Bank of Japan Working Paper Series

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No.24-E-11
September 2024

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Pricing Implications of Centrality in an OTC Derivative Market: An Empirical Analysis Using Transaction-Level CDS Data*

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September 2024

Abstract

Using transaction-level records making up the universe of single-name credit default swap (CDS) contracts in Japan, we document whether and how the relative centrality of sellers to buyers, which proxies for their search ability and thus bargaining power, affects single-name CDS prices. Our main findings are as follows. First, our panel estimation, which comprehensively controls for the standard pricing factors considered in practice (e.g., entities' risk, counterparty risk, the notional amount, and maturity), suggests that CDS prices are higher the higher the relative centrality of sellers to buyers. Second, such centrality premium becomes more apparent under unfavorable market conditions and further increases when buyers attempt to unwind their short positions. Given the non-negligible quantitative impacts of relative centrality on CDS prices, we find that CDS prices to a large extent are determined by the bargaining power originating from the ability to search for counterparties. Third, deeper trade relations between sellers and buyers result in a centrality discount when market conditions are unfavorable and a centrality premium when market conditions are favorable. This result suggests that there is a tradeoff between the cost of maintaining relationship in periods of favorable market conditions and the benefit of securing cheaper access to CDSs in periods of unfavorable market conditions.

Keywords: Credit default swaps, centrality, bargaining power, search and matching frictions

JEL classification: G12, G15, G18, G20, G28.

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* The authors thank Kenji Fujita, Tomoyuki Iida, Takuji Kawamoto, Tomonori Kimata, Tomiyuki Kitamura, Jouchi Nakajima, Iichiro Uesugi, Yoshihiko Sugihara and seminar participants at the Japanese Economic Association Spring 2024 Meeting, the 32nd meeting of the Special Interest Group on Financial Informatics of the Japanese Society for Artificial Intelligence, Kwansei Gakuin-Waseda Banking and Finance Workshop, Tohoku University and Waseda University for their valuable comments and discussions. The authors gratefully acknowledge the provision of data from Japan's Financial Services Agency. Any errors in this paper are those of the authors themselves. Additionally, the views expressed herein are those of the authors and do not necessarily reflect the official views of the Bank of Japan.

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1. Introduction

Many transactions in financial markets take place in over-the-counter (OTC) markets and are usually negotiated bilaterally, resulting in price heterogeneity. This price heterogeneity in OTC financial markets is rooted in the nature of bilateral transactions between sellers and buyers. Specifically, in OTC financial markets, there is heterogeneity in participating parties' ability to find a counterparty to trade with, and such heterogeneity in search ability results in heterogeneity in market participants' bargaining power (Duffie et al. 2005). As a consequence of this heterogeneity in bargaining power, prices in OTC financial markets even for the same product tend to be heterogeneous. Such price heterogeneity is unlikely to be observed in transparent financial markets, such as markets for stocks and sovereign bonds, where the transactions are centralized and thus quickly executed through, for example, electronic platforms.

Among the various OTC financial markets, such as the foreign exchange (FX), corporate bond, securitized asset, and interbank lending OTC markets, a market that has been receiving a great deal of attention from both a practical and a policy perspective is the OTC derivatives market. Given that the lack of price transparency in OTC derivatives markets in the 2000s resulted in speculative trades with insufficient risk hedging, leading to a catastrophic market breakdown, financial authorities in major countries have been working on the reform of OTC derivatives markets over the last decade and a half (OECD 2009, FSB 2010, 2022).

Despite these efforts to improve OTC derivatives markets, however, a number of recent empirical studies using highly granular data have shown that OTC derivative markets continue to be characterized by sizable price heterogeneity (see, e.g., Cenedese et al. 2020 for the interest rate swap market and Hau et al. 2021 for the FX derivatives market). Therefore, understanding how price heterogeneity arises remains an important research topic to enable policy makers to design effective measures to achieve transparent markets (Miyakawa et al. 2023). In the present paper, we follow this strand of the recent empirical literature and, focusing on the credit default swap (CDS) market in Japan, show that the source of price heterogeneity is market participants' relative bargaining power due to heterogeneity in their search ability for counterparties. The aim of the empirical analyses presented in this paper is to contribute to the active discussions toward the further development of OTC markets.

The determination of prices in OTC derivative markets has been modeled in a series of theoretical studies, starting with Duffie et al. (2005). The main ingredient of the models in these theoretical studies is individual parties and the bargaining power they hold and search friction they face. Parties are categorized into two different groups based on their trading motive, i.e., whether they want to buy or sell derivatives. Based on their motive, individual parties look for counterparties, incurring costs linked to the duration of their search. On the one hand, parties want to find a counterparty and settle their transactions as quickly as possible. On the other hand, they also want to find a counterparty that offers favorable terms. Such a trade-off between the need to settle as soon as possible and to find a counterparty that offers favorable terms presents a dynamic optimization problem with regard to how long to search for a counterparty. Aggregating the results of parties' individual dynamic optimization problems based on a specific bargaining structure with regard to prices (such as Nash bargaining), the theoretical models provide the equilibrium price as a function of parties' relative bargaining power, which is rooted in the search friction they face. The higher the search friction faced by buyers in comparison with the friction faced by sellers, the higher the equilibrium price. This is because it is more expensive for buyers to look for another counterparty (which can be interpreted as a lower outside option) than for sellers, reducing buyers' bargaining power vis-à-vis sellers. This implies that, in theory, CDS prices are determined by parties' relative bargaining power, which in turn is based on their search ability.

Despite the simple prediction of these theoretical considerations, testing it empirically has not been straightforward. The main reason is that the highly granular data necessary for such empirical analysis, such as transaction-level records including identifiers of buyers and sellers and accounting for the universe of derivative contracts in the OTC derivatives market, used to be unavailable to researchers. Given such data constraints, the majority of extant studies employ aggregate data to examine for the presence of price heterogeneity (e.g., Mallick 2004; Cereda et al. 2022). In the present paper, we take advantage of granular data on OTC derivative markets in Japan, which has recently become available thanks to the efforts of regulatory authorities, to examine whether and how price heterogeneity in the CDS market is driven by parties' bargaining power.

The single-name CDS market in Japan presents an ideal setting for this empirical analysis. First, the market consists of a large number of transactions between a fairly large number of sellers and buyers. (Specifically, during our observation period, there were on average 381.02 transactions among 16.41 unique buyers and 20.39 unique sellers per month.) Such a large number of observations makes it possible to conduct reliable empirical analyses. Second, as we will carefully explain in a later section, the degree of heterogeneity in terms of bargaining power in the Japanese single-name CDS market is high. This is due to the core-periphery structure of the Japanese single-name CDS market. The large variation in bargaining power generated by this network structure makes our empirical estimation feasible. Third, as reported in previous extant studies (e.g., Eisfeldt et al. 2023), "new connections in the CDS market are rarely formed and existing connections are rarely broken" (footnote 8 on p. 622). The lack of flexibility in the network structure allows us to treat the observed network structure in the most recent period as given and interpret the estimated results as causal.

To proxy for parties' search ability-based bargaining power as a key determinant of CDS prices, we focus on the centrality measures used in the recent literature (e.g., Hau et al. 2021; Hasbrouck and Levich 2021). Specifically, we employ the "relative" centrality of sellers to buyers, which is calculated, for example, as the ratio of the degree centrality of a seller to that of a buyer. In addition to this local centrality measure, we also employ a global centrality measure (namely, eigenvector centrality) to check the robustness of our empirical results.

An important feature of our analysis is that we further take the following factors into account that determine the extent to which relative centrality affects prices: (i) whether market conditions are unfavorable or favorable; and (ii) the type of trade relationship between the seller and buyer. Given that prior studies (e.g., Di Maggio et al. 2017; Gabrieli and Georg 2017; Hollifield et al. 2017; Li and Schürhoff 2019) have produced mixed results with regard to the impact of centrality on prices, we take these factors into account to gain clearer insight into the relationship between centrality and CDS prices.

Regarding how market conditions potentially determine the degree to which relative centrality affects prices, at least two scenarios are conceivable. On the one hand, if sellers' centrality is high, sellers' search friction decreases because of many potential counterparties. Lower search frictions (i.e., lower transaction costs) would allow sellers to offer lower CDS prices. On the other hand, if sellers' centrality is higher than that of buyers and sellers use their stronger bargaining power, sellers' high centrality may result in higher prices or what is called the "centrality premium" in the literature. This might be further aggravated when buyers of protection are desperate to uncover short positions (i.e., buy back borrowed securities) as such positions make losses under unfavorable market conditions and could result in margin calls.

In addition, the higher centrality of sellers relative to buyers could result in lower or in higher prices when sellers and buyers have already established a close relationship. That is, prices could be lower if close relationships reduce trading costs, while they could be higher if relying on established relationships results in switching costs, making buyers captive (Kim et al. 2003; Cocco et al. 2009; Hendershott et al. 2020). Thus, centrality potentially has a variety of effects and the implications for prices may depend on a range of factors.

In this paper, we examine the role of centrality in determining prices using transaction-level CDS data for the period from April 2013 to December 2021. Our empirical analysis consists of panel estimations in which we regress CDS prices on the relative centrality measure. In the regressions, we control not only for observable characteristics such as the maturity and notional amounts of CDSs using both linear and non-linear specifications (by including the squares of these variables), but also for unobservable factors such as time-variant reference entity fixed effects, seller fixed effects, and buyer fixed effects. Controlling for these unobservable time-variant factors, which subsume, for example, the credit risk of each party and the referenced assets as well as macro factors, is essential to identify the price effects of relative centrality. Fortunately, our transaction-level data including identifiers of buyers and sellers allows us to control for these factors.

Our empirical results can be summarized as follows. First, on average, CDS prices are higher the higher the relative centrality of sellers to buyers. This means that higher centrality of a seller (relative to a buyer) results in a centrality premium, which is in line with preceding studies. Quantitatively, our results show that an increase in the ratio of the centrality of a seller to that of a buyer (referred to as the "seller-buyer centrality ratio" hereafter) by one standard deviation in our dataset is associated with a non-negligible increase in CDS prices of 35bps, which corresponds to 35% of the standard deviation of CDS prices in our data. Another indicator of the importance of relative centrality as a determinant of CDS prices is that around

70% of the standard deviation of predicted CDS prices based on our model can be explained by relative centrality. These back-of-the-envelope calculations suggest that relative centrality plays a substantial role in determining CDS prices.

Second, this centrality premium is more pronounced during phases when the iTraxx Japan, an indicator of overall credit risk in Japan and a proxy for the market conditions, is high. This result provides an important detail regarding the impact of centrality on CDS prices. On one hand, higher centrality of a seller does not greatly affect CDS prices during favorable market periods when the iTraxx Japan is at low or moderate levels. This finding is somewhat different from the simple conjecture that higher centrality leads to lower search friction and hence lower CDS prices (i.e., a centrality discount). Instead, our results imply that, at least in our dataset, such benefit is not sizable. Presumably, the reduction in search friction and CDS prices is offset by the effect of sellers' bargaining power on CDS prices. On the other hand, under unfavorable market conditions when the iTraxx Japan is at high level, higher seller centrality leads to higher CDS prices. This suggests that when buyers find it relatively difficult to find counterparties offering a reasonable price, which is typically the case if market conditions are unfavorable but buyers are still eager to buy protection, sellers with higher centrality could exploit their bargaining power to charge a premium. Note that the results for unfavorable market conditions do not necessarily mean that sellers with a high centrality cannot leverage their greater search ability to find counterparties. Instead, our results suggest that the pricing impact of bargaining power resulting from greater relative centrality dominates the impact of the greater search ability of sellers with higher centrality.

An important additional finding to this second result is that the centrality premium paid by buyers with lower centrality to sellers with higher centrality becomes more pronounced when buyers attempt to unwind short positions under unfavorable market conditions. This result implies that sellers with higher relative centrality than buyers tend to charge buyers that are "desperate" – for example, due to margin calls – higher prices under unfavorable market conditions. Interestingly, these mechanisms are absent in a favorable market environment where buyers are not desperate and/or can easily find counterparties offering reasonable prices, so that sellers do not have the opportunity to take advantage of their higher relative centrality.

Third, the centrality premium under unfavorable market conditions is smaller when sellers and buyers have established transaction relationships. Defining relationships in terms of the notional amount and number of transactions, we tested whether relationships were strong in terms of both of these criteria or one of them. We find that when a relationship was strong in terms of one of the criteria, the centrality premium under unfavorable market conditions was lower than would have otherwise been the case. Furthermore, when a relationship was strong in terms of both criteria, the centrality premium under unfavorable market conditions in fact was zero. One subtle but important additional detail regarding this result is that when buyers have established a strong relationship with sellers in terms of both criteria, they pay a centrality premium under favorable market conditions. These results suggest that there is a tradeoff between the cost of maintaining relationships in favorable periods and the benefit of securing access to relatively cheap CDSs in unfavorable periods. Given that, on average, higher centrality of sellers to buyers means higher prices (i.e., there is a centrality premium), we conjecture that a certain number of less central buyers refrain from maintaining relationships and thus could ultimately face higher CDS prices during periods of stress.

