CFA INSTITUTE
FINANCIAL ANALYSTS JOURNAL
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Financial Analysts Journal
Volume 72 • Number 4

Interconnectedness in the CDS Market

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Concentrated risks in the market for credit default swaps (CDSs) are widely considered to have contributed significantly to the 2007–08 financial crisis. We examine the structure of the CDS market using a network-based approach that allows us to capture the interconnectedness between dealers and nondealers of CDS contracts. We find a high degree of interconnectivity among major market participants. Our work helps assess the stability of the CDS market and the potential contagion among market participants. Our findings are of practical importance because even after central clearing becomes mandatory, counterparty risk will remain a relevant systemic consideration owing to the long-term nature of CDS contracts.

The concentration of transactions and positions in the credit default swap (CDS) market among a select group of large dealers is widely considered to have contributed significantly to the 2007–08 financial crisis. Because of the highly concentrated and interconnected nature of bilateral CDS contracting, the counterparty risk associated with potential defaults of large protection sellers is a possible source of systemic risk. Historically, the decentralized nature of over-the-counter (OTC) derivatives markets has made it difficult for regulators and market participants to obtain reliable information on prices and market exposures. The lack of transparency regarding exposures held by market participants complicates the management of counterparty risk. This lack of transparency was reportedly one of the reasons why, before the recent crisis, certain market participants, such as American International Group (AIG), were able to create large, yet unobservable, exposures (e.g., Markose, Giansante, and Shaghaghi 2012).

To the extent that a counterparty failure of a large CDS market participant can result in sequential counterparty defaults that send shock waves throughout the swap market, the ensuing contagion can become systemically important. The systemic implications of the 2007–08 financial crisis resulted in a coordinated policy response in the United States and abroad. In 2009, the G–20 agreed that standardized OTC derivatives contracts should be traded on exchanges or electronic trading platforms (known as swap execution facilities), cleared through central counterparties (CCPs), and reported to "trade repositories." To coordinate this global response, the Financial Stability Board (FSB) was tasked with monitoring the progress of the implementation of these reforms.

In July 2010, the US Congress passed the Dodd–Frank Wall Street Reform and Consumer Protection Act (Dodd–Frank), signed into law by President Obama on 21 July. Dodd–Frank envisioned a set of reforms that would, among other things, "promote the financial stability of the United States by improving accountability and transparency in the financial system."[1] In passing Dodd–Frank, Congress identified the OTC derivatives market as a key source of instability;[2] an overarching aim of Title VII of Dodd–Frank was to mitigate the buildup and transmission of systemic risk in the swap market.[3]

Among its requirements, Title VII mandates the central clearing of certain contracts that, in the aggregate, are deemed to have the potential to create systemic risk. Central clearing is a market practice that may result in significant systemic risk mitigation. Its function is to transfer counterparty risk previously borne by each party to the swap transaction

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Editor's note: This article was reviewed and accepted by Robert Litterman, executive editor at the time the article was submitted.

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to CCPs. CCPs are designed to reduce the likelihood that the default of a large swap market participant will result in sequential counterparty defaults and to ameliorate systemic risk transmission throughout the swap market.[4] The effectiveness of CCPs is predicated on the requirement that clearing members must post capital and collect margin so that defaults by either counterparties or clearing members can be absorbed. CCPs are considered an effective risk-sharing mechanism that mitigates counterparty risk without necessarily eliminating it.

Many researchers have studied the risks in the OTC markets for CDSs.[5] Some have argued that Title VII reforms may reallocate systemic risk without actually reducing it—if, for example, mandatory clearing for one product precludes more efficient multilateral netting across products (see Duffie and Zhu 2011). Acharya, Shachar, and Subrahmanyam (2010) offer a good overview of the Dodd–Frank Act and CDS clearing requirements.

Despite pending regulatory requirements that mandate central clearing, the majority of single-name CDS transactions remain bilateral trades that are not centrally cleared. Practitioners will continue to need a thorough understanding of how counterparty risk is concentrated among the major security-based swap dealers, for a number of reasons.

