specifications (3)-(4) show effects for securities to which Credit Suisse had short exposure, and (5)-(6) for securities to which the bank had long exposure.

In Panel (a), short swap spreads increase by 33-35 basis points following Credit Suisse's exit. Notably, this result is consistent across specifications and holds whether the bank had net positive or net negative swap notional exposure to the asset. Long swaps, in contrast, do not experience a statistically significant change in spreads. This result suggests that the exit of a supplier from the market raises short swap spreads more than long spreads and that short spreads may be more reactive to competitive dynamics in the market. This difference is also consistent with the findings in Section 6.3, where short spreads were more reactive than long spreads to competition between dealers.

In Panel (b), which displays results for the analysis around Credit Suisse's final exit from prime brokerage after the third quarter of 2022, short swap spreads again increase, although the change is noticeably smaller than in Panel (a). This result is consistent with the bank having almost no short exposure at the time: Few traders may have been affected at this point. Long swap spreads, in contrast, now increase significantly, by approximately 5.2-5.6 basis points. The larger increase than in Panel (a) corresponds to the bank's complete exit from the market after the third quarter of 2022, as opposed to its partial exit in the second quarter of 2021.

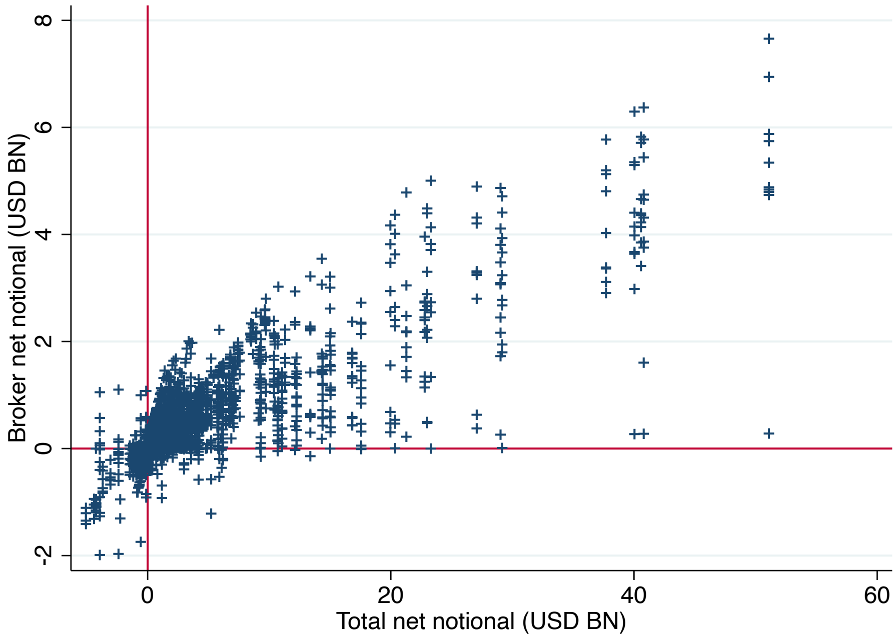
The results from the natural experiment align with and strengthen the findings earlier in Section 6.3: Swap spreads increase when competition between dealers decreases.

9 Conclusion

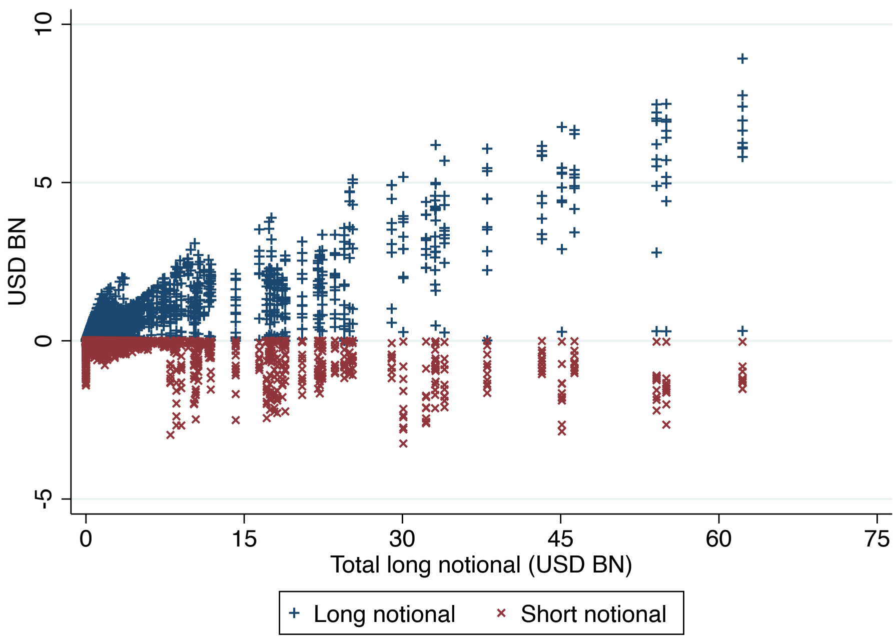
Over-the-counter markets are gaining increasing importance in institutional trading, whether in bonds, large block trades, or derivatives. It is therefore important to understand how broker-dealers price trades in and access into these markets and how competitive dynamics affect this pricing.