The contributions of our paper are at least threefold. First, the present study is the first to show the existence of an (unconditional) centrality premium in the CDS market. Given that such a centrality premium has been reported for other OTC financial markets such as the corporate bond (Di Maggio et al. 2017), interbank lending (Gabrieli and Georg 2017), municipal bond (Li and Schürhoff 2019), and FX derivatives (Hasbrouck and Levich 2021) markets, the existence of a centrality premium in the CDS market per se is not necessarily surprising. Nonetheless, our empirical results are still informative for practitioners and policy makers to understand the market structure for one of the most important OTC derivatives. Moreover, it is also informative that even after the introduction of various regulatory reforms after the 2008-2009 global financial crisis such a centrality premium still exists. This result is useful in considering how financial regulators can support the further development of the CDS market in Japan and other OTC markets.

Second, the present study is the first to show that the impact of centrality on prices depends on market conditions. That is, the relative centrality of sellers to buyers is not necessarily critical when market conditions are favorable and buyers can find counterparties easily but leads to higher CDS prices under unfavorable market conditions – a finding that is quite intuitive. Our results therefore mean that financial authorities should keep an eye on the transaction network in the CDS market, since the impact of centrality on prices may be exacerbated under unfavorable market conditions.

Third, we obtain a finding that is novel to the empirical literature on the price implications of established transaction relationships. Studies in this field, such as Hau et al. (2021), have reported that relationships potentially have unfavorable effects. Specifically, Hau et al. (2021) empirically show that stronger relationships lead to higher prices when buyers are not sophisticated. They interpret this result as evidence that such buyers are captive in such relationships. Hau et al. (2021) also report that even the most sophisticated buyers still end up paying a seller centrality premium, which can be interpreted as the cost of obtaining access to business with powerful counterparties. Our empirical results, complementing the results of Hau et al. (2021), show that there is a nuanced mechanism in which buyers maintaining a strong relationship with sellers pay a premium during favorable periods so that they can mitigate the centrality premium during unfavorable periods. Our result implies that buyers consider such a dynamic tradeoff between favorable and unfavorable periods, which is a new finding in the literature.

The abovementioned empirical results have several practical implications. First, as already mentioned, it is beneficial for financial authorities to understand the pricing implications of the network structure. Second, it is also important for market participants to understand the dynamic tradeoff between the cost of maintaining relationships in favorable periods and benefit of access to relatively cheap insurance in unfavorable periods so as to optimize their hedging strategy.

The remainder of the paper is organized as follows. Section 2 offers a brief review of the related literature. Section 3 then provides an overview of the theoretical underpinnings for our empirical study, while Section 4 outlines the institutional setting of the Japanese CDS market. Sections 5 and 6 then present our empirical strategy and the data used for the estimation, while Section 7 presents the empirical results and discusses their implications. Further, Section 8 provides various robustness checks of the empirical results. Finally, Section 9 summarizes the results and highlights avenues for future research.

2. Related Literature

This section provides a brief review of the literature related to our study. We start with a quick overview of theoretical studies. The key building block of those theoretical studies is search friction, which manifests itself in the form of parties' bargaining power. We outline studies highlighting that search friction and bargaining power are closely related to parties' centrality in transaction networks and then move on empirical studies focusing on the role of search friction and bargaining power in a wide range of OTC financial markets. Finally, we review some recent studies using highly granular data and paying specific attention to the centrality of individual parties to empirically examine the price implications of search friction and bargaining power.

The most widely used theoretical framework for modeling OTC financial markets is that developed in a series of studies starting with Duffie et al. (2005, 2012). The key element of this framework is frictions that impede an immediate matching with a counterparty. Also modeled in this framework is that the seller of the traded asset incurs costs associated with the transaction and attempts to pass on the costs to buyers. These factors impeding smooth transactions are then modeled as the absence of an outside option (Duffie et al. 2005, 2007), lower network centrality (Li and Schürhoff 2019), a lack of expertise in such transactions (Glode et al. 2012), or asymmetric information (Bolton et al. 2016).

To test the empirical implications of these theoretical discussions, subsequent studies have used proxies for factors underlying frictions that hinder smooth transactions and have examined their pricing implications. As a convenient and plausible proxy for search friction and bargaining power, recent studies employ the centrality of individual parties in the transaction network and examine the association between centrality and price (e.g., Hau et al. 2021; Hasbrouck and Levich 2021).

Despite this reasonable empirical strategy, these studies obtain mixed results regarding the association between transaction prices and the centrality of parties in OTC financial markets. While many studies (e.g., Di Maggio et al. 2017; Gabrieli and Georg 2017; Li and Schürhoff 2019) find a positive association between prices and centrality (i.e., a centrality premium), other studies, such as Hollifield et al. (2017), arrive at the opposite empirical finding (i.e., a centrality discount). In this sense, the empirical link between the centrality of transacting parties and the price of traded assets remains an important subject of empirical research.

Regarding the OTC derivative markets, Cenedese et al. (2020) report that dealers selling interest rate swaps tend to charge their non-dealer customers high prices while non-dealer customers selling interest rate swaps to dealers are charging low prices. Since dealers presumably have greater search ability and hence greater bargaining power, Cenedese et al.'s (2020) results suggest that there is a centrality premium. As for the currency swap market, Hasbrouck and Levich (2020) report that parties with higher centrality in the transaction network enjoy better price conditions. In a similar vein, Hau et al. (2021) report that dealers in FX swaps tend to offer discriminatorily high price to unsophisticated buyers.

The present study follows these strands of literature that empirically examine price formation in OTC financial markets while paying special attention to the centrality of each player as a proxy for search friction and hence bargaining power. As we detail in the following section, our study takes a similar approach to that of Hasbrouck and Levich (2020) and uses the relative degree of centrality of sellers and buyers. One important difference from the abovementioned studies is that we are interested not only in the unconditional association between centrality and prices but also in how this association is conditional on the market environment and transaction relationships. Such a detailed analysis of the price implications of centrality allows us to elicit the exact pricing mechanisms in OTC financial markets.

3. Theoretical Underpinnings

This section provides a brief description of CDSs, the asset class we focus on in our study, and an overview of the theoretical background of our empirical study by briefly sketching the model by Duffie (2012) on which our own estimation model is based.

CDSs are a type of derivative that provides quasi-insurance against the default of an individual business enterprise (i.e., a single-name CDS) or the government of a country (i.e., a sovereign CDS). The business enterprise, government, or other legal entity that has issued the debt that is the subject of a CDS is referred to as the reference entity. Each CDS transaction consists of a seller and a buyer of protection for a specific reference entity. In terms of pricing, the buyer is obliged to pay a premium, which is calculated by multiplying the pre-determined coupon rate by the notional amount. In the case that the reference entity defaults before the debt matures, the buyer stops paying the premium, while the seller pays an amount equivalent to the amount of principal to the buyer.

To give a theoretical illustration, assume an investor wants to hedge its exposure to a reference entity's default risk. Unlike in standard well-functioning financial markets such as the stock or sovereign bond market, it takes time to find a seller of protection who offers a reasonable price. Specifically, the prospective CDS buyer faces the following two difficulties. First, it may take time to find a counterparty simply because there is no centralized market with, for example, a standardized auction mechanism. Thus, the CDS buyer faces search and matching frictions. Second, even if the prospective CDS buyer manages to communicate with a potential seller of protection, the sellers might offer price with premium. This highlights that bargaining power plays a significant role in such transactions.

Regarding offered prices, recent studies have shown for various markets that prices are heterogeneous (e.g., Cenedese et al. 2020 for interest rate swaps; Hasbrouck and Levich 2020, Hau et al. 2021 for currency swaps). The main message of these studies is that offered prices differ even after standard factors potentially determining the prices of assets such as their maturity, the notional amount, the riskiness of the referenced assets, and counterparty risk are controlled for. These studies report that there is a link between sellers' and buyers' characteristics and price levels, meaning that the mechanism featured in, for example, Duffie (2012) matters in practice.

As we explain in the following section, we proxy for search and matching frictions and bargaining power using the centrality measure for each party, without making a distinction between frictions and bargaining power. This reflects our notion that these two are closely interrelated. Suppose parties have access to a technology (such as an electronic communication system) that speeds up the search for potential counterparties. Simply using that system, the parties can quickly search for another transaction opportunity, so that they do not have to make large concessions and never agree to inferior transaction conditions. The use of this technology reduces the frictions in the search and matching of the parties, while at the same time increasing their bargaining power. This illustration shows that our approach to not distinguish between search/matching frictions and bargaining power is justified.

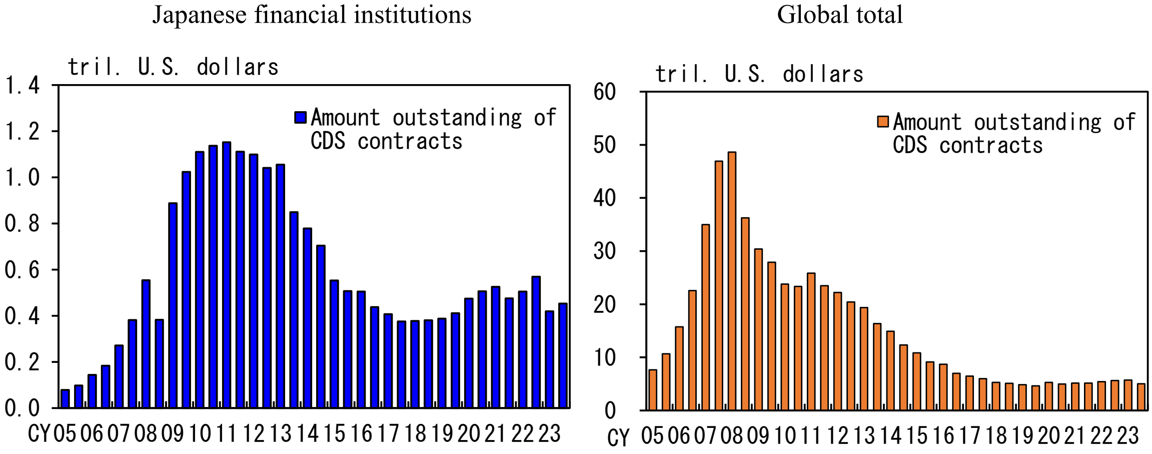
4. Institutional Background

Before presenting our empirical strategy and the data we use for our empirical analysis, we briefly outline some institutional features of the Japanese CDS market.

Let us start with the size of the CDS market in Japan. Figure 1 presents developments in the amount outstanding of CDS contracts (in trillion USD) since 2005. As of December 2023, the data on the amount outstanding covers 16 financial institutions located in Japan and is collected by Bank of Japan (BoJ) and reported to the Bank for International Settlements (BIS).

The figure shows that the outstanding amount of CDS contracts increased until 2008 both in Japan and globally. In Japan, after a dip in the second half of 2008, the amount continued to increase until 2011, while globally the total amount followed a downward trend until the end of 2010s. These diverging trends may reflect that between 2008 and 2011 Japanese financial institutions made efforts to expand their business through mergers and acquisitions and replaced U.S. and European financial institutions in the CDS market (Yoshizaki et al. 2017). Anecdotal evidence from market participants suggests that the reason for the decline in the outstanding amount of CDS contracts since 2011 is the changes in the global financial regulatory framework implemented in the wake of the global financial crisis.

Figure 1: Notional amount outstanding of CDS contracts



Notes: Figures as of the end of June and the end of December are shown.

Further, let us look at developments in credit risk in Japan as indicated by the CDS market. To this end, Figure 2 shows developments in the iTraxx Japan, an index of CDS prices for highly liquid Japanese companies. The value of the index rises when the credit risk of the reference entities, i.e., companies, worsens, and vice versa. As an additional implication, an increase in this value implies a situation in which the appetite for credit risk, or risk at large, is receding. Figure 2 shows that the credit risk of Japanese companies rose sharply at the beginning of the COVID-19 pandemic in early 2020 and then fell again.

Next, let us turn to the structure of the transaction network in the Japanese CDS market. This is presented in Figure 3, which depicts the network structure of single-name CDS transactions using data that we explain in the following section. As can be seen, the network is characterized by a core and periphery structure. In the figure, circles denote buyers and sellers of CDSs, while the lines represent transactions between a specific buyer-seller pair. Although transactions are directional in nature, the figure for simplicity abstracts from this and shows transactions simply as lines.

In Figure 3, which covers the entire observation period, the numbers of unique sellers and buyers are 104 and 54, respectively. Of these, 49 participate in transactions as both seller and buyer. Furthermore, in this figure, the 20-30 parties at the center of the network are major banks, Japanese securities companies, foreign securities companies, and trust companies. Moreover, of these, 5-6 parties are connected to the peripheral players as hubs. These central players are mostly Japanese securities firms (based in Japan). The edges from these 5-6 central players are linked to parties in various industries such as banks, life insurance companies, and business corporations. There are also links connecting the central players to overseas securities firms and overseas business corporations.