First, many of the rules under Title VII of Dodd–Frank have yet to be finalized by the US Securities and Exchange Commission (SEC) and the Commodity Futures Trading Commission (CFTC). Until key components of Title VII are adopted, the decision to centrally clear a trade will remain a voluntary decision that must be agreed to by both parties before the trade is assigned to a CCP. Thus, the market will continue to function in its current state despite regulator encouragement to centrally clear eligible CDS transactions.

Second, not all reference entities—the underlying legal entity on which the CDS is based—are currently eligible for central clearing. Dodd–Frank granted the SEC the authority to determine which contracts are eligible for central clearing (Porter 2015). In making this determination, the SEC should consider a number of factors: (1) sufficient activity, trading liquidity, and adequate pricing data; (2) a well-functioning infrastructure to support clearing; (3) the opportunity for systemic risk mitigation; (4) the impact on competition; and (5) the opportunity to resolve failures of the clearinghouse or clearing members with reasonable legal certainty. Although the SEC is expected to require more reference entities to be centrally cleared, Porter (2015) reported that as of 31 December 2013, only 21% of all single-name reference entities were eligible for clearing (161 of 840 North American single-name reference entities and 121 of 493 European single-name reference entities).[6]

Third, mandatory central clearing will not necessarily eliminate bilateral exposure. Nonstandard contracts are not centrally cleared, and mandatory clearing can be avoided by designing nonstandard contracts for eligible reference entities. The International Swaps and Derivatives Association (ISDA) has developed standard North American corporate (SNAC) documentation for US single-name reference entities that requires standard contracts to have standard coupon rates of either 100 or 500 bps and maturities of 10 years or less. In addition, restructuring cannot be included as a credit event. The extent to which initial cost efficiencies will push CDS trading toward nonstandard contracts has important implications for practitioners, particularly if unwinding these positions is relatively expensive.

A fourth, compelling reason why our study is especially useful to practitioners is that CDS transactions create long-term exposures that will persist, even after central clearing becomes mandatory. CDS transactions obligate dealers to enter into long-term contracts that expose them to significant counterparty risk over the life of each contract. Although economic risk can be reduced by taking offsetting positions, transacting with counterparties to which a dealer has direct exposure is the only way to reduce bilateral exposure. This point is relevant because even if mandatory central clearing were implemented immediately, dealers would continue to have significant counterparty exposure, which would persist until all existing contracts were terminated or had matured. In this context, an important component of monitoring systemic risk is understanding dealers' gross notional exposures vis-à-vis one another and continuing to track bilateral exposures until positions become sufficiently small.

All these reasons explain why an analysis of the interconnectedness in the CDS market is relevant to practitioners—even though Dodd–Frank mandates central clearing. Understanding counterparty concentration, particularly among systemically important financial institutions, is critical because it can create stress on the financial system in the unlikely event of a failure by a large CDS dealer.

In our study, we sought to better understand the structure of the CDS market, looking specifically at its topology (i.e., the mapping of the links between dealers involved in CDS transactions). To do so, we used data from the Trade Information Warehouse (TIW) of the Depository Trust & Clearing Corporation (DTCC), which holds records on approximately 98% of all global credit derivatives transactions by notional amount. Given the breadth of coverage, we were able to obtain a reasonably complete picture of interdealer transactions and positions.[7] The database did not provide information on transactions

that fell outside the ambit of US regulators—that is, transactions between two foreign counterparties on a foreign reference entity.[8]

To understand the structure—and conditions for stability and fragility—of the CDS market, we mapped the network of connections between dealers and nondealers. Network-based approaches have been used successfully to study fragility and systemic risk in various markets.[9] These approaches allow for the study of market structure by capturing bilateral connections and evaluating their relative magnitude and by identifying important players—all as a way to understand potential systemic risk. A network approach is useful in studying the dynamics of contagion—that is, how the failure of one financial institution can cause other financial institutions to fail.[10]

■ *Discussion of findings.* We studied the structure of the CDS market using explicit connections based on the total number of CDS transactions, the notional value of CDS transactions, and network diagrams. Allen and Gale (2000) and Freixas, Parigi, and Rochet (2000) introduced some of the first formal models of financial contagion. To investigate the fragility of the system, we estimated several network measures for the system between dealers. We report a set of statistics that characterize the CDS market, the degree of counterparty concentration, the size of different contracts, and the underlying contractual features. Our approach considers the size, interconnectedness, and complexity of individual dealers and nondealers and their interrelationships, allowing for the assessment of potential systemic vulnerabilities in the CDS market. We found a high degree of interconnectivity among major market participants. Our findings are relevant in assessing the degree of potential contagion because risk is transmitted across market participants and affects the stability of the system.