I answer these questions by examining the market for total return swaps. TRS contracts enable me to establish a baseline theoretical framework for pricing and hedging the derivatives. The theoretical framework yields four hypotheses, which I test empirically using novel regulatory data on swap trading by mutual funds. I show that swap spreads move in correspondence with dealers' hedging costs and that the main determinant of this cost varies with a dealer's net position in the swap. I find that swap dealers seek to fully hedge their exposure, either by internally matching trades in opposite directions or by trading the swap reference asset. I also find that dealers entice hedging trades by offering lower swap spreads and that swap spreads – especially for short swaps – generally decrease with increasing competition between dealers. Finally, I confirm the earlier findings using a natural experiment in which a dealer exits the market after experiencing large losses due to the collapse of a large leveraged trader.

The empirical results I find in the setting of total return swaps are likely to generalize to other over-the-counter markets: These markets are defined by traders engaging with broker-dealers and facing high opacity on pricing across brokers and time. Traders should internalize their broker-dealers' cost of trading and negotiate fees and spreads that correspond more closely with the competitive level.



Panel (a): Dealer net notional and total market net notional



Panel (b): Dealer notional and total market long notional

Figure 1: Dealer notional vs. Total notional

This figure plots the notional swap exposure of dealers against market total notional. Panel (a) illustrates dealers' total net notional on an asset against the market total net notional. Panel (b) illustrates dealers' long and short notional exposures against the market total long notional exposure.