Figure 2: Developments in the iTraxx Japan

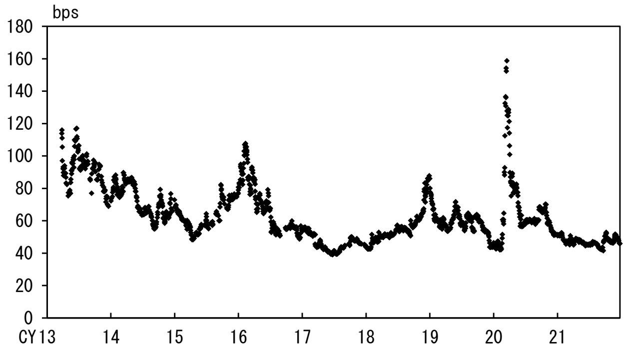
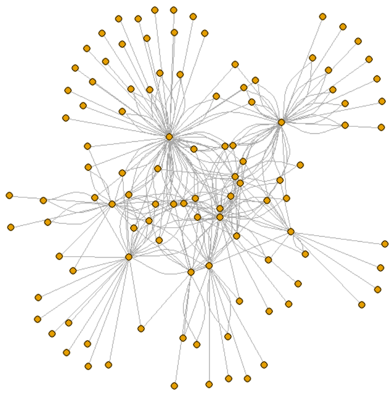


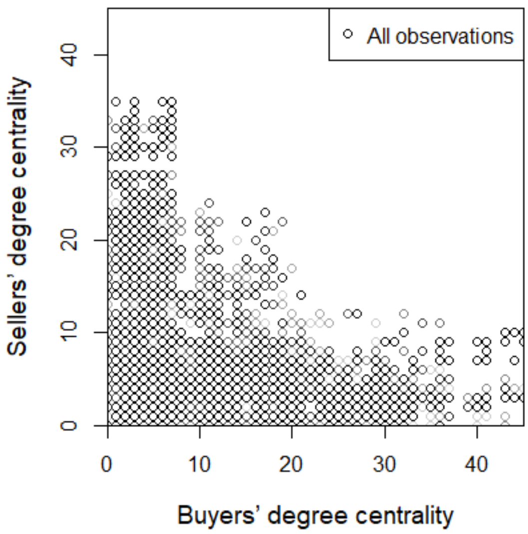
Figure 3: Transaction network of the CDS market in Japan



Notes: The figure shows the transaction network of the CDS market in Japan (full sample). Each yellow circle represents a buyer/seller and each link represents a transactions or transactions between them. The more counterparties a party has, the more centered in the network it is depicted. The figure illustrates that the transaction network has a core-periphery structure.

Finally, Figure 4 sketches the matching pattern in the Japanese CDS market. The figure shows buyers' degree centrality on the horizontal axis and sellers' degree centrality on the vertical axis. Each dot represents a particular buyer-seller combination. For example, a dot with a seller degree centrality of 10 and a buyer degree centrality of 1 represents transactions between sellers with 10 connections and buyers with only one connection. Darker dots represent a larger number of transactions, while lighter dots mean that the number of transactions is relatively small. The figure indicates that assortativity in the matching is negative. That is, buyers with high degree centrality tend to be connected with sellers with low degree centrality and vice versa.

Figure 4: Assortativity of degree centrality in the CDS market



Note: This figure shows buyers' degree centrality on the horizontal axis and sellers' degree centrality on the vertical axis. Each dot represents a particular buyer-seller combination. Darker dots represent a larger number of transactions, while lighter dots mean that the number of transactions is relatively small.

To summarize, over the last two decades, the Japanese CDS market experienced substantial changes in terms of the amount outstanding of contracts and prices under a rigid core-periphery structure consisting of various matching patterns in terms of assortativity.

5. Empirical Strategy

This section presents our empirical strategy to examine the pricing implications of parties' centrality. We employ the following estimation equation for our benchmark estimation to understand the unconditional association between CDS prices and the relative centrality of parties:

$$CDS\ Price_{b,s,k,i,t} = \alpha + \beta \cdot \frac{Link_{s,t}}{Link_{b,t}} + \gamma_1 \cdot Maturity_{i,t} + \gamma_2 \cdot Maturity_{i,t}^2$$
$$+ \delta_1 \cdot Notional_{i,t} + \delta_2 \cdot Notional_{i,t}^2 + Fixed\ effects + \varepsilon_{i,t} \qquad (1)$$

In this equation, $CDS\ Price_{b,s,k,i,t}$ represents the premium paid by buyer b to seller s of reference entity k in month t. Given that there may be multiple transaction on a specific date, we also denote each transaction by i as an identifier.[4] The key variable in the equation is $(Link_{s,t}/Link_{b,t})$, consisting of

[4] Strictly speaking, since this index i is sufficient to identify a specific transaction, the other indexes (b, s, k, t) are in fact redundant. Nonetheless, we incorporate these indexes in the estimation equation to avoid confusion regarding the

$Link_{s,t}$ and $Link_{b,t}$, which represent the degree centrality of seller s and buyer b, respectively. The degree centrality measure is the number of edges (i.e., links) each player has. We measure the number of edges taking their direction into account. Specifically, the degree centrality of buyer b is the number of edges buyer b has as a buyer in period t. Similarly, the degree centrality of seller s is the number of edges seller s has as a seller in period t. We use the ratio of those two numbers, $Link_{s,t}/Link_{b,t}$, to indicate the relative centrality of seller s to buyer b in period t. $Maturity_{i,t}$ and $Notional_{i,t}$ represent basic characteristics of transaction i, and we include these variables and their squared terms as control variables.

To avoid various endogeneity issues related to this measure for parties' relative search ability and hence relative bargaining power, we measure local centrality over the three months preceding month t. We also include individual effects, which aim to capture high-dimensional unobservable individual effects to address potential omitted variable biases. As we attempt to identify the causal relationship running from $(Link_{s,t}/Link_{b,t})$ to $CDS\ Price_{b,s,k,i,t}$, it is necessary to control as much as possible for various potential confounding factors, most of which are used by market participants in practice to price CDSs, to ensure that our estimation satisfies the conditional independence assumption. Based on these considerations, we include a time-variant individual effect for reference entities, which we denote by $k \times t$. The inclusion of this time-variant reference entity individual effect takes care of the variation in the fundamental risk of reference assets in a specific month. In addition, we include time-variant individual effects for buyers, denoted by $b \times ym(t)$. Given that the number of observations is limited, we employ $ym(t)$ instead of t. The inclusion of this time-variant buyer individual effect takes care of variation in hedging demand across buyers in a particular month. Finally, we include time-variant individual effects for sellers, denoted by $s \times ym(t)$. The inclusion of this time-variant seller individual effect takes care of variation in sellers' counterparty risk in a particular month.

We estimate equation (1) for the entire observation period as well as subperiods when market conditions are favorable or unfavorable, which we define based on the level of the iTraxx.[5] Through this subperiod analysis, we explicitly examine how the price impact of relative centrality depends on market conditions.

To examine the impact of sellers' and buyers' relative centrality on prices in greater detail, we also estimate the following augmented equation:

$$CDS\ Price_{b,s,k,i,t} = \alpha + \beta \cdot \frac{Link_{s,t}}{Link_{b,t}} + \gamma_1 \cdot Unwind^{M}_{i,t} \cdot \frac{Link_{s,t}}{Link_{b,t}} + \gamma_2 \cdot Unwind^{C}_{i,t} \cdot \frac{Link_{s,t}}{Link_{b,t}}$$

definitions of the variables.

[5] A possible alternative measure for market conditions is a volatility index such as the VIX. As the credit risk measured by the iTraxx is closely related to such volatility indexes, we focus on the level of the iTraxx.

$$+ \delta_1 \cdot Unwind^M_{i,t} + \delta_2 \cdot Unwind^C_{i,t} + Control\ variables$$
$$+ Fixed\ effect + \varepsilon_{i,t} \tag{2}$$

In this equation, $Unwind^M_{i,t}$ denotes the amount of CDSs of reference entity k sold by buyer b and $Unwind^C_{i,t}$ denotes the frequency of such sales over the three-month period preceding month t. Including these variables on their own as well as their interaction terms with $(Link_{s,t}/Link_{b,t})$ allows us to examine whether and how the price impact of relative centrality changes when buyers need to unwind short positions. In practice, buyers may face inferior price conditions when there is a sudden change in prices and they are desperate to cover their short positions to avoid margin calls. Our interest lies in whether there is evidence of such "short squeezes" in our dataset. If there is, this would help us to understand under what circumstances the exertion of sellers' stronger relative bargaining power vis-à-vis buyers is more pronounced.[6] As highlighted by Schultz (2024), while there are relatively few empirical studies on short squeezes, he finds that more than two thirds of the excess return from short-selling is lost through short squeezes. It is therefore informative to empirically examine if there is evidence of short squeezes in the CDS market.

Further, to examine whether the impact of relative centrality depends on whether parties have an established transaction relationship, we estimate the following equation:

$$CDS\ Price_{b,s,k,i,t} = \alpha + \beta \cdot \frac{Link_{s,t}}{Link_{b,t}} + \gamma \cdot Relationship_{i,t} \cdot \frac{Link_{s,t}}{Link_{b,t}}$$
$$+ \delta \cdot Relationship_{i,t} + Control\ variables + Fixed\ effect + \varepsilon_{i,t} \tag{3}$$

Here, $Relationship_{i,t}$ is a dummy variable that takes a value of one if both the amount $(Rel^M_{i,t})$ and frequency $(Rel^C_{i,t})$ of past transactions between buyer b and seller s over the three-month period prior to month t are large. Alternatively, we define $Relationship_{i,t}$ as a dummy variable that takes a value of one if at least one of the two, i.e., the amount or the frequency of past transactions between buyer b and seller s over the three-month period prior to month t, is large. We include these variables both own their own and as an interaction term with $(Link_{s,t}/Link_{b,t})$ and examine whether and how the impact of relative centrality on prices changes when buyers and sellers had a close transaction relationship. Some studies, such as Cocco et al. (2009) and Hendershott et al. (2020), report that sustained relationships result in cheaper transaction costs, while other studies, such as Hau et al. (2021), find that, except for a few sophisticated parties, most parties in OTC markets pay a premium to counterparties with which they have

[6] Sellers' bargaining power originating from their greater search ability compared to buyers could have a positive impact on transaction prices even if sellers are not aware that there is strong demand for short cover from buyers. The reason is that in their desperation to get cover quickly, buyers might accept the first offer they receive and pay a high price even if they might be able to find a lower price from other sellers later. In the process of bargaining, sellers with higher centrality can negotiate the price with buyers and effectively exert their bargaining power.

a long transaction relationship. In other words, there is no *a priori* reason to expect closer relationships to result in higher or lower prices. Instead, the impact is purely an empirical question, which we aim to examine here.

6. Data

The data we use for our analysis is trade repository data (TR data) obtained from Japan's Financial Services Agency (FSA). To construct the data, the FSA asks all financial instruments clearing organizations, foreign financial instruments clearing organizations, financial instruments business operators, and registered financial institutions to report all of their derivative transactions. As detailed in Kawai et al. (2021) and Miyakawa et al. (2023), financial instruments business operators and registered financial institutions include business operators that conduct Type I Financial Instruments Business, all banks, Shoko Chukin Bank, Development Bank of Japan, the members of the Federation of Shinkin Banks operating nationwide, Norinchukin Bank, and insurance companies. This means that we can assume that our dataset covers the entire universe of CDS contracts involving at least one party located in Japan.

The TR data provides information on individual transactions reported to the FSA. Specifically, it contains (i) identifiers of the sellers and buyers of each CDS, (ii) the name of the reference asset, (iii) the price of the traded CDS, (iv) the notional amount of the traded CDS, (v) the date of the transaction, and (vi) the central counterparty (i.e., the central counterparty in bilateral transactions). In addition, the TR data provides other detailed information related to each transaction, such as whether an electronic ordering system was used. The FSA shares the TR data with the BOJ, and the data has been employed in some preceding empirical studies such as Miyakawa et al. (2023).

Given that the aim of this study is to examine the impact of parties' centrality on prices, we focus on single-name CDSs, which can be assumed to exhibit larger heterogeneity in terms of price dynamics and have lower liquidity. The original data file consists of trades observed during the period from April 1, 2013 to December 31, 2021. We clean the data in several steps. We start by excluding duplicate records of transactions. The reason why there are duplicate records is that both the seller and the buyer in a particular transaction report the transaction to the FSA. The number of transactions in our data after excluding duplicate records is 118,983. Of these, 9,547 are records reported by the Japan Securities Clearing Corporation (JSCC) that need to be linked to the corresponding transactions reported by the JSCC's counterparty. This matching process reduces the 9,547 records to 4,842 records, so that the total number of observations falls to 114,278.[7]

[7] Regarding the abovementioned reduction in the number of observations from 9,547 to 4,842, when there is one transaction between a buyer and a seller that is cleared by the JSCC, the transaction is reported by the JSCC as two transactions (one is between the buyer and the JSCC, and the other is between the JSCC and the seller). Therefore, we first checked whether the two transactions reported by the JSCC were the same. Specifically, we checked whether the transaction identification numbers were consecutive numbers (in many cases, they were in a contiguous row). If this

Next, regarding the price data, we follow the data cleaning process proposed by Loon and Zhong (2016). First, we omit 14,717 records without price information, which reduces the number of records to 99,561. Second, we drop records not cleared through the JSCC but reported as if they were, which reduces the number to 95,117 records. Third, following Loon and Zhong (2016), we drop all records reported with a round number such as 0, 0.01, and so on. Dropping such records reduces the number of observations to 45,505. The substantial reduction in the number of observations as a result of this step reflects the fact that a substantial share of the prices in the TR data may not be reliable. We therefore decide to focus on the more reliable part of the data by dropping price records with a round number. Fourth, we exclude transactions with foreign central counterparties and transactions in which the price type is reported as "upfront points," which leaves us with 40,007 records that we use for our analysis. We also winsorized the data, excluding observations that fall above or below two standard deviations from the mean.