One of the unique aspects of our study is that it covers a period after the Volcker rule was proposed but before its formal adoption.[11] The Volcker rule prohibits large bank holding companies from engaging in proprietary trading. Although the rule had yet to be finalized at the end of our sample period, the broad contours of the proposal made it clear that an aggressive interpretation would likely be promulgated—which probably caused banks to preemptively shed many unambiguously proprietary activities.[12]

Consistent with this conjecture, we found that banks may have responded to the anticipated final version of the Volcker rule by reducing both gross notional and net notional exposures in 2012. As banks partially pulled back from CDS markets, nondealers (e.g., hedge funds) responded by increasing their marginal participation levels.

CDS Contracts

A CDS contract is a bilateral agreement that transfers between counterparties the credit exposure on a specific obligation of the reference entity. The protection buyer makes periodic payments to the protection seller in exchange for a positive payoff when a prespecified credit event occurs.[13] When a credit event occurs, the seller of the CDS contract pays the buyer either (1) the notional amount of the CDS contract against delivery of the reference obligation or (2) the difference between the notional amount and the remaining value of the reference obligation as determined in an auction process (depending on whether a physical settlement or a cash settlement is specified).

A party to a CDS contract may exit the contract through termination or novation. In a termination, both contract parties must agree to terminate, possibly for an additional payment that depends on current market conditions. A novation is executed by identifying a market participant willing to assume the obligation of one of the original counterparties at prevailing market prices.

Other contract changes concern "compression" mechanisms, which are designed to cancel redundant contracts when counterparties have taken mutually offsetting positions. For example, if the same counterparties have entered into offsetting positions on contracts with the same economic terms, a compression trade cancels the contracts and creates a new contract with the same net exposure as the original contracts.

Selling protection through a CDS contract replicates a leveraged long position in bonds of the underlying reference entity, exposing protection sellers to risks similar to those of a creditor. In contrast, buying protection through a CDS contract replicates a leveraged short position in bonds of the underlying reference entity, allowing protection buyers to either hedge credit risk they may already be exposed to or effectively take a short position in the credit risk of the underlying reference entity.

Because of their bilateral nature, noncentrally cleared OTC CDS contracts also expose each counterparty to a potential default by the other counterparty. From the perspective of a protection buyer, counterparty risk arises when the protection seller defaults and the buyer loses its protection against default by the reference entity. In contrast, the protection seller carries the risk that the buyer may default, depriving the seller of the expected revenue stream. Depending on the performance of the reference entity at the time of a counterparty default, the CDS contract may be more or less valuable than the original CDS and may thus involve an unanticipated gain or loss. Therefore, both holders of a CDS contract face the risk of loss in

two ways: (1) through the performance of the reference entity and (2) through potential counterparty default.

Standardized Contractual Features. ISDA has developed protocols for contract standardization. The original master agreement was established in 1992 and revised in 2002. The primary purpose of these agreements was to create, among other considerations, standards for the netting and collateralization of contracts as well as standards for certain contract specifications, such as contract tenors and credit event triggers.

In 2009, ISDA developed the so-called big bang protocol, which introduced procedures to determine whether a credit event has occurred and specified auction procedures for the pricing of defaulted bonds. ISDA also introduced contract standardization for maturity dates and premium payments (the fixed rates that determine the amount of the periodic payment). For example, CDS premiums were set at 100 or 500 bps for US contracts and at 25, 100, 500, or 1,000 bps for European single-name CDSs. Because prespecified premiums prevent contracts from having zero value on the initiation date, the contract typically requires upfront payments to compensate for the difference between the market premium and the standardized premium.

Finally, a number of issues related to default triggers for European firms caused ISDA to issue the "small bang" protocol in July 2009 to further standardize procedures concerning the determination of credit events. The protocol also applies to the handling of any globally outstanding CDS trades in which the underlying reference entity has engaged in some form of restructuring. The motivations for the convention changes in European contracts are similar to those for the North American convention changes: to facilitate central clearing, gain efficiencies in trade and operational processing, and reduce the gross notional amount outstanding in the market.