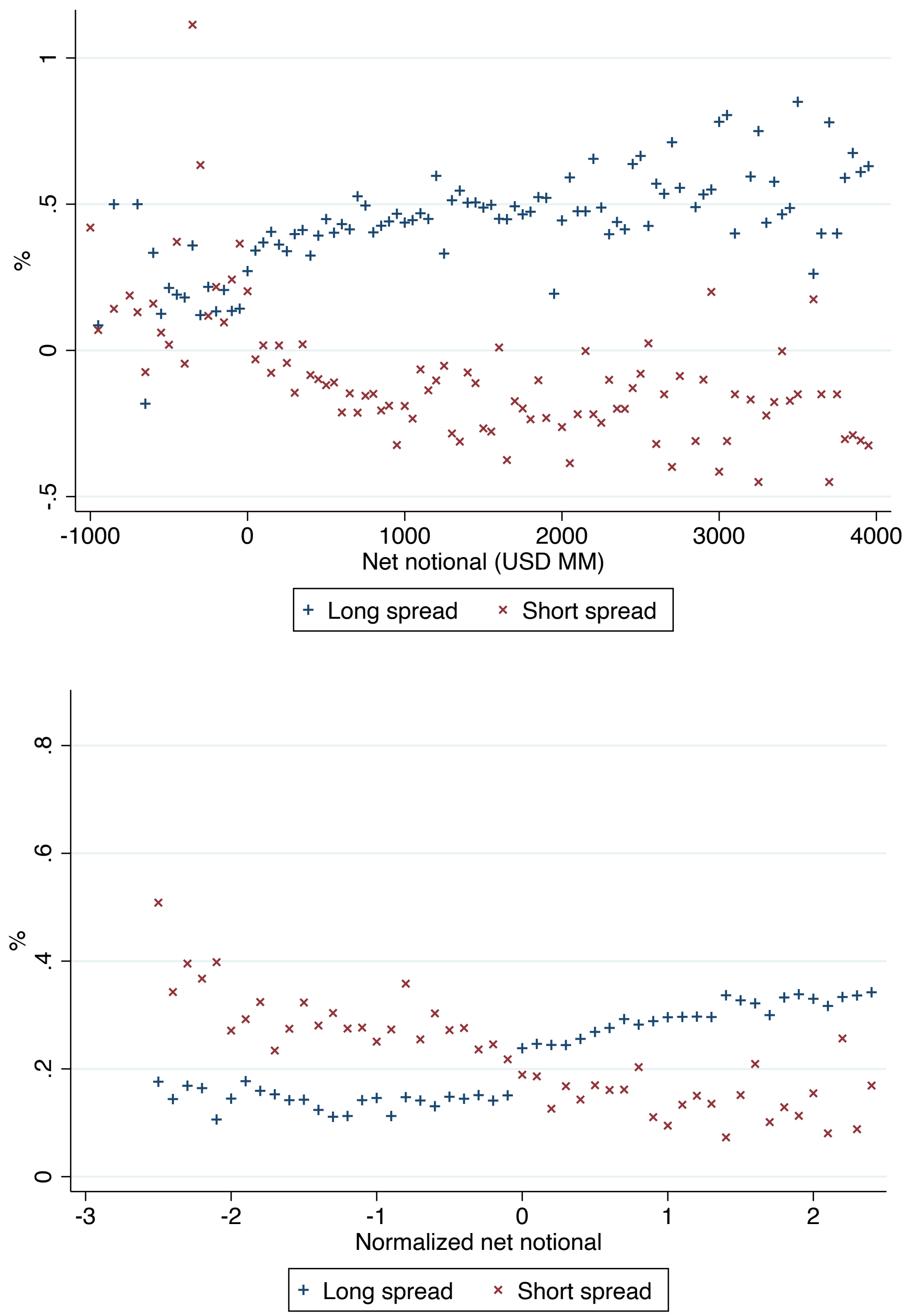


Figure 2: Swap spreads and net notional exposure

This figure plots the swap spreads as a function of the dealer's net notional on the underlying security or asset. Dealers' net notional exposure against an asset is normalized by dividing by the standard deviation of the net notionals of all dealers active in the asset. This figure is truncated at -2.5 and 2.5 standard deviations from 0 for clarity. Figure A.1 displays the all data.

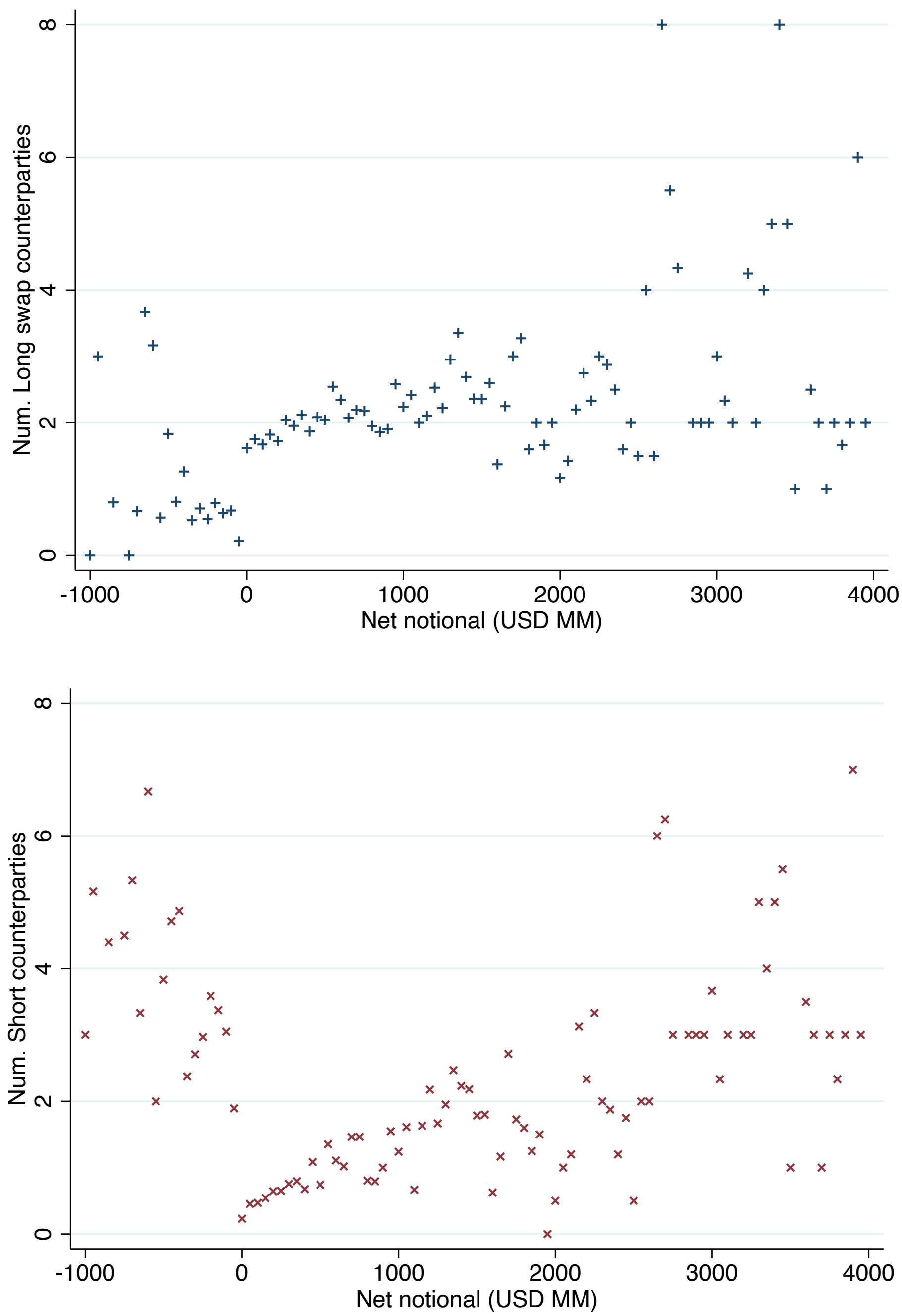
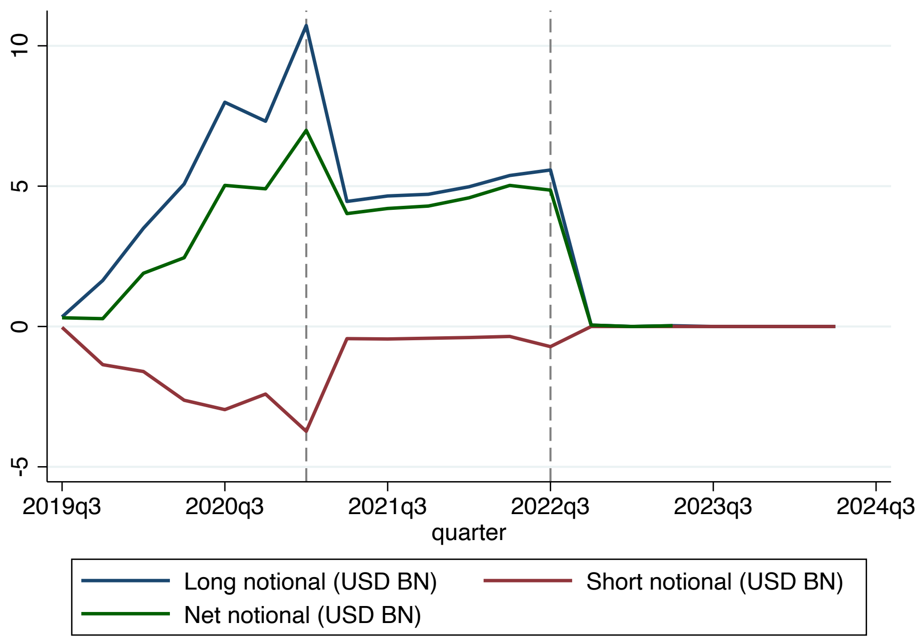