Figure 5 depicts the network structure of the single-name CDS transactions in our dataset in periods of favorable and unfavorable market conditions. As mentioned in Section 4, the dots and lines represent participating parties and the transactions between those parties. Figure 5 indicates that in both favorable periods (defined as periods when the iTraxx Japan is below the sample median) and unfavorable periods (defined as periods when the iTraxx Japan is equal to or above the sample median), there are some parties at the center of the network and many at the periphery, as discussed in Section 4.

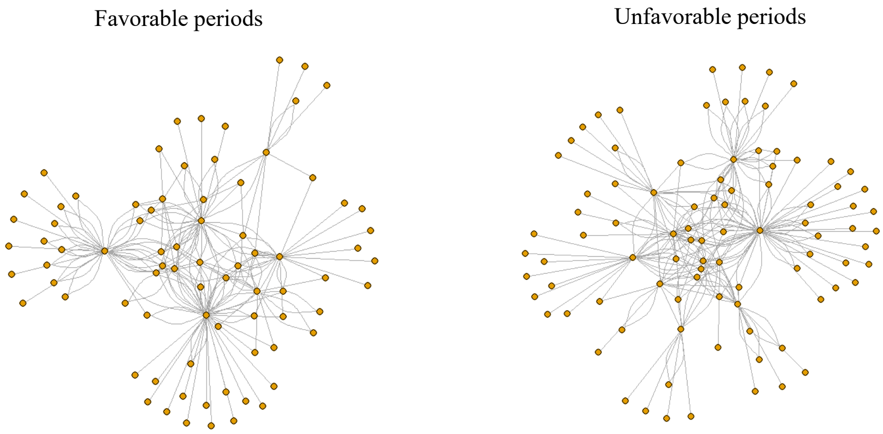
was the case, we further checked that all the details of the transactions were identical by checking (a) the benchmark date for the transaction, (b) the transaction date, (c) that starting date of the transaction, (d) the final date of the transaction, (e) the buyer and seller, (f) the reference entity, (g) the contract type, (h) the product classification, (i) whether the transaction was centrally cleared or not, (j) the price, (k) the way the price type was reported (e.g., in % or basis points), (l) the currency, (m) the notional amount, and (n) the maturity.

Table 1: Data cleaning of the TR data

	Reported CDS price (bps)	Number of observation	Total amount
Total		95,117	660,680
Excluded data	0	3,649	23,163
	0.01	11	81
	0.1	4	16
	0.25	134	1,187
	0.5	17	94
	1	20,668	125,938
	10	60	432
	100	21,617	150,915
	1,000	2	6
	10,000	26	923
	2.5	14	45
	25	363	2,632
	2,500	1	18
	5	1,121	5,307
	50	271	2,079
	500	1,650	8,598
	5,000	1	7
	50,000	3	48
Remaining data		45,505	339,191

Notes: This table illustrates how the reported CDS prices in the TR data include dubious numbers. According to Loon and Zhong (2016), if the reported number is round, such as "100" or "50," this usually is the result of the reporting party confusing spreads (which should be reported) and coupons (which should not be reported). We regard the numbers shown in the table (from "0" to "50,000") as misreported numbers and exclude these reports from our dataset.

Figure 5: Transaction network in Japan's CDS market during favorable and unfavorable periods



Notes: The figure shows the transaction network in Japan's CDS market (favorable periods in the left panel and unfavorable periods in the right panel). Favorable and unfavorable periods are defined based on the level of the iTraxx Japan. Each yellow circle represents a buyer/seller, while each link represents a transaction or transactions between them. The more counterparties a player has, the more centered in the network it is depicted. The figure indicates that in both favorable and unfavorable periods the network is characterized by a core-periphery structure.

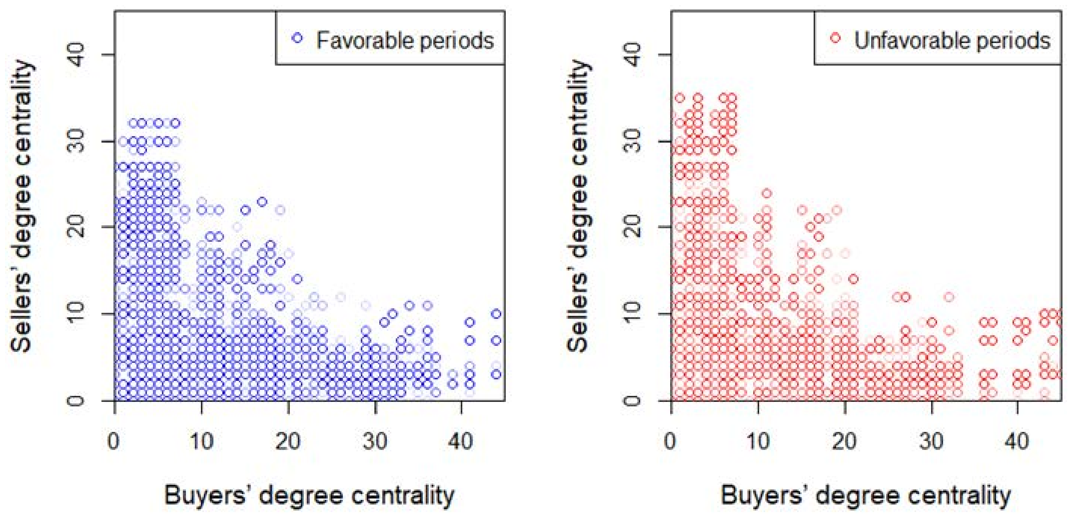
Next, Figure 6, which presents the assortativity of degree centrality for favorable and unfavorable periods, indicates the following. First, just like in Figure 4 for the observation period overall, we find that the matching is disassortative in both favorable and unfavorable periods. Sellers with higher centrality tend to be matched with counterparties with lower centrality and vice versa. Second, somewhat unexpectedly, the matching pattern in terms of the centrality of sellers and buyers is quite stable across market conditions. That is, we find a disassortative pattern regardless of the level of the iTraxx Japan. Given that in the next section we examine the impact of relative centrality on prices, this finding of a stable matching pattern is quite informative. Suppose that disassortativity became less pronounced under unfavorable market conditions. This would imply that buyers refrain from trading with sellers with higher centrality so as to, for example, avoid higher prices reflecting such sellers' greater bargaining power (e.g., Du et al. 2023). This, in turn, would mean that we would need to be careful in interpreting the estimation results of equation (1), since the estimate of β would be affected by buyers' decision not to trade with sellers with higher centrality. However, as seen in Figure 6, the degree of disassortativity is almost identical in favorable and unfavorable periods, so that our estimation results are unlikely to be greatly affected by the endogeneity of matching patterns under favorable and unfavorable market conditions.[8]

Table 2 shows summary statistics of the variables we use for our empirical analysis. *bp* denotes the price of a CDS that the seller of the CDS receives, measured in basis points. *Notional* denotes the notional amount of CDS transactions, which is measured in 100 million JPY.[9] *Maturity* denotes the difference between the starting point of each transaction (i.e., the effective date) and the end point (i.e., the scheduled termination date), measured in months. Fourth, *Link ratio* denotes $(Link_{s,t}/Link_{b,t})$. Fifth, *Seller degree centrality* and *Buyer degree centrality* denote the aforementioned degree centrality measures and take the direction of the transaction into account. Sixth, *iTraxx Japan* denotes the composite index of the creditworthiness of investment grade Japanese firms as of date t. When *iTraxx Japan* is not available for date t, we use that for $t-1$. Seventh, *Unwind (value)* and *Unwind (count)* denote the amount (in 100 million JPY) and number of transactions in CDSs for reference entity k between seller s and buyer b in the three months prior to t. Eighth, *Relation (value)* and *Relation (count)* denote the amount and number of transactions between buyer b and seller s in the three months prior to t, which we use to define $Relationship_{i,t}$. In our estimation, we set a specific threshold and convert these numbers to dummy variables.

[8] The assortativity coefficient is -0.581 in favorable periods and -0.510 in unfavorable periods.

[9] As a robustness check, we also employ the log value of the notional amount. However, the results remain qualitatively unchanged.

Figure 6: Assortativity of degree centrality in the CDS market in periods of favorable and unfavorable market conditions



Notes: This figure shows buyers' degree centrality on the horizontal axis and sellers' degree centrality on the vertical axis. Each dot represents a particular buyer-seller combination. Darker dots represent a larger number of transactions, while lighter dots mean that the number of transactions is relatively small. We divide the observation period into periods of favorable and unfavorable market conditions based on the level of the iTraxx Japan. We find no significant difference in the assortativity of degree centrality between the favorable and unfavorable periods.

Table 2: Summary statistics of the variables

Variable	N	Mean	Std. dev.	Min	25th percentile	75th percentile	Max
bp	40,007	130.967	98.567	15	60	176.125	537.136
Notional	40,007	6.996	9.054	0	2.5	8.039	221.72
Maturity	40,007	47.396	22.7	0	33	59	241
Link ratio	32,619	3.115	5.031	0	0.094	5	35
Seller degree centrality	33,533	10.067	9.506	0	3	15	35
Buyer degree centrality	33,533	14.53	12.549	0	3	26	45
iTraxx Japan	40,007	64.39	16.533	39.056	51.593	74.7	158.736
Unwind (value)	30,686	73.421	333.017	0	0	20.722	4409.288
Unwind (count)	30,686	6.488	24.094	0	0	4	330
Relation (value)	33,533	393.366	803.765	0	29.101	409.9	6423.39
Relation (count)	33,533	61.604	111.929	0	6	74	932

Notes: This table reports summary statistics of the main variables in our analysis. *bp* denotes the price of a CDS that the seller of the CDS receives, measured in basis points. *Notional* is the notional amount of CDS transactions, measured in 100 million JPY. *Maturity* refers to the number of months between the effective date and the maturity date of a CDS contract. *Link ratio* denotes $(Link_{s,t}/Link_{b,t})$. *Seller degree centrality* and *Buyer degree centrality* denote the degree centrality measures and take the direction of transactions into account. *iTraxx Japan* denotes the composite index of creditworthiness of investment grade Japanese firms as of date t. *Unwind (value)* and *Unwind (count)* denote the amount and number of transactions in CDSs for reference entity k between the seller and the buyer in the transaction (b, s, k, i, t) over the three months prior to t. *Relation (value)* and *Relation (count)* denote the amount and number of transactions between the seller and buyer in the transaction (b, s, k, i, t) over the three months prior to t, which we use to define $Relation_{i,t}$. In our estimation, we set a specific threshold and convert *Relation (value)* and *Relation (count)* to $Relationship_{i,t}$. The sample covers all CDS transactions by Japan-based counterparties during the period from April 1, 2013 to December 31, 2021.

7. Empirical Results

Before running the regressions based on the three equations introduced in the previous section, we show the results based on the specification employed in Hasbrouck and Levich (2021). Specifically, we regress the CDS price measured in basis points on six dummy variables representing different configurations of buyers' degree centrality and sellers' degree centrality. Following Hasbrouck and Levich (2021), we categorize buyers and sellers each into three groups based on their degree centrality using the following steps. First, for each month, we rank parties in ascending order based on their degree centrality. Second, we measure the monthly trading volume of each party. Third, we compute the cumulative trading volume of the parties. Fourth, we compute the cumulative trading volume of the parties until we reach 1/3 of the total trading volume in that month and classify the included parties as parties with the highest degree centrality. Similarly, we then compute the cumulative trading volume of the parties until a further 1/3 of the total volume is reached and classify the included parties as those with intermediate degree centrality. The remaining parties are those with the lowest degree centrality. Thus, for each month, we group parties into those with low, intermediate, and high degree centrality. In addition to the dummy variables, we include a number of control variables, namely, the maturity of the CDS contracts, the square of maturity, the notional amount, the square of the notional amount, and a dummy taking a value of one if the trade is cleared by a CCP. Further, we control for time-variant reference entity fixed effects. In the estimation, we regress *bp* on these variables and conduct separate regressions for favorable and unfavorable periods.

Table 3 shows the coefficient estimates. We find the following. First, under unfavorable market conditions, when a buyer with low centrality and a seller with high centrality transact with each other, CDS prices are around 9 bps higher than when parties with similar centrality (i.e., buyers and sellers with low centrality, buyers and sellers with intermediate centrality, or buyers and sellers with high centrality) transact with each other. This points to the presence of heterogeneity favoring sellers with high relative centrality vis-à-vis buyers. Second, although the coefficient is not significantly different from zero, under favorable market conditions, CDS prices are around 1bp higher when a buyer with low centrality transacts with a seller with high centrality. Third, under favorable market conditions, CDS prices are around 6 bps lower when a buyer with high centrality and a seller with low centrality transact with each other.

This exercise suggests that there is a positive association between the relative centrality of sellers vis-à-vis buyers and CDS prices. One drawback of this analysis is that standard factors such as sellers' and buyers' credit risk are not controlled for, so that it does not necessarily provide concrete evidence on the association between relative centrality and prices. To address this concern, as mentioned in Section 5, we control for a comprehensive set of fixed effects. We start with the estimation results for equation (1), which are shown in Table 4.