Data

We used transaction data for single-name CDSs submitted to the DTCC's Trade Information Warehouse. Established by the DTCC in November 2006, the TIW is the electronic central registry for CDS contracts. We used transaction data, recorded daily, over 1 January 2012 to 31 December 2012—in particular, five snapshots of the positions data: 6 January, 30 March, 29 June, 28 September, and 28 December.

We had access to all TIW data on CDS transactions except for solely foreign transactions. Thus, our sample includes all transactions with at least one of the following: (1) a US reference entity, (2) a US counterparty, (3) a foreign branch of a US counterparty, or (4) a foreign affiliate of a US counterparty. For example, we excluded from the analysis transactions between two non-US counterparties unless they had transacted in CDSs in which the reference entity was a US entity.[14] The total gross notional outstanding at the beginning of our sample was $11.4 trillion. At the same date (January 2012), the total gross notional globally for single-name CDSs and index CDSs was $13.8 trillion and $25.1 trillion, respectively.[15] Therefore, our sample represents about 82.6% of the global single-name CDS market and 45.4% of the total CDS market (including multi-names).

The data identify the counterparties to each transaction. For each individual market participant, the data include a consistent identifier throughout the dataset, its classification by type (dealer versus nondealer), and its domicile.[16] The sample of nondealers includes pension funds, asset managers, hedge funds, banks, and nonfinancial companies (though the dataset does not distinguish between them).[17]

Each transaction record contains the following information: name of the reference entity, trade date, contract maturity date, identities and type (dealer versus nondealer) of the participating counterparties, whether the transaction is cleared,[18] the executed notional amount, market sector to which the reference entity belongs, and other transaction-specific information. Transactions are classified as one of several types. A transaction can be a new trade or a cash settlement of an existing trade, or it can be novated.[19] Contracts can be partially or fully closed out or assigned/novated before maturity.

We applied a number of filters to the data. First, we eliminated both index and product/tranche CDSs, thus leaving single-name corporate and sovereign CDSs to be analyzed.[20] We then deleted trades that had been reassigned within a company and trades in which a counterparty had completed a legal name change but kept contracts that had been partially terminated and assigned. Erroneous records, such as negative notional amounts, were also removed from the data. Finally, we aggregated the names of the counterparties by the highest-level name available. If higher-level information was unavailable, we aggregated by parent name, fund name, or firm name to better understand each counterparty's aggregate involvement in the CDS market.

Methodology

We used several measures of connectedness to map the network of dealers and nondealers. To protect the privacy of market participants, we anonymized the identities of the counterparties by using several masking techniques in reporting our results.

To assess the systemic importance of both dealers and nondealers, we defined several measures of connectedness.

Gross Notional Amounts. This measure has three components:

- *Notional bought:* The gross notional amount bought by each counterparty
- *Notional sold:* The gross notional amount sold by each counterparty
- *Net notional positions outstanding:* The difference between the notional values of all outstanding contracts bought and sold by each counterparty

Number of Contracts. This measure has two components:

- *Number of contracts bought:* The number of CDS contracts bought by each counterparty
- *Number of contracts sold:* The number of CDS contracts sold by each counterparty

Number of Connections. This measure has three components:

- *Number of buy-side connections:* The number of different counterparties from which a specific market participant buys CDS contracts
- *Number of sell-side connections:* The number of different counterparties to which a specific market participant sells CDS contracts
- *Number of buy-side/sell-side connections:* The number of different counterparties that a specific market participant both buys protection from and sells protection to

Average Number of Contracts per Day. This measure has two components:

- *Average number of contracts bought per day:* The average number of CDS contracts bought per day by each counterparty
- *Average number of contracts sold per day:* The average number of CDS contracts sold per day by each counterparty

Concentration Indexes. The Herfindahl–Hirschman Index (HHI) is the most widely used concentration measure (Bikker and Haaf 2002).[21] Therefore, we used the HHI in our analysis.