Figure 3: Number of swap counterparties as a function of notional exposure

This figure plots the number of swap counterparties for long (top panel) and short (bottom panel) swaps as a function of the net notional exposure of the dealer.

Panel (a): Credit Suisse



Panel (b): UBS

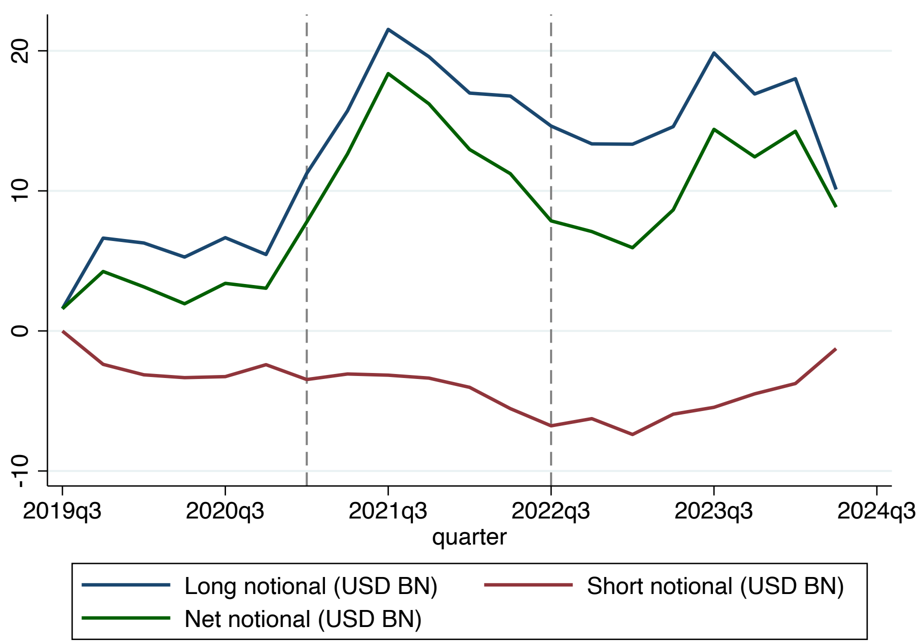


Figure 4: This figure plots the swap exposure of Credit Suisse and UBS against U.S. mutual funds.