Table 3: Estimation results for the specification employed in Hasbrouck and Levich (2021)

(Panel A. All observations)

		Seller Centrality		
		Low	Middle	High
Buyer Centrality	Low	—	-11.27 (8.007)	7.983*** (2.713)
	Middle	-7.735 (6.150)	—	4.076** (1.747)
	High	-0.1961 (2.852)	2.131 (1.827)	—

		(Panel B. Favorable periods)			(Panel C. Unfavorable periods)		
		Seller Centrality			Seller Centrality		
		Low	Middle	High	Low	Middle	High
Buyer Centrality	Low	—	-16.24 (10.09)	1.251 (2.235)	—	3.825 (5.343)	9.457*** (3.280)
	Middle	-12.23 (7.467)	—	2.597* (1.558)	1.758 (10.13)	—	4.420* (2.425)
	High	-5.901** (2.408)	-0.7539 (1.566)	—	1.342 (3.667)	3.331 (2.541)	—

* p < 0.1, ** p < 0.05, *** p < 0.01
Figures in parentheses are the standard errors of the estimated coefficients.

Notes: This table reports the results of transaction-level panel regressions in which CDS prices are regressed on a dummy variable that takes a value of one for each group (low/middle/high centrality) of buyers and sellers, with control variables and time-reference entity fixed effects, following the specification in Hasbrouck and Levich (2021):

$$bp_{b,s,i,t} = \beta_1 1(High_b, Mid_s) + \beta_2 1(High_b, Low_s) + \beta_3 1(Mid_b, High_s) + \beta_4 1(Mid_b, Low_s) + \beta_5 1(Low_b, High_s) + \beta_6 1(Low_b, Mid_s) + \beta_7 CCP_{b,s,i,t} + X_{i,t}\gamma + \eta_{r,t} + \varepsilon_{i,t}$$

The observation period is from April 1, 2013 to December 31, 2021. Figures in parentheses are clustered standard errors clustered by time and reference entity. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. Statistically significant coefficients in the table show the association between relative centrality and CDS prices. For example, in Panel A, when a buyer in the low-centrality group trades with a seller in the high-centrality group, the partial regression coefficient associated with the case of sellers (high) and buyers (low) is 7.983, indicating a significant positive relationship between relative centrality and CDS prices.

The baseline estimation results suggest the following. First, the results in the column labeled "All observations" shows that there is a positive association between the seller-buyer centrality ratio and CDS prices. This result suggests that central sellers' greater bargaining power vis-à-vis less central buyers outweighs the technical advantage of sellers with higher centrality in searching for trading counterparts. Second, the column labeled "Favorable periods" indicates that there is no such pattern during periods when market conditions are favorable. This suggests that our theoretical prediction of a centrality discount in favorable period is not supported by our dataset. Third, the columns labeled "All observations" and "Unfavorable periods," show that the centrality premium in the period overall (7.049) is smaller than that in unfavorable periods (11.984). In general, it is more difficult for buyers to find counterparties in unfavorable market conditions than in favorable conditions. The baseline result implies that sellers with higher centrality may use their bargaining power and charge a premium when buyers still want to buy

Table 4: Baseline estimation results of equation (1)

	All observations	Favorable periods	Unfavorable periods
Link ratio	7.049**	2.592	11.984**
	(2.974)	(3.873)	(5.893)
Maturity	0.421*	0.381	0.399
	(0.216)	(0.420)	(0.253)
Maturity (squared)	0.002	0.001	0.003
	(0.002)	(0.003)	(0.002)
Notional principal	-0.103	0.339	-0.211
	(0.164)	(0.300)	(0.201)
Notional principal (squared)	-0.001	-0.003	-0.001
	(0.002)	(0.003)	(0.003)
CCP dummy	-2.091	-4.937	-2049.043
	(7.101)	(5.891)	(20878.592)
Observations	32,614	16,303	16,311
R^2	0.889	0.943	0.839
Fixed effects			
Reference × date	Yes	Yes	Yes
Seller× month/year	Yes	Yes	Yes
Buyer × month/year	Yes	Yes	Yes

* p < 0.1, ** p < 0.05, *** p < 0.01

Notes: This table reports the results of transaction-level panel regressions in which CDS prices are regressed on *Link ratio* and various control variables. All specifications include time-reference entity ID, time-seller ID, and time-buyer ID fixed effects. *Link ratio* denotes $(Link_{s,t}/Link_{b,t})$. The column "All observations" shows the results for all transactions. The columns "Favorable periods" and "Unfavorable period" show the results when observations are divided based on the level of the iTraxx Japan on the day when the transaction took place. The observation period is from April 1, 2013 to December 31, 2021. Figures in parentheses are clustered standard errors clustered by time and reference entity. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. The results show that there is a positive correlation between a high seller centrality relative to the buyer (a high seller-buyer centrality ratio) and prices, suggesting that sellers with higher centrality charge buyers with lower centrality a premium (i.e., we find evidence of a centrality premium).

protection in such a situation. Thus, the relative centrality between sellers and buyers manifests itself in higher prices under unfavorable market conditions. This result is consistent with the story that sellers with higher centrality take advantage of their bargaining power to set higher prices.[10]

Next, let us examine how quantitatively important relative centrality is in the determination of CDS prices. As a back-of-the-envelope calculation, suppose the ratio of sellers' centrality to buyers' centrality increases by one standard deviation. In this case, CDS prices increase by 35 bps, which is in fact not negligible, as it corresponds to 35% of the standard deviation in CDS prices in our data. To further illustrate the quantitative importance of relative centrality, we also take a look at the standard deviation of the predicted CDS prices obtained from our estimated model. For this exercise, we use the estimation results shown in the first column of Table 4 and the data of the independent variables so that we can predict the

[10] As a robustness check, we define favorable and unfavorable periods using the iTraxx Japan up to each data point instead of the median of the iTraxx Japan for the period overall. The idea is to rule out possible contamination through the use of "future" values of the iTraxx Japan. That is, when we judge whether market conditions on a specific date are favorable or unfavorable, we only use information up to that date and consider market conditions on that date to be favorable if the iTraxx Japan is higher than the median up to that date, and vice versa. However, our empirical results remain essentially unchanged. For details, see Section 8 and Appendix Table A7.

CDS prices for each transaction. We compute the standard deviation of the predicted prices (i.e., 56.4.). Then, using the same set of the estimated coefficients except for that associated with the link ratio, we repeat the same exercise and obtain the standard deviation of the predicted CDS price, which is 15.9. The difference between these two numbers for the standard deviation of predicted prices suggests that predicted prices become much more volatile once we take the relative centrality between sellers and buyers into account to predict CDS prices. Relative centrality accounts for around 70% (i.e., =(56.4-15.9)/56.4) of the standard deviation of predicted CDS prices based on our model. These exercises show that relative centrality plays a quantitatively important role in the determination of CDS prices.

Further, to examine under what circumstance the centrality premium we found becomes larger, we estimate equation (2). Table 5 shows the results. In this estimation, *Unwind (value)* and *Unwind (count)* denote the amount and number of times a buyer has sold CDSs of a particular reference entity of which the buyer is going to buy CDSs. In this sense, *Unwind (value)* and *Unwind (count)* proxy for the degree of short covering the buyer attempts to obtain.[11] We find the following. First, the estimated coefficient on the relative centrality measure (*Link ratio*) is positive and significant, and is larger in unfavorable periods than favorable periods, which is consistent with the results of our benchmark regression. Second, we find that the coefficient on the interaction term between the relative centrality measure and the amount of selling, *Unwind (value)*, is positive and weakly significant for unfavorable periods, suggesting that buyers trying to cover a short position are likely to face an additional centrality premium. As the standard deviation of *Unwind (value)* is 333, the marginal impact of the relative centrality measure increases by 333*0.012=3.996. This is sizable in comparison with the coefficient on the relative centrality measure (i.e., 13.335). Thus, buyers face considerably inferior price conditions when they try to cover a short position in unfavorable market conditions. This result fits the story that sellers with higher centrality take advantage of their bargaining power to set higher prices, particularly vis-à-vis "desperate" buyers looking to cover their short positions.

[11] In addition to using the gross short position to measure *Unwind*, we also use the short cover needs by calculating the net short position. The results are almost identical to those reported in the text.

Table 5: Estimation results for *Unwind*

	All observations	Favorable periods	Unfavorable periods
Link ratio	10.176***	7.334***	13.335**
	(2.464)	(2.369)	(6.201)
Unwind (value)	0.016	-0.025	0.027
	(0.021)	(0.023)	(0.026)
Link ratio × Unwind (value)	0.010*	-0.003	0.012*
	(0.006)	(0.006)	(0.007)
Unwind (count)	0.156	0.613	0.055
	(0.291)	(0.545)	(0.369)
Link ratio × Unwind (count)	-0.051	0.072	-0.079
	(0.079)	(0.109)	(0.095)
Maturity	0.478**	0.360	0.483*
	(0.222)	(0.428)	(0.261)
Maturity (squared)	0.002	0.002	0.002
	(0.002)	(0.003)	(0.002)
Notional principal	-0.104	0.359	-0.224
	(0.166)	(0.309)	(0.199)
Notional principal (squared)	-0.001	-0.003	-0.001
	(0.002)	(0.003)	(0.003)
CCP dummy	1.175	-5.307	-3359.007
	(7.557)	(5.942)	(20627.901)
Observations	30,084	15,041	15,043
R^2	0.883	0.937	0.832
Fixed effects			
Reference × date	Yes	Yes	Yes
Seller× month/year	Yes	Yes	Yes
Buyer × month/year	Yes	Yes	Yes

* p < 0.1, ** p < 0.05, *** p < 0.01

Notes: This table reports the results of transaction-level panel regressions in which CDS prices are regressed on *Link ratio* and various control variables. All specifications include time-reference entity ID, time-seller ID, and time-buyer ID fixed effects. *Link ratio* denotes $(Link_{s,t}/Link_{b,t})$. *Unwind (value)* and *Unwind (count)* denote the amount and number of times a buyer has sold CDSs of a particular reference entity of which the buyer is going to buy CDSs. The column "All observations" shows the results for all transactions. The columns "Favorable periods" and "Unfavorable period" show the results when observations are divided based on the level of the iTraxx Japan on the day when the transaction took place. The observation period is from April 1, 2013 to December 31, 2021. Figures in parentheses are clustered standard errors clustered by time and reference entity. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Table 6 shows the results for equation (3), which takes into account whether parties have an established transaction relationship. We define parties as having an established relationship when both $Rel_{i,t}^{M}$ and $Rel_{i,t}^{C}$ exceed a certain threshold. For our benchmark analysis, we use the 68 percentile points of $Rel_{i,t}^{M}$ and $Rel_{i,t}^{C}$, which correspond to the mean plus one standard deviation in the case of the normal distribution.

The results suggest that when the relationship is stronger in the sense that both the amount and frequency are large enough, the centrality premium observed in unfavorable periods disappears (i.e., 12.824bps – 12.673bps).

Table 6: Estimation results when both $Rel_{i,t}^{M}$ and $Rel_{i,t}^{C}$ exceed the threshold

	All observations	Favorable periods	Unfavorable periods
Link ratio	9.703*** (2.522)	6.247*** (1.829)	12.824** (6.116)
Relationship dummy	20.429* (12.380)	8.598 (15.435)	-29.997* (16.345)
Link ratio × Relationship dummy	6.424* (3.894)	7.113* (4.045)	-12.673** (5.573)
Maturity	0.420* (0.216)	0.378 (0.421)	0.399 (0.253)
Maturity (squared)	0.002 (0.002)	0.001 (0.003)	0.003 (0.002)
Notional principal	-0.103 (0.164)	0.340 (0.300)	-0.211 (0.201)
Notional principal (squared)	-0.001 (0.002)	-0.003 (0.003)	-0.001 (0.003)
CCP dummy	-2.093 (7.103)	-4.947 (5.894)	-2049.407 (20916.030)
Observations	32,614	16,303	16,311
R^2	0.889	0.943	0.839
Fixed effects			
Reference × date	Yes	Yes	Yes
Seller× month/year	Yes	Yes	Yes
Buyer × month/year	Yes	Yes	Yes

* p < 0.1, ** p < 0.05, *** p < 0.01

Notes: This table reports the results of transaction-level panel regressions in which CDS prices are regressed on *Link ratio* and various control variables. All specifications include time-reference entity ID, time-seller ID, and time-buyer ID fixed effects. *Link ratio* denotes $(Link_{s,t}/Link_{b,t})$. *Relationship dummy* is a dummy variable that takes a value of one if the amount and frequency of past transactions between buyer b and seller s over the three-month period prior to period t is large. The column "All observations" shows the results for all transactions. The columns "Favorable periods" and "Unfavorable period" show the results when observations are divided based on the level of the iTraxx Japan on the day when the transaction took place. The observation period is from April 1, 2013 to December 31, 2021. We report clustered standard errors (by time and reference entity) in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Next, Table 7 presents the results based on equation (3) where parties are regarded as having a relationship when either $Rel_{i,t}^{M}$ or $Rel_{i,t}^{C}$ is higher than the mean plus one standard deviation. Again, the centrality premium is completely offset in unfavorable periods when parties have established relationships (i.e., 12.987bps – 13.778bps).

Finally, we examine the role of relationships by focusing only on one of the variables, i.e., the dummy for the amount of past transactions or the dummy for the frequency of past transactions, to define whether parties have an established relationship. Consistent with the previous results, we find that regardless of whether relationships are defined in terms of the amount ($Rel_{i,t}^{M}$) or the frequency ($Rel_{i,t}^{C}$), buyers with a closer relationship with the seller enjoy lower CDS prices in unfavorable periods. Again, the relationship effect is large enough to cancel out the centrality premium. In addition, in the estimation in which relationships are defined in terms of the frequency of transactions ($Rel_{i,t}^{C}$), we obtain a weakly significant positive coefficient on the interaction term of the *Link ratio* and the *Relationship dummy* for favorable periods, suggesting that in favorable periods buyers pay a premium to maintain relationships.