For each dealer and nondealer i, we calculated the HHI as the sum of squared fractions of CDS contract purchases from other dealers and nondealers j—that is,

$$\text{HHI}_i = \sum_{j=1}^{N} w_{ij}^2,$$

where $i \neq j$, and w_{ij} is the fraction of CDS purchases by a dealer or nondealer from other dealers and nondealers. N is the total number of market participants. By construction, the index ranges from 0 to $1/(N-1)$. It takes the value 1 when a single counterparty buys 100% of its CDS contracts from only one counterparty, and it approaches $1/(N-1)$ when purchases are perfectly diversified across a large number of sellers.[22] This concentration index was inspired by a popular concentration measure originally proposed by Herfindahl (1950) and Hirschman (1964). The result is proportional to the diversification that each counterparty achieves in the long side of its portfolio (i.e., the CDS contracts bought).[23]

We calculated the average HHI by averaging HHI_i across all i types of counterparties:

$$\text{Average HHI} = \frac{\sum_{i=1}^{N} \text{HHI}_i}{N}.$$

The average HHI measures the average diversification that counterparties achieve in the long side of their portfolios.

Dealer Topology. Using network diagrams, we provide information about the overall bilateral exposures between counterparties. The graphical representations of the network are characterized by bilateral relationships across market participants; the results are depicted in **Figure 1**, **Figure 2**, and **Figure 3**. Figure 1 captures the overall gross notional amount traded between counterparties. Figures 2 and 3 capture counterparty topology for all reference entities based on positions data. Both network diagrams use gross outstanding and net outstanding positions.

Results

In describing the results of our empirical analyses, we present the calculations on a highly aggregated basis that incorporates many reference entities and

Figure 1. Dealer Topology for All Reference Entities and All Counterparties Based on 2012 Transaction Data

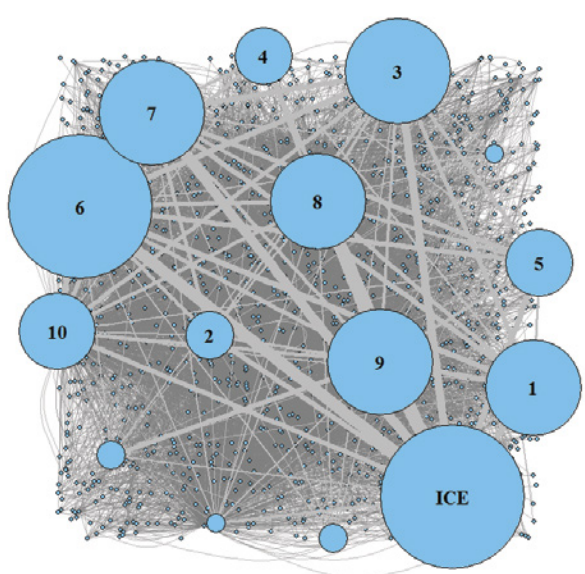
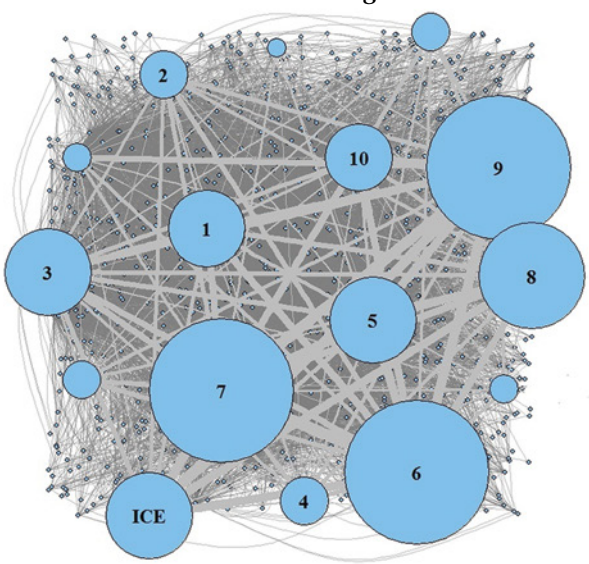
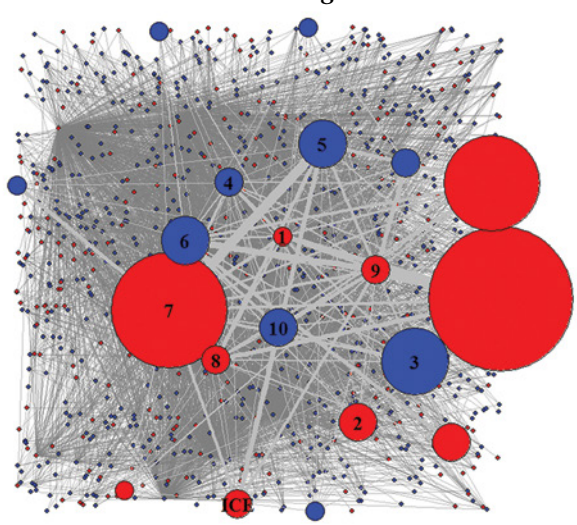