Table 1: Descriptive statistics – Dealer-Asset

This table provides asset-level descriptive statistics for each dealer. Net notional is measured in million USD and reflects the total net notional of a dealer on a specific swap asset. Long (Short) notional is the total long (short) swap notional when it is non-zero. Num. Long (Short) swap transactions measures how many unique swap transactions the dealer has on a given asset on a given date. Long (Short) spread measures the spread the dealer charges on long (short) swaps.

Broker-asset level	mean	p10	p50	p90	sd
Net notional (USD MM)	17.27	-2.08	0.01	8.29	177.79
Long notional (USD MM)	42.05	0.01	0.39	32.91	287.06
Short notional (USD MM)	-14.21	-7.19	-0.42	-0.02	109.61
Num. Long swap trades	1.21	0.00	1.00	3.00	2.13
Num. Short swap trades	1.16	0.00	1.00	3.00	2.03
Long spread	0.27	0.00	0.25	0.65	0.33
Short spread	0.34	0.00	0.00	0.50	1.14
Observations	89510				

Table 2: Cost of financing vs short-selling cost

The table presents the results from regressing swap spreads on the dealer CDS spread and the short-selling cost of the reference asset. I include Dealer×Stock and Quarter fixed effects. t-statistics are in parentheses. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel (a): Low Herfindal-Hirschman Index

	$N_L > N_S$				$N_L < N_S$			
	(1) Long (bp)	(2) Short (bp)	(3) Long (bp)	(4) Short (bp)	(5) Long (bp)	(6) Short (bp)	(7) Long (bp)	(8) Short (bp)
CDS spread (bp)	0.248***	-0.066	0.194**	-0.110			0.066	-0.338**
	(3.84)	(-0.17)	(2.38)	(-0.38)			(0.12)	(-2.15)
Borrow fee (bp)			-0.002	0.258	-0.133*	0.103**	-0.133*	0.103**
			(-0.66)	(0.83)	(-1.91)	(2.24)	(-1.83)	(2.24)
Dealer × Stock	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Quarter	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	6410	2168	2173	267	260	3834	260	3832
Adjusted R^2	0.656	0.487	0.908	0.698	0.689	0.794	0.687	0.792

Panel (b): High Herfindahl-Hirschman Index

	$N_L > N_S$				$N_L < N_S$			
	(1) Long (bp)	(2) Short (bp)	(3) Long (bp)	(4) Short (bp)	(5) Long (bp)	(6) Short (bp)	(7) Long (bp)	(8) Short (bp)
CDS spread (bp)	0.013	0.451**	0.070	0.119			0.317	-0.299**
	(0.21)	(2.08)	(1.02)	(0.38)			(0.80)	(-2.00)
Borrow fee (bp)			0.002	0.060	0.274*	0.025**	0.274*	0.026**
			(1.20)	(0.34)	(1.84)	(2.51)	(1.84)	(2.56)
Dealer × Stock	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Quarter	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	11748	1423	4674	621	918	8409	918	8363
Adjusted R^2	0.742	0.604	0.875	0.633	0.550	0.841	0.549	0.812

Table 3: Dealer competition

This table regresses the transaction level swap spread on the number of dealers present (Panel (a)) and the Herfindahl-Hirschman index (Panel (b)) in the swap market for a particular asset. Columns (1)-(2) look at the unconditional effect. Columns (3)-(4) look at the spreads when the dealer has a positive net notional exposure, and Columns (5)-(6) examine the effects when the dealer's net notional exposure is negative. t-statistics are in parentheses. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel (a)

	All trades		$N_L > N_S$		$N_L < N_S$	
	(1)	(2)	(3)	(4)	(5)	(6)
	Short (bp)	Long (bp)	Short (bp)	Long (bp)	Short (bp)	Long (bp)
Num. brokers	-6.161***	0.649***	0.493	0.310*	1.769***	-1.554***
	(-30.85)	(9.09)	(0.77)	(1.65)	(4.13)	(-3.77)
Stock	No	No	Yes	Yes	Yes	Yes
Broker	No	No	Yes	Yes	Yes	Yes
Observations	50137	53716	8118	45855	40244	5277
Adjusted R^2	0.009	0.001	0.337	0.684	0.701	0.384

Panel (b)

	All trades		$N_L > N_S$		$N_L < N_S$	
	(1)	(2)	(3)	(4)	(5)	(6)
	Short (bp)	Long (bp)	Short (bp)	Long (bp)	Short (bp)	Long (bp)
HHI	41.371***	-1.817***	1.741	-3.096***	-0.212	1.130
	(23.66)	(-3.43)	(0.43)	(-4.15)	(-0.12)	(0.72)
Stock	No	No	Yes	Yes	Yes	Yes
Broker	No	No	Yes	Yes	Yes	Yes
Observations	50137	53716	8118	45855	40244	5277