Table 7: Estimation results when either $Rel_{i,t}^{M}$ or $Rel_{i,t}^{C}$ exceeds the threshold

	All observations	Favorable periods	Unfavorable periods
Link ratio	9.547***	7.425***	12.987**
	(2.504)	(1.944)	(6.151)
Relationship dummy	19.033	24.143	-33.723**
	(12.011)	(15.971)	(14.645)
Link ratio × Relationship dummy	6.274	5.503	-13.778***
	(3.872)	(4.054)	(5.107)
Maturity	0.420*	0.377	0.399
	(0.216)	(0.421)	(0.253)
Maturity (squared)	0.002	0.001	0.003
	(0.002)	(0.003)	(0.002)
Notional principal	-0.103	0.341	-0.211
	(0.164)	(0.300)	(0.201)
Notional principal (squared)	-0.001	-0.003	-0.001
	(0.002)	(0.003)	(0.003)
CCP dummy	-2.093	-4.955	-2039.985
	(7.103)	(5.892)	(20923.100)
Observations	32,614	16,303	16,311
R^2	0.889	0.943	0.839
Fixed effects			
Reference × date	Yes	Yes	Yes
Seller× month/year	Yes	Yes	Yes
Buyer × month/year	Yes	Yes	Yes

* p < 0.1, ** p < 0.05, *** p < 0.01

Notes: This table reports the results of transaction-level panel regressions in which CDS prices are regressed on *Link ratio* and various control variables. All specifications include time-reference entity ID, time-seller ID, and time-buyer ID fixed effects. *Link ratio* denotes $(Link_{s,t}/Link_{b,t})$. *Relationship dummy* is a dummy variable that takes a value of one if the amount and frequency of past transactions between buyer b and seller s over the three-month period prior to period t is large. The column "All observations" shows the results for all transactions. The columns "Favorable periods" and "Unfavorable period" show the results when observations are divided based on the level of the iTraxx Japan on the day when the transaction took place. The observation period is from April 1, 2013 to December 31, 2021. We report clustered standard errors (by time and reference entity) in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Table 8: Estimation results when only the transaction value or only the transaction frequency is included in the estimation of equation (3)

	(a) *Relationship dummy* is defied in terms of the value of transactions			(b) *Relationship dummy* is defied in terms of the frequency of transactions		
	All observations	Favorable periods	Unfavorable periods	All observations	Favorable periods	Unfavorable periods
Link ratio	9.702***	7.425***	12.824**	9.547***	6.247***	12.988**
	(2.522)	(1.945)	(6.116)	(2.504)	(1.829)	(6.151)
Relationship dummy	20.424*	24.143	-30.007*	19.039	8.599	-33.745*
	(12.380)	(15.971)	(16.347)	(12.011)	(15.430)	(14.643)
Link ratio × Relationship dummy	6.423*	5.503	-12.660**	6.276	7.116*	-13.785***
	(3.894)	(4.054)	(5.574)	(3.872)	(4.045)	(5.107)
Maturity	0.420*	0.377	0.399	0.420*	0.378	0.399
	(0.216)	(0.421)	(0.253)	(0.216)	(0.421)	(0.253)
Maturity (squared)	0.002	0.001	0.003	0.002	0.001	0.003
	(0.002)	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)
Notional principal	-0.103	0.341	-0.211	-0.103	0.340	-0.211
	(0.164)	(0.300)	(0.201)	(0.164)	(0.300)	(0.201)
Notional principal (squared)	-0.001	-0.003	-0.001	-0.001	-0.003	-0.001
	(0.002)	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)
CCP dummy	-2.093	-4.955	-2050.642	-2.093	-4.947	-2072.870
	(7.103)	(5.892)	(20916.033)	(7.103)	(5.894)	(20922.996)
Observations	32,614	16,303	16,311	32,614	16,303	16,311
R^2	0.889	0.943	0.839	0.889	0.943	0.839
Fixed effects						
Reference × date	Yes	Yes	Yes	Yes	Yes	Yes
Seller× month/year	Yes	Yes	Yes	Yes	Yes	Yes
Buyer × month/year	Yes	Yes	Yes	Yes	Yes	Yes

* p < 0.1, ** p < 0.05, *** p < 0.01

Notes. This table reports the results of transaction-level panel regressions in which CDS prices are regressed on *Link ratio* and various control variables. All specifications include time-reference entity ID, time-seller ID, and time-buyer ID fixed effects. *Link ratio* denotes $(Link_{s,t}/Link_{b,t})$. In the part labeled (a), *Relationship dummy* is a dummy variable that takes a value of one if the amount of past transactions between buyer b and seller s over the three-month period prior to period t is large. In the part labeled (b), *Relationship dummy* is a dummy variable that takes a value of one if the frequency of past transactions between buyer b and seller s over the three-month period prior to period t is large. In both panels, the column "All observations" shows the results for all transactions. The columns "Favorable periods" and "Unfavorable period" show the results when observations are divided based on the level of the iTraxx Japan on the day when the transaction took place. The observation period is from April 1, 2013 to December 31, 2021. Figures in parentheses are clustered standard errors clustered by time and reference entity. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

8. Robustness Checks

Finally, we present a number of checks to confirm the robustness of our empirical results. All the results are provided in the Appendix and we only briefly explain how we address various potential concerns regarding our empirical results.

First, a potential concern is the extent to which the reported results are sensitive to the choice of the centrality measure. To address this concern, we employ various alternative ways to measure relative centrality. (i) The first alternative we employ is to measure the ratio of sellers' and buyers' degree centrality over the six months preceding each transaction instead of three months. However, doing so leaves our results qualitatively unchanged (Table A1). (ii) Next, we drop transactions involving sellers that did not have any transactions over the preceding three months from the computation of the link ratio. Again, we find that the results are unchanged (Table A2). Note that in the baseline estimation, we drop transactions involving *buyers* that did not have any transactions over the preceding three months from the computation of the link ratio because this number needs to be used as the denominator of the link ratio. This robustness check aims to confirm that our results are unchanged even if we treat buyers and sellers in the same manner in this regard. (iii) Further, unlike in the baseline estimation, where we take the direction of transactions into account, we intentionally do not take the direction of the transaction into account but use the data as an undirected network, where ties have no direction, to compute the degree centrality and find that, again, the results remain qualitatively unchanged (Table A3). (iv) To extract the variation in the link ratio, which in our main specification may be the result of variation in the numerator (i.e., sellers' centrality) or variation in the denominator (i.e., buyers' centrality), or both, we focus on either (a) sellers with small centrality versus buyers with small or large centrality (Table A4 (A)) or (b) sellers with small or large centrality versus buyers with small centrality (Table A4 (B)).[12] We find that the obtained empirical results in both cases are consistent with the main results. (v) Instead of using local centrality (i.e., degree centrality), we employ eigenvector centrality as a global centrality measure. Again, we find that the results are unchanged (Table A5). (vi) Instead of using transaction frequencies, we use transaction amounts to measure parties' search ability. Once again, we obtain qualitatively the same results as in the baseline estimation (Table A6). (vii) When judging whether a specific date falls into a favorable or unfavorable period, we only use information up to the date of the transaction and classify the transaction as falling into a favorable or unfavorable period if the iTraxx Japan on the day is lower or higher than the median of the iTraxx Japan up to that day. This allows us to prevent any contamination from "future" values. In this case, too, the results remain qualitatively unchanged (Table A7).

Second, as further robustness checks, we conducted the following subsample analyses. (i) We limit the sample to transactions among domestic institutions in terms of nationality or geographic location (Table B1). (ii) We conduct subsample analyses for transactions that were cleared by a CCP and transactions that there were not (Table B2). (iii) We limit the sample to dealer-to-customer transactions (i.e., transactions where a dealer takes the role of seller while a non-dealer party takes the role of buyer, D2C) or to customer-to-dealer (C2D) transactions (Table B3). (iv) We limit observations to either inter- or intra-group transactions. Here, intra-group transactions refer transactions between the head office and overseas branches of a company or transactions between securities companies and banks belonging to a corporate group, while inter-group transactions are transactions not categorized as intra-group transactions (Table B4). (v) Further, we limit observations to seller-buyer pairs that had not been observed in the past (i.e., new transaction relationships) (Table B5). (vi) And finally, in order to exclude trading pairs with a limited number of transactions, we classify pairs based on the number of months they have been transacting with

[12] Note that cases where both the seller and the buyer have large centrality are rare in our data, as can be seen in Figures 4 and 6.

each other and limit the data to pairs of sellers and buyers that had transacted with each other for more than a certain number of months throughout the observation period (Table B6). Again, the results of these various robustness checks are in line with our baseline results.

9. Conclusion

In the present paper, we used transaction-level records of CDS contracts in Japan to examine whether and how the relative centrality of sellers to buyers affects CDS prices. Our panel estimations controlling for standard pricing factors employed in practice suggest that there is a positive association between CDS prices and the relative centrality of sellers to buyers. Such centrality premium is observed during periods of unfavorable market conditions, when credit risk was high and some party likely experienced a short squeeze. Interestingly, closer transaction relationships between sellers and buyers result in a centrality discount during unfavorable periods and a centrality premium during favorable periods. These results indicate that there is a tradeoff between the cost of maintaining a relationship in favorable periods and the benefit of securing cheap access to CDSs in unfavorable periods. Given that we observe a centrality premium under unfavorable market conditions, it is likely that peripheral buyers without established transaction relationships face higher CDS prices during periods of stress. Our findings suggest that it is helpful for financial authorities to know whether and to what extent there is asymmetry in buyers' and sellers' centrality in CDS and other derivative markets, since such asymmetry may lead to a surge in prices under unfavorable market conditions.

While our study adds novel findings to the literature, there are several avenues for future research. Specifically, one useful follow-up question to examine is how parties initiate and terminate transaction relationships. In the present paper, we focused on existing relationships between sellers and buyers and did not pay specific attention to the formation to new relationships, given that the network structure is rigid. Documenting the entry and exit of transaction relationships and examining the pricing implications represents a promising avenue for future research.

APPENDIX A

A1. Six months

	All observations	Favorable periods	Unfavorable periods
Link ratio	5.500	-3.979	16.001**
	(6.280)	(3.873)	(5.893)
Maturity	0.426**	0.384	0.402
	(0.216)	(0.420)	(0.253)
Maturity (squared)	0.002	0.001	0.003
	(0.002)	(0.003)	(0.002)
Notional principal	-0.091	0.338	-0.194
	(0.165)	(0.299)	(0.202)
Notional principal (squared)	-0.001	-0.003	-0.001
	(0.002)	(0.003)	(0.003)
CCP dummy	-2.154	-4.960	-1767.393
	(7.016)	(5.863)	(20878.592)
Observations	32,507	16,441	16,066
R^2	0.889	0.944	0.838
Fixed effects			
Reference × date	Yes	Yes	Yes
Seller× month/year	Yes	Yes	Yes
Buyer × month/year	Yes	Yes	Yes

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table reports the results of transaction-level panel regressions in which CDS prices are regressed on *Link ratio* and various control variables. All specifications include time-reference entity ID, time-seller ID, and time-buyer ID fixed effects. *Link ratio* denotes $(Link_{s,t}/Link_{b,t})$. While in the main specification links are calculated over a 3-month period, here, links are calculated over a 6-month period as a robustness check. The column "All observations" shows the results for all transactions. The columns "Favorable periods" and "Unfavorable period" show the results when observations are divided based on the level of the iTraxx Japan on the day when the transaction took place. The observation period is from April 1, 2013 to December 31, 2021. Figures in parentheses are clustered standard errors clustered by time and reference entity. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. We observe a centrality premium in unfavorable periods (i.e., the coefficient estimate for *Link ratio* is 16.001).

A2. Dropping transactions involving sellers without transactions over the preceding three months

	All observations	Favorable periods	Unfavorable periods
Link ratio	10.384*** (2.770)	4.963** (2.140)	14.729** (6.694)
Maturity	0.374* (0.227)	0.226 (0.458)	0.371 (0.264)
Maturity (squared)	0.003 (0.002)	0.003 (0.003)	0.003 (0.002)
Notional principal	-0.074 (0.166)	-0.446 (0.337)	-0.177 (0.197)
Notional principal (squared)	-0.001 (0.002)	-0.004 (0.003)	-0.001 (0.003)
CCP dummy	-2.323 (7.043)	-5.738 (6.105)	-3468.071 (20416.097)
Observations	30,815	15,157	15,658
R^2	0.899	0.943	0.841
Fixed effects			
Reference × date	Yes	Yes	Yes
Seller× month/year	Yes	Yes	Yes
Buyer × month/year	Yes	Yes	Yes

* p < 0.1, ** p < 0.05, *** p < 0.01

Notes. This table reports the results of transaction-level panel regressions in which CDS prices are regressed on *Link ratio* and various control variables. All specifications include time-reference entity ID, time-seller ID, and time-buyer ID fixed effects. *Link ratio* denotes $(Link_{s,t}/Link_{b,t})$. This table reports the results when we exclude not only transactions involving buyers with zero links but also sellers with zero links. The column "All observations" shows the results for all transactions. The columns "Favorable periods" and "Unfavorable period" show the results when observations are divided based on the level of the iTraxx Japan on the day when the transaction took place. The observation period is from April 1, 2013 to December 31, 2021. Figures in parentheses are clustered standard errors clustered by time and reference entity. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. We observe a centrality premium (i.e., the coefficient estimate for *Link ratio* is 10.384 in the estimation for all observations, 4.963 for favorable periods, and 14.729 for unfavorable periods).