Figure 2. Dealer Topology for All Reference Entities Based on Positions Data, 6 January 2012

A. Gross Outstanding Positions



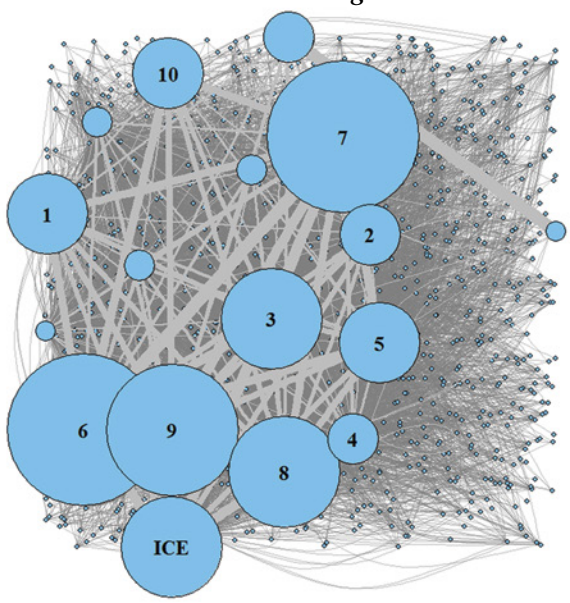
B. Net Outstanding Positions



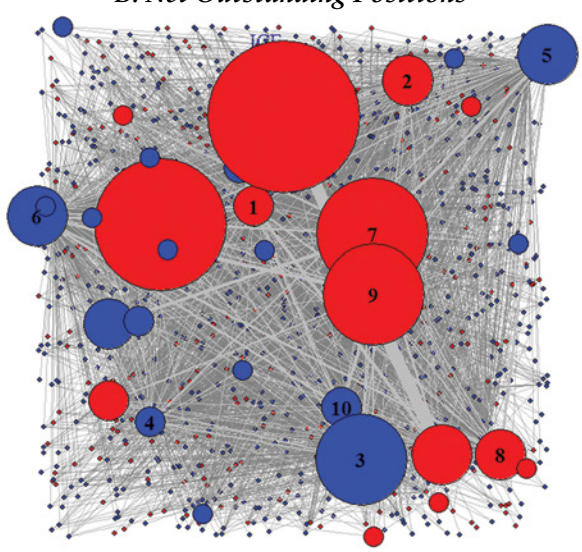
Note: In Panel B, blue represents buyers of CDS contracts, and red represents sellers of CDS contracts.

Figure 3. Dealer Topology for All Reference Entities Based on Positions Data, 28 December 2012

A. Gross Outstanding Positions



B. Net Outstanding Positions



Note: In Panel B, blue represents buyers of CDS contracts, and red represents sellers of CDS contracts.

counterparties. In addition to reporting aggregate statistics, we have reduced the scope of the network connections by providing analyses that focus separately on corporate financial and nonfinancial reference entities for CDS contracts.

Summary Statistics. The gross notional value of all CDS contracts traded in 2012 was $5.07 trillion across 1,758 single-name reference entities.[24] **Table 1** shows that the average daily volume was $15.2 billion,[25] which corresponds to a total of 971,972 trades, or approximately 3,586 contracts traded per trading day. A total of 1,298 market participants bought CDS protection and 1,100 sold protection. Among these market participants, 436 only bought CDS protection, 238 only sold CDS protection, and 862 were on both sides of the market. Among the total number of counterparties that transacted in 2012, 25 were dealers, 2 were CCPs (ICE Clear Credit