Table 4: New client trades

This table regresses the transaction-level swap spread on a dummy variable that identifies new swap trades for a dealer within an asset. Columns (1) and (2) regress short and long swap spreads, respectively, only on the *newtrade* indicator variable, and Columns (3) and (4) include the *Hedge* indicator variable and its interaction with the *newtrade* variable. t-statistics are in parentheses. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)
	Short (bp)	Long (bp)	Short (bp)	Long (bp)
New trade	0.784	7.362***	2.188	9.122**
	(0.47)	(2.58)	(1.03)	(2.57)
Hedge			-2.100	-325.569
			(-0.26)	(-1.08)
New trade × Hedge			-6.287**	-7.824**
			(-2.57)	(-2.21)
Broker × Asset × Quarter	Yes	Yes	Yes	Yes
Observations	65645	52326	65645	52326
Adjusted R^2	0.696	0.462	0.696	0.464

Table 5: Dealers' hedging

This table presents the results from regressing changes in dealers' 13F holdings of stocks on changes in their net swap exposure to the stocks. Long and short spreads are measured in basis points. New trade is an indicator variable that takes the value of one for new counterparties within a dealer-asset pair, compared to the previous quarter. Hedge is an indicator variable that takes the value of one when a trade is in the opposite direction of a dealer's net exposure. t-statistics are in parentheses. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)
	13f hold change	13f hold change	13f hold change	13f hold change
Notional shares change	0.701**	0.699**	0.700**	0.752**
	(2.49)	(2.55)	(2.47)	(2.57)
Quarter	No	Yes	Yes	Yes
Broker	No	No	Yes	Yes
Stock	No	No	No	Yes
Observations	20091	20091	20091	19704
Adjusted R^2	0.001	0.005	0.006	-0.020

Table 6: Natural experiment: Credit Suisse market exit

This table presents results from a natural experiment in which Credit Suisse exited the swaps market. The treatment variables identify securities in which Credit Suisse was active in 2021Q1 (panel (a)) and 2022Q3 (panel (b)). Specifications (1)-(2) show treatment effects for securities in which Credit Suisse was active from 2021Q1 to 2022Q3. Specifications (3)-(4) show treatment effects for those to which Credit Suisse had short exposure to, and Specifications (5)-(6) show effects for securities to which Credit Suisse had long exposure. t-statistics are in parentheses. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel (a): Treatment after 2021Q1

	All trades		Short trades		Long trades	
	(1)	(2)	(3)	(4)	(5)	(6)
	Long (bp)	Short (bp)	Long (bp)	Short (bp)	Long (bp)	Short (bp)
Treatment × Post	0.365	34.912***	0.123	35.438***	0.864	33.611***
	(0.36)	(16.77)	(0.11)	(16.81)	(0.84)	(15.79)
Treatment	4.720***	-30.827***	3.388***	-30.541***	4.976***	-29.773***
	(5.32)	(-21.78)	(3.77)	(-21.51)	(5.57)	(-20.28)
Post	5.382***	-25.942***	5.534***	-25.964***	5.335***	-25.738***
	(19.47)	(-20.45)	(20.18)	(-20.50)	(19.32)	(-20.37)
Broker	Yes	Yes	Yes	Yes	Yes	Yes
Observations	55592	51942	55592	51942	55592	51942
Adjusted R^2	0.076	0.052	0.075	0.052	0.076	0.052

Panel (b): Treatment after 2022Q3

	All trades		Short trades		Long trades	
	(1)	(2)	(3)	(4)	(5)	(6)
	Long (bp)	Short (bp)	Long (bp)	Short (bp)	Long (bp)	Short (bp)
Treatment × Post	1.800	21.126***	5.195*	10.556***	5.600***	13.738***
	(1.32)	(6.47)	(1.80)	(3.89)	(3.58)	(5.59)
Treatment	9.804***	-23.475***	5.177*	-42.265***	6.645***	-24.984***
	(10.88)	(-14.35)	(1.94)	(-17.94)	(4.78)	(-15.03)
Post	3.285***	-22.526***	3.441***	-21.536***	3.278***	-21.851***
	(10.01)	(-24.40)	(10.76)	(-23.98)	(10.23)	(-24.28)
Broker	Yes	Yes	Yes	Yes	Yes	Yes
Observations	55592	51942	55592	51942	55592	51942
Adjusted R^2	0.074	0.048	0.071	0.048	0.074	0.048

References

Armstrong, Robert, "Archegos debacle reveals hidden risk of banks' lucrative swaps business," *Financial Times*, Apr 2021.

Arora, Navneet, Priyank Gandhi, and Francis A. Longstaff, "Counterparty credit risk and the credit default swap market," *Journal of Financial Economics*, 2012, *103* (2), 280–293.

CFTC, "CFTC Charges Archegos Capital Management and Three Employees with Scheme to Defraud Resulting in Swap Counterparty Losses Over $10 Billion," *CFTC Press release 8520-22*, Apr 2022.