A3. Direction

	All observations	Favorable periods	Unfavorable periods
Link ratio	3.904 (4.648)	-4.458 (6.174)	12.321* (7.220)
Maturity	0.419* (0.215)	0.368 (0.414)	0.402 (0.253)
Maturity (squared)	0.002 (0.002)	0.002 (0.003)	0.003 (0.002)
Notional principal	-0.107 (0.164)	0.321 (0.297)	-0.211 (0.201)
Notional principal (squared)	-0.001 (0.002)	-0.003 (0.003)	-0.001 (0.003)
CCP dummy	-2.098 (7.089)	-4.911 (5.895)	-3483.707 (20700.644)
Observations	32,814	16,459	16,355
R^2	0.889	0.943	0.39
Fixed effects			
Reference × date	Yes	Yes	Yes
Seller× month/year	Yes	Yes	Yes
Buyer × month/year	Yes	Yes	Yes

* p < 0.1, ** p < 0.05, *** p < 0.01

Notes: This table reports the results of transaction-level panel regressions in which CDS prices are regressed on *Link ratio* and various control variables. All specifications include time-reference entity ID, time-seller ID, and time-buyer ID fixed effects. *Link ratio* denotes $(Link_{s,t}/Link_{b,t})$. This table reports the results when we do not take the direction of transactions into account. The column "All observations" shows the results for all transactions. The columns "Favorable periods" and "Unfavorable period" show the results when observations are divided based on the level of the iTraxx Japan on the day when the transaction took place. The observation period is from April 1, 2013 to December 31, 2021. Figures in parentheses are clustered standard errors clustered by time and reference entity. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. We observe a centrality premium in unfavorable periods (i.e., the coefficient estimate for *Link ratio* is 12.321).

A4. (A) Sellers with small centrality versus buyers with small or large centrality

	Sellers with small centrality vs buyers with small centrality	Sellers with small centrality vs buyers with large centrality	Sellers with small centrality
Link ratio	7.657*** (2.175)	—	9.002*** (2.603)
Maturity	-0.154 (0.310)	1.188*** (0.323)	0.203 (0.242)
Maturity (squared)	0.005** (0.002)	0.000 (0.003)	0.003* (0.002)
Notional principal	-0.072 (0.318)	-0.125 (0.240)	-0.053 (0.232)
Notional principal (squared)	-0.001 (0.004)	0.000 (0.003)	-0.002 (0.003)
CCP dummy	-5358.779 (60782.206)	-1.992 (2.961)	1.921 (3.983)
Observations	16,345	8,147	24,492
R^2	0.845	0.934	0.868
Fixed effects			
Reference × date	Yes	Yes	Yes
Seller× month/year	Yes	Yes	Yes
Buyer × month/year	Yes	Yes	Yes

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table reports the results of transaction-level panel regressions in which CDS prices are regressed on *Link ratio* and various control variables. All specifications include time-reference entity ID, time-seller ID, and time-buyer ID fixed effects. *Link ratio* denotes $(Link_{s,t}/Link_{b,t})$. This table reports the results when sellers whose link centrality is above the 75th percentile are excluded from the data. Buyers are classified as having large centrality if their centrality is above the 75th percentile and as having small centrality if their centrality is below the 75th percentile. The observation period is from April 1, 2013 to December 31, 2021. Figures in parentheses are clustered standard errors clustered by time and reference entity. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. We observe a centrality premium in the case of transactions between sellers with small centrality and buyers with small centrality (i.e., the coefficient estimate for *Link ratio* is 7.657) and transactions between sellers with small centrality and buyers in general (i.e., the coefficient estimate for *Link ratio* is 9.002).

A4. (B) Sellers with small or large centrality versus buyers with small centrality

	Sellers with small centrality vs buyers with small centrality (Same as Panel A)	Sellers with large centrality vs buyers with small centrality	Buyers with small centrality
Link ratio	7.657***	1.994	6.978**
	(2.175)	(655385.549)	(3.110)
Maturity	-0.154	2.179***	0.053
	(0.310)	(0.345)	(0.275)
Maturity (squared)	0.005**	-0.009***	0.004*
	(0.002)	(0.002)	(0.002)
Notional principal	-0.072	-0.175	-0.109
	(0.318)	(0.117)	(0.210)
Notional principal (squared)	-0.001	0.001	-0.001
	(0.004)	(0.001)	(0.002)
CCP dummy	-5358.779	7.184	-31.807
	(60782.206)	(8.329)	(24.680)
Observations	16,345	8,122	24,467
R^2	0.845	0.984	0.879
Fixed effects			
Reference × date	Yes	Yes	Yes
Seller× month/year	Yes	Yes	Yes
Buyer × month/year	Yes	Yes	Yes

* p < 0.1, ** p < 0.05, *** p < 0.01

Notes: This table reports the results of transaction-level panel regressions in which CDS prices are regressed on *Link ratio* and various control variables. All specifications include time-reference entity ID, time-seller ID, and time-buyer ID fixed effects. *Link ratio* denotes $(Link_{s,t}/Link_{b,t})$. This table reports the results when buyers whose link centrality is above the 75th percentile are excluded from the data. Sellers are classified as having large centrality if their centrality is above the 75th percentile and as having small centrality if their centrality is below the 75th percentile.”] The observation period is from April 1, 2013 to December 31, 2021. Figures in parentheses are clustered standard errors clustered by time and reference entity. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. We observe a centrality premium in the case of transactions between sellers with small centrality and buyers with small centrality (i.e., the coefficient estimate for *Link ratio* is 7.657) and transaction between buyers with small centrality and sellers in general (i.e., the coefficient estimate for *Link ratio* is 6.978).

A5. Eigenvector centrality

	All observations	Favorable periods	Unfavorable periods
Eigenratio	6.202***	-19.893	8.495*
	(1.701)	(18.530)	(4.725)
Maturity	0.484**	0.941***	0.385
	(0.223)	(0.239)	(0.264)
Maturity (squared)	0.002	-0.001	0.003
	(0.002)	(0.001)	(0.002)
Notional principal	-0.205	-0.121	-0.188
	(0.150)	(0.138)	(0.198)
Notional principal (squared)	0.000	0.001	-0.001
	(0.002)	(0.001)	(0.003)
CCP dummy	-1.463	-1.764	-1425.871
	(7.148)	(4.919)	(22725.042)
Observations	31,076	14,978	16,098
R^2	0.900	0.981	0.843
Fixed effects			
Reference × date	Yes	Yes	Yes
Seller× month/year	Yes	Yes	Yes
Buyer × month/year	Yes	Yes	Yes

* p < 0.1, ** p < 0.05, *** p < 0.01

Notes: This table reports the results of transaction-level panel regressions in which CDS prices are regressed on *Link ratio* and various control variables. All specifications include time-reference entity ID, time-seller ID, and time-buyer ID fixed effects. This table reports the results when the link ratio is defined as the ratio of sellers' eigenvector centrality to buyers' eigenvector centrality, where both are measured over the preceding three months. The column "All observations" shows the results for all transactions. The columns "Favorable periods" and "Unfavorable period" show the results when observations are divided based on the level of the iTraxx Japan on the day when the transaction took place. The observation period is from April 1, 2013 to December 31, 2021. Figures in parentheses are clustered standard errors clustered by time and reference entity. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. We observe a centrality premium (i.e., the coefficient estimate for *Link ratio* is 6.202 for all observations and 8.495 for unfavorable periods).

A6. Using transaction amounts instead of degree centrality

	All observations	Favorable periods	Unfavorable periods
Amount ratio	0.372*	0.167	0.510*
	(0.211)	(0.156)	(0.308)
Maturity	0.377*	0.239	0.373
	(0.225)	(0.446)	(0.265)
Maturity (squared)	0.003	0.003	0.003
	(0.002)	(0.003)	(0.002)
Notional principal	-0.082	0.397	-0.179
	(0.165)	(0.328)	(0.197)
Notional principal (squared)	-0.001	-0.003	-0.001
	(0.002)	(0.003)	(0.003)
CCP dummy	-2.308	-5.532	-2151.161
	(7.030)	(6.057)	(23541.092)
Observations	31,618	15,849	15,769
R^2	0.891	0.944	0.842
Fixed effects			
Reference × date	Yes	Yes	Yes
Seller× month/year	Yes	Yes	Yes
Buyer × month/year	Yes	Yes	Yes

* p < 0.1, ** p < 0.05, *** p < 0.01

Notes: This table reports the results of transaction-level panel regressions in which CDS prices are regressed on *Link ratio* and various control variables. All specifications include time-reference entity ID, time-seller ID, and time-buyer ID fixed effects. *Link ratio* denotes $(Link_{s,t}/Link_{b,t})$. This table reports the results when we use the transaction amount to gauge links. The column "All observations" shows the results for all transactions. The columns "Favorable periods" and "unfavorable periods" show the results when observations are divided based on the level of the iTraxx Japan on the day when the transaction took place. The observation period is from April 1, 2013 to December 31, 2021. Figures in parentheses are clustered standard errors clustered by time and reference entity. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. We observe a centrality premium (i.e., the coefficient estimate for *Link ratio* is 0.372 for all observations and 0.510 for unfavorable periods).

A7. Moving average

	All observations	Favorable periods	Unfavorable periods
Link ratio	7.049**	-3.264	9.858***
	(2.974)	(2.041)	(2.895)
Maturity	0.421*	1.936***	0.270
	(0.216)	(0.283)	(0.239)
Maturity (squared)	0.002	-0.007***	0.003*
	(0.002)	(0.002)	(0.002)
Notional principal	-0.103	-0.508***	-0.012
	(0.164)	(0.160)	(0.198)
Notional principal (squared)	-0.001	0.004***	-0.002
	(0.002)	(0.001)	(0.002)
CCP dummy	-2.091	1.853	-1912.274
	(7.101)	(3.958)	(50855.543)
Observations	32,614	12341	20273
R^2	0.889	0.988	0.847
Fixed effects			
Reference × date	Yes	Yes	Yes
Seller× month/year	Yes	Yes	Yes
Buyer × month/year	Yes	Yes	Yes

* p < 0.1, ** p < 0.05, *** p < 0.01

Notes: This table reports the results of transaction-level panel regressions in which CDS prices are regressed on *Link ratio* and various control variables. All specifications include time-reference entity ID, time-seller ID, and time-buyer ID fixed effects. *Link ratio* denotes $(Link_{s,t}/Link_{b,t})$. We define favorable and unfavorable periods by referring to the iTraxx Japan up to each data point instead of the median of the iTraxx Japan for the entire observation period. Specifically, we use the 75-day trailing moving average. Moreover, as a robustness check, we also use the 25-, 100-, and 200-day moving averages and obtain almost identical results. To avoid contamination from "future" observations, we only use data up to the date of each transaction to define favorable and unfavorable periods. The column "All observations" shows the results for all transactions. The columns "Favorable periods" and "unfavorable periods" show the results when observations are divided based on the level of the iTraxx Japan on the day when the transaction took place. The observation period is from April 1, 2013 to December 31, 2021. Figures in parentheses are clustered standard errors clustered by time and reference entity. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. We observe a centrality premium (i.e., the coefficient estimate for *Link ratio* is 7.049 for all observations and 9.858 for unfavorable periods).

Appendix B

B1. Domestic institutions in terms of nationality or geographic location

	Both counterparties are located in Japan			One of the counterparties is located in Japan		
	All observations	Favorable periods	Unfavorable periods	All observations	Favorable periods	Unfavorable periods
Link ratio	3.945 (2.804)	0.713 (3.139)	8.472* (4.657)	9.837*** (2.568)	8.311*** (2.186)	11.577** (5.894)
Domestic institutions dummy	16.464* (9.924)	31.852*** (10.961)	5.469 (9.903)	-14.117** (7.079)	-25.340*** (8.525)	-5.507 (6.363)
Link ratio × Domestic institutions dummy	5.973** (2.480)	7.517** (3.022)	3.159 (2.144)	-5.930** (2.483)	-7.695** (3.031)	-3.045 (2.106)
Maturity	0.412* (0.217)	0.378 (0.421)	0.390 (0.254)	0.412* (0.217)	0.378 (0.420)	0.390 (0.254)
Maturity (squared)	0.002 (0.002)	0.001 (0.003)	0.003 (0.002)	0.002 (0.002)	0.001 (0.003)	0.003 (0.002)
Notional principal	-0.093 (0.165)	0.340 (0.300)	-0.210 (0.202)	-0.093 (0.165)	0.339 (0.300)	-0.200 (0.202)
Notional principal (squared)	-0.001 (0.002)	-0.003 (0.003)	-0.001 (0.003)	-0.001 (0.002)	-0.003 (0.003)	-0.001 (0.003)
CCP dummy	-2.142 (7.125)	-4.947 (5.894)	-345.872 (21114.311)	-2.142 (7.125)	-4.946 (5.887)	-247.346 (21105.952)
Observations	32,324	16,261	16,063	32,324	16,261	16,063
R^2	0.888	0.943	0.838	0.888	0.943	0.838
Fixed effects						
Reference × date	Yes	Yes	Yes	Yes	Yes	Yes
Seller× month/year	Yes	Yes	Yes	Yes	Yes	Yes
Buyer × month/year	Yes	Yes	Yes	Yes	Yes	Yes

* p < 0.1, ** p < 0.05, *** p < 0.01

Notes: This table reports the results of transaction-level panel regressions in which CDS prices are regressed on *Link ratio* and various control variables. All specifications include time-reference entity ID, time-seller ID, and time-buyer ID fixed effects. *Link ratio* denotes $(Link_{s,t}/Link_{b,t})$. This table reports the results when the sample is limited in terms of the location of parties. The first three columns show the results when the sample is limited to the case where both the seller and the buyer are located in Japan. The last three columns show the results when the sample is limited to the case where one of the two – the seller or the buyer – is located in Japan. The observation period is from April 1, 2013 to December 31, 2021. Figures in parentheses are clustered standard errors clustered by time and reference entity. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. We observe a centrality premium in unfavorable periods (i.e., the coefficient estimate for *Link ratio* is 8.472 for the case where both the seller and the buyer are located in Japan and 11.577 for the case where either the buyer or the seller is located in Japan).