Table 1. CDS Market Statistics

	Amount	Number
Notional amount and number of contracts traded		
Total gross notional traded (millions)	$5,070,201	
Average daily volume (millions)	$15,226	
Total number of contracts		971,972
Reference entities		1,758
Number of counterparties by buy side/sell side		
Number of counterparties that buy protection		1,298
Number of counterparties that sell protection		1,100
Number of counterparties that only buy protection		436
Number of counterparties that only sell protection		238
Number of counterparties that buy and sell protection		862
Number of counterparties by type		
Total number of counterparties that transact		1,536
Total number of dealer counterparties that transact		25
Total number of CCPs that transact		2
Total number of nondealer counterparties that transact		1,509

Note: We obtained aggregate market statistics for single-name CDS transactions in 2012 from the DTCC Trade Information Warehouse.

and ICE Clear Europe), and the remaining 1,509 were nondealers.

Table 2 reports the number of unique counterparties for various reference entities. It provides a sense of the type of protection demanded by market participants and how widely the associated counterparty risk is distributed. Table 2 shows that almost all the top 20 reference entities are either sovereigns or financial institutions. The reference entity attracting the most interest is the Kingdom of Spain, with 338 counterparties. The second-most-popular reference entity is the French Republic, with 328 counterparties.

During the eurozone crisis of 2011, CDS contracts written on the sovereign debt of Spain, Italy, and Greece were actively traded as investors sought protection against sovereign defaults. Although Portugal, another country on the European periphery, had similar solvency problems, its sovereign debt was never actively traded. As the eurozone crisis extended into 2012, CDSs written on the sovereign debt of Spain and Italy were among the most actively traded contracts. In contrast, Greek CDS contracts cannot be found in Table 2 because ISDA determined that a Greek restructuring was a credit event, which triggered default payments to protection buyers.

The number of counterparties is a function of demand, availability, and diversification of counterparty risk for various reference entities. For those reference entities outside the top 20, the number of counterparties declines rapidly. Table 2 shows that the average number of counterparties for reference entities in activity bins sorted on the number of counterparties per reference entity—21–100, 101–500, and 501–1,758—drops monotonically from 94 to 49 to 12.

Table 3 provides a more granular look at the size of the market for CDS contracts. It reports the number of contracts traded and their gross notional amounts by reference entity type and market sector. In 2012, corporate CDS contracts represented 84.39% of all contracts traded and 71.07% of the total gross notional amount. Sovereign CDS contracts and "others" made up the remainder. Financials represented the largest portion of corporate contracts traded, accounting for 20.39% of the total number of contracts and 21.20% of the total gross notional amount of CDSs traded. Many of the actively traded reference entities were large bank holding companies, such as Bank of America, Morgan Stanley, and Goldman Sachs. Given the concerns about systemic risk in the aftermath of the financial crisis, investors continued to seek protection against bank failures.

Trading Activity. Because the data identified buyers and sellers, we were able to calculate the total number of contracts bought and sold by different counterparties. We separated counterparties into dealers, nondealers, and those that were centrally cleared. **Table 4** tabulates the number of contracts traded in 2012 by various buyers and sellers, aggregated across size tiers.[26] Dealers represented the majority of buyers and sellers by both number of contracts and gross notional amount. For example, the top 10 buyers and sellers of CDSs in 2012 were all dealers.

Table 2. Number of Unique Counterparties for Various Reference Entities

Reference Entity	Number
Kingdom of Spain	338
French Republic	328
Republic of Italy	266
Federative Republic of Brazil	243
Federal Republic of Germany	220
Bank of America Corporation	173
Morgan Stanley	171
Goldman Sachs Group, Inc.	166
Japan	160
Russian Federation	160
United Mexican States	159
Republic of Turkey	158
JP Morgan Chase & Co.	157
People's Republic of China	157
Citigroup Inc.	154
Republic of Korea	153
Hewlett-Packard Company	152
J.C. Penney Company, Inc.	149
Safeway Inc.	148
Chesapeake Energy Corporation	147
Average (top 21–100 entities)	94
Average (top 101–500 entities)	49
Average (top 501–1,758 entities)	12

Notes: This table reports the number of unique counterparties for the 1,758 different reference entities, sorted on the basis of the number of counterparties per reference entity. It shows the number of unique counterparties for the top 20 reference entities and the average number of counterparties for three activity bins (21–100, 101–500, and 501–1,758) for contracts traded in 2012. Activity bins are sorted on the number of unique counterparties per reference entity.