Collin-Dufresne, Pierre and Bruno Solnik, "On the Term Structure of Default Premia in the Swap and LIBOR Markets," *The Journal of Finance*, 2001, *56* (3), 1095–1115.

Cooper, Ian A. and Antonio S. Mello, "The Default Risk of Swaps," *The Journal of Finance*, 1991, *46* (2), 597–620.

Credit Suisse, "Credit Suisse announces its Group strategy with a clear focus on strengthening, simplifying and investing for growth," *Credit Suisse – UBS media release*, Nov. 4, 2021.

Di Maggio, Marco, Amir Kermani, and Zhaogang Song, "The value of trading relations in turbulent times," *Journal of Financial Economics*, 2017, *124* (2), 266–284.

Duffie, Darrell and Ming Huang, "Swap Rates and Credit Quality," *The Journal of Finance*, 1996, *51* (3), 921–949.

Engelberg, Joseph E., Adam V. Reed, and Matthew C. Ringgenberg, "Short-Selling Risk," *The Journal of Finance*, 2018, *73* (2), 755–786.

Goodman, Laurie S. and Frank J. Fabozzi, "CMBS Total Return Swaps," *Journal of Portfolio Management*, 2005, *Sept. 2005*, 162–167.

He, Hua, "Modeling Term Structures of Swap Spreads," *Yale School of Management Working Paper*, 2000, *00-16.*

Jermann, Urban, "Negative Swap Spreads and Limited Arbitrage," *The Review of Financial Studies*, 03 2019, *33* (1), 212–238.

Johannes, Michael and Suresh Sundaresan, "The Impact of Collateralization on Swap Rates," *The Journal of Finance*, 2007, *62* (1), 383–410.

Klingler, Sven and Suresh Sundaresan, "An Explanation of Negative Swap Spreads: Demand for Duration from Underfunded Pension Plans," *The Journal of Finance*, 2019, *LXXIV* (2), 675–710.

Liu, Jun, Francis A. Longstaff, and Ravit E. Mandell, "The Market Price of Risk in Interest Rate Swaps: The Roles of Default and Liquidity Risks," *The Journal of Business*, 2006, *79* (5), 2337–2359.

Lou, Wujiang, "Pricing Total Return Swaps," *The Journal of Derivatives*, 2023, *30* (3), 66–83.

Osler, Carol, Geir Bjonnes, and Neophytos Kathitziotis, "Bid-Ask Spreads in OTC Markets," *Brandeis International Business School Working Paper*, 2016.

Pütz, Achim and SJ Berwin, "The Case of Volkswagen," *The Hedge Fund Journal*, November 2008, *42.*

Saltmarsh, Matthew, "Continental accepts offer from Schaeffler," *The New York Times*, Aug 2008.

Solomon, Steven Davidoff, "Anticlimax in Long-Running CSX Railroad Court Case," *The New York Times*, July 2011.

Sun, Tong-sheng, Suresh Sundaresan, and Ching Wang, "Interest rate swaps: An empirical investigation," *Journal of Financial Economics*, 1993, *34* (1), 77–99.

Tuckman, Bruce and Angel Serrat, *Fixed income securities: Tools for today's markets*, John Wiley & Sons, Inc, 2022.

Walker, Owen, "Credit Suisse takes axe to prime broking after multibillion-dollar losses," *The Financial Times*, November 2021.

Appendix

A Figures

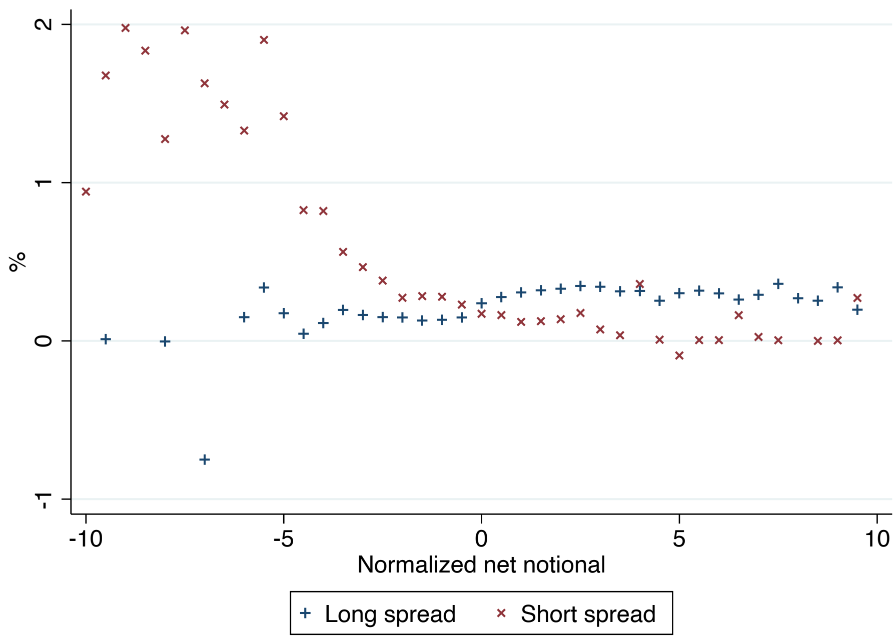


Figure A.1: Swap spreads and net notional exposure

This figure plots the swap spreads as a function of the dealer's net notional on the underlying security or asset. Dealers' net notional exposure against an asset is normalized by dividing by the standard deviation of the net notionals of all dealers active in the asset.