B2. Transactions cleared by a CCP and transactions not centrality cleared

	Transaction cleared by a CCP			Transactions not centrally cleared		
	All observations	Favorable periods	Unfavorable periods	All observations	Favorable periods	Unfavorable periods
Link ratio	—	—	—	7.045** (2.978)	2.619 (3.890)	11.917** (5.891)
Maturity	2.505** (0.972)	2.950*** (0.724)	5.058*** (0.000)	0.408* (0.217)	0.314 (0.431)	0.400 (0.253)
Maturity (squared)	-0.009 (0.011)	-0.019*** (0.006)	-0.022*** (0.000)	0.002 (0.002)	0.002 (0.003)	0.003 (0.002)
Notional principal	0.048 (0.804)	-0.298 (0.785)	0.000 (0.000)	0.094 (0.168)	0.375 (0.312)	-0.211 (0.201)
Notional principal (squared)	0.001 (0.005)	0.004 (0.005)	—	-0.001 (0.002)	-0.003 (0.003)	-0.001 (0.003)
Observations	432	417	15	32,182	15,886	16,296
R^2	0.992	0.995	1.000	0.888	0.941	0.839
Fixed effects						
Reference × date	Yes	Yes	Yes	Yes	Yes	Yes
Seller× month/year	Yes	Yes	Yes	Yes	Yes	Yes
Buyer × month/year	Yes	Yes	Yes	Yes	Yes	Yes

* p < 0.1, ** p < 0.05, *** p < 0.01

Notes: This table reports the results of transaction-level panel regressions in which CDS prices are regressed on *Link ratio* and various control variables. All specifications include time-reference entity ID, time-seller ID, and time-buyer ID fixed effects. *Link ratio* denotes $(Link_{s,t}/Link_{b,t})$. This table shows the results when the sample is split depending on whether transactions were cleared by a CCP or not. The first three columns present the results for transactions cleared by a CPP and the last three columns those for transactions not cleared by a CPP. The column "All observations" shows the results for all transactions. The columns "Favorable periods" and "unfavorable periods" show the results when observations are divided based on the level of the iTraxx Japan on the day when the transaction took place. The observation period is from April 1, 2013 to December 31, 2021. Figures in parentheses are clustered standard errors clustered by time and reference entity. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. We observe a centrality premium (i.e., the coefficient estimate for *Link ratio* is 7.045 for all transactions that were not centrally cleared, and 11.917 for transactions during unfavorable periods that were not centrally cleared).

B3. D2C vs C2D transactions

	D2C			C2D		
	All observations	Favorable periods	Unfavorable periods	All observations	Favorable periods	Unfavorable periods
Link ratio	6.962** (3.363)	2.713 (3.970)	13.916* (7.520)	7.114** (2.992)	2.694 (3.912)	11.745** (5.653)
Type dummy	-0.001 (9.924)	0.014 (198320.004)	—	249.783 (7694.999)	722.770 (87538.249)	1681.168 (24961.307)
Link ratio × Type dummy	0.397 (4.697)	-7.638 (9.258)	-4.941 (7.640)	3.888 (6.541)	6.305 (6.153)	-10.175 (65.502)
Maturity	0.421* (0.216)	0.380 (0.420)	0.399 (0.253)	0.421* (0.216)	0.381 (0.420)	0.399 (0.253)
Maturity (squared)	0.002 (0.002)	0.001 (0.003)	0.003 (0.002)	0.002 (0.002)	0.001 (0.003)	0.003 (0.002)
Notional principal	-0.103 (0.164)	0.338 (0.300)	-0.211 (0.201)	-0.103 (0.164)	0.339 (0.300)	-0.211 (0.201)
Notional principal (squared)	-0.001 (0.002)	-0.003 (0.003)	-0.001 (0.003)	-0.001 (0.002)	-0.003 (0.003)	-0.001 (0.003)
CCP dummy	-2.091 (7.101)	-4.933 (5.893)	-2086.489 (20568.355)	-2.091 (7.101)	-4.938 (5.893)	-2147.066 (20906.030)
Observations	32,614	16,303	16,311	32,614	16,303	16,311
R^2	0.888	0.943	0.839	0.888	0.943	0.839
Fixed effects						
Reference × date	Yes	Yes	Yes	Yes	Yes	Yes
Seller× month/year	Yes	Yes	Yes	Yes	Yes	Yes
Buyer × month/year	Yes	Yes	Yes	Yes	Yes	Yes

* p < 0.1, ** p < 0.05, *** p < 0.01

Notes: This table reports the results of transaction-level panel regressions in which CDS prices are regressed on *Link ratio* and various control variables. All specifications include time-reference entity ID, time-seller ID, and time-buyer ID fixed effects. *Link ratio* denotes $(Link_{s,t}/Link_{b,t})$. This table shows the results when the sample is limited to dealer-to-customer (D2C) transactions or customer-to-dealer (C2D) transactions. Here, dealers are defined as foreign securities firms, foreign banks, and Japanese securities firms. The first three columns show the results for transactions between dealers (sellers) and customers (buyers), while the last three columns show the results for transactions between customers (sellers) and dealers (buyers). The column "All observations" shows the results for all transactions. The columns "Favorable periods" and "unfavorable periods" show the results when observations are divided based on the level of the iTraxx Japan on the day when the transaction took place. The observation period is from April 1, 2013 to December 31, 2021. Figures in parentheses are clustered standard errors clustered by time and reference entity. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. We observe a centrality premium in unfavorable periods (i.e., the coefficient estimate for *Link ratio* is 13.916 for D2C transactions and 11.745 for C2D transactions).

B4. Inter- or Intra-group transactions

	Inter-group transactions			Intra-group transactions		
	All observations	Favorable periods	Unfavorable periods	All observations	Favorable periods	Unfavorable periods
Link ratio	—	1.828 (190601.842)	—	7.108** (2.973)	2.835 (3.875)	11.983** (5.892)
Maturity	0.691 (1.332)	0.678 (1.310)	1.761*** (0.014)	0.424* (0.218)	0.418 (0.444)	0.399 (0.253)
Maturity (squared)	-0.009 (0.014)	-0.010 (0.014)	—	0.002 (0.002)	0.002 (0.003)	0.003 (0.002)
Notional principal	1.164** (0.499)	1.208** (0.504)	-0.580*** (0.219)	-0.137 (0.168)	0.266 (0.343)	-0.211 (0.201)
Notional principal (squared)	-0.017*** (0.006)	-0.017** (0.006)	0.011** (0.004)	-0.001 (0.002)	-0.002 (0.003)	-0.001 (0.003)
CCP dummy	—	—	—	-1.954 (7.106)	-4.601 (5.746)	-4721.045 (21199.804)
Observations	809	715	94	31805	15588	16217
R^2	0.897	0.865	1.000	0.889	0.946	0.838
Fixed effects						
Reference × date	Yes	Yes	Yes	Yes	Yes	Yes
Seller× month/year	Yes	Yes	Yes	Yes	Yes	Yes
Buyer × month/year	Yes	Yes	Yes	Yes	Yes	Yes

* p < 0.1, ** p < 0.05, *** p < 0.01

Notes: This table reports the results of transaction-level panel regressions in which CDS prices are regressed on *Link ratio* and various control variables. All specifications include time-reference entity ID, time-seller ID, and time-buyer ID fixed effects. *Link ratio* denotes $(Link_{s,t}/Link_{b,t})$. This table shows the results when the sample is limited to either inter- or intra-group transactions. The first three columns present the results for inter-group transactions and the last three columns those for intra-group transactions. The column "All observations" shows the results for all transactions in these subsamples. The columns "Favorable periods" and "unfavorable periods" show the results when observations are divided based on the level of the iTraxx Japan on the day when the transaction took place. The observation period is from April 1, 2013 to December 31, 2021. Figures in parentheses are clustered standard errors clustered by time and reference entity. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. We observe a centrality premium for the transaction with intra-group (i.e., the coefficient estimate for Link ratio is 7.108 for all observations and 11.983 for unfavorable periods).

B5. Newly established relationships

	New relationships			Not new relationships		
	All observations	Favorable periods	Unfavorable periods	All observations	Favorable periods	Unfavorable periods
Link ratio	5.665 (134409.592)	—	8.216 (135360.695)	8.920*** (2.402)	10.579* (5.621)	5.301*** (1.958)
Maturity	1.228** (0.542)	1.526** (0.691)	1.447 (0.911)	0.392* (0.224)	0.378 (0.262)	0.313 (0.459)
Maturity (squared)	-0.004 (0.004)	-0.005 (0.005)	-0.012 (0.009)	0.003 (0.002)	0.003 (0.002)	0.002 (0.003)
Notional principal	0.187 (0.420)	-0.121 (0.673)	0.904* (0.477)	-0.121 (0.168)	-0.202 (0.199)	0.328 (0.353)
Notional principal (squared)	-0.004 (0.005)	-0.001 (0.007)	-0.015** (0.006)	-0.001 (0.002)	-0.001 (0.003)	-0.002 (0.003)
CCP dummy	—	—	—	-2.143 (7.045)	-2047.124 (20929.545)	-5.081 (5.935)
Observations	1,650	725	925	30,964	15,586	15,378
R^2	0.879	0.860	0.89	0.893	0.845	0.946
Fixed effects						
Reference × date	Yes	Yes	Yes	Yes	Yes	Yes
Seller× month/year	Yes	Yes	Yes	Yes	Yes	Yes
Buyer × month/year	Yes	Yes	Yes	Yes	Yes	Yes

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table reports the results of transaction-level panel regressions in which CDS prices are regressed on *Link ratio* and various control variables. All specifications include time-reference entity ID, time-seller ID, and time-buyer ID fixed effects. *Link ratio* denotes $(Link_{s,t}/Link_{b,t})$. This table shows the results when we split the sample based on whether relationships are newly established or not. “New relationships” refers to transactions where the pair of parties traded for the first time (taking the direction of the transaction into account). The first three columns show the results for new relationships, while the last three columns show the results for relationships that are not new. The column “All observations” shows the results for all transactions. The columns “Favorable periods” and “unfavorable periods” show the results when observations are divided based on the level of the iTraxx Japan on the day when the transaction took place. The observation period is from April 1, 2013 to December 31, 2021. Figures in parentheses are clustered standard errors clustered by time and reference entity. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. We observe a centrality premium for relationships that are not new.

B6. Transactions observed more than a certain number of periods of time (by transaction months)

	Coefficient of Link ratio			Observations		
	All observations	Favorable periods	Unfavorable periods	All observations	Favorable periods	Unfavorable periods
More than 2 months	7.123** (2.988)	2.822 (3.904)	12.030** (5.912)	32,614	16,303	16,311
More than 3 months	7.289** (2.998)	2.879 (3.916)	11.902** (5.869)	31,869	15,637	16,232
More than 5 months	7.397** (3.028)	2.906 (3.967)	12.124** (5.886)	31,781	15,576	16,205
More than 10 months	9.697*** (2.572)	5.386*** (1.885)	12.230** (5.895)	31,577	15,474	16,103
More than 20 months	9.794*** (2.719)	6.272*** (0.003)	18.459 (12.023)	31,139	15,223	15,916
More than 30 months	7.733 (4.899)	-10.313 (148.383)	8.196** (3.345)	30,036	14,693	15,343
Fixed effects						
Reference × date	Yes	Yes	Yes	Yes	Yes	Yes
Seller× month/year	Yes	Yes	Yes	Yes	Yes	Yes
Buyer × month/year	Yes	Yes	Yes	Yes	Yes	Yes

* p < 0.1, ** p < 0.05, *** p < 0.01

Notes: This table reports the results of transaction-level panel regressions in which CDS prices are regressed on *Link ratio* and various control variables. All specifications include time-reference entity ID, time-seller ID, and time-buyer ID fixed effects. *Link ratio* denotes $(Link_{s,t}/Link_{b,t})$. The first three columns show the coefficient estimates for the link ratio for various subsamples based on how many months parties in each trading pair transacted with each other during the observation period. The last three columns show the number of observations for each subsample. The column "All observations" shows the results for all transactions. The columns "Favorable periods" and "unfavorable periods" show the results when observations are divided based on the level of the iTraxx Japan on the day when the transaction took place. The observation period is from April 1, 2013 to December 31, 2021. Figures in parentheses are clustered standard errors clustered by time and reference entity. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

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