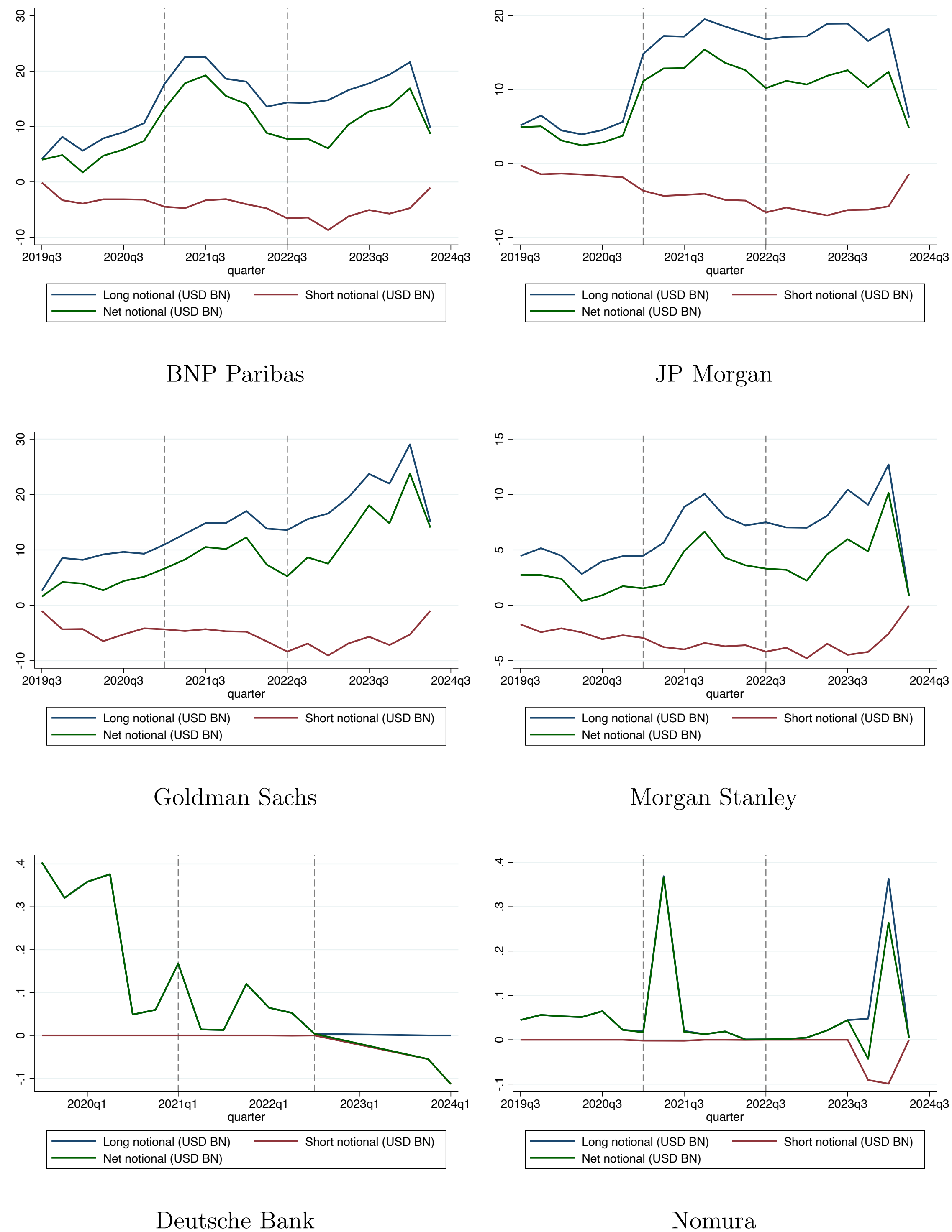


Figure A.2: Swap exposure of major prime brokers

This figure plots the swap exposure of the largest counterparties – in addition to UBS and Credit Suisse, whose swap exposure is shown in Figure 4 – against U.S. mutual funds. Deutsche Bank, Goldman Sachs, Morgan Stanley, and Nomura were also counterparties to Archegos.