Table 3. Number of Contracts and Gross Notional Amounts by Reference Entity Type and Market Sector

	Number of Contracts		Gross Notional Amount	
Grouping	Amount (no.)	Total (%)	Amount ($ millions)	Total (%)
Corporate	820,240	84.39	3,603,258	71.07
Financials	198,207	20.39	1,075,192	21.20
Consumer services	151,961	15.63	582,341	11.49
Consumer goods	121,059	12.45	515,917	10.18
Industrials	80,199	8.25	331,927	6.55
Basic materials	63,953	6.58	256,521	5.06
Technology	44,083	4.54	148,507	2.93
Telecommunications services	48,289	4.97	223,621	4.41
Utilities	43,508	4.48	184,928	3.65
Energy	43,395	4.46	173,565	3.42
Health care	25,458	2.62	109,743	2.16
Unknown	128	0.01	995	0.02
Sovereign (government)	144,816	14.90	1,434,878	28.30
Others	1,386	0.14	5,407	0.11
Unknown	5,530	0.57	26,659	0.53
Grand total	971,972	100.00	5,070,201	100.00

Note: This table reports the number and gross notional amounts of contracts traded in 2012 for different reference entity types and market sectors.

Table 4. Number of Contracts and Gross Notional Traded by Counterparty Grouping

	Buy Side				Sell Side			
	Number of Contracts		Gross Notional Traded		Number of Contracts		Gross Notional Traded	
Grouping	Amount (no.)	Total (%)	Amount ($ millions)	Total (%)	Amount (no.)	Total (%)	Amount ($ millions)	Total (%)
Tier 1 (top 5)	405,656	41.74	2,454,094	42.67	443,433	45.62	2,665,863	46.35
Tier 2 (6–10)	258,424	26.59	1,477,992	25.70	271,107	27.89	1,580,215	27.48
Tier 3 (11–15)	63,499	6.53	390,372	6.79	71,167	7.32	380,197	6.61
Tier 4 (16–20)	24,285	2.50	108,113	1.88	23,578	2.43	124,620	2.17
Other dealers	10,481	1.08	35,412	0.62	3,502	0.36	29,969	0.52
Other nondealers	111,172	11.44	605,456	10.53	60,494	6.22	288,099	5.01
Central clearing	98,455	10.13	679,607	11.82	98,691	10.15	682,082	11.86
Grand total	971,972	100.00	5,751,046	100.00	971,972	100.00	5,751,045	100.00

Notes: This table reports transaction activity for single-name CDS contracts by counterparty grouping for 2012. The top 20 counterparties for both buy and sell sides are grouped on the basis of the size of the characteristic (buy-/sell-side number of contracts or gross notional traded). The table also reports statistics for the remaining dealer and nondealer counterparties and for all contracts that are centrally cleared.

Consistent with previous studies (e.g., ECB 2009; Peltonen, Scheicher, and Vuillemey 2013), we found that the five largest buyers, by number of contracts, were the counterparties for 41.74% of all contracts bought in 2012. Cumulatively, the top 10 and the top 20 buyers accounted for 68.33% (41.74 + 26.59) and 77.36% (68.33 + 6.53 + 2.50), respectively, of all market activity in 2012. Under our counterparty classifications, the top 10 buyers of CDS contracts were all dealers. A number of nondealers were among the top 11–20 buyers (tiers 3 and 4). Note that 10.13% of all transactions were cleared through the available clearinghouses (ICE Clear Credit and ICE Clear Europe).

Selling activity was more concentrated in 2012. The top 10 sellers of CDS protection transacted in 73.51% of all contracts traded in 2012, whereas the top 20 sellers captured 83.26% of all contracts sold. Similar to buyers, the top 10 sellers were all dealers, but there were some nondealers in the top 11–20 sellers (tiers 3 and 4), as was also the case for buyers. The disproportionate amount of selling relative to buying by the top 10 dealers suggests that they tend to be net sellers of protection. Not surprisingly, the fraction of contracts sold that were centrally cleared is comparable to the fraction of contracts that were bought and submitted for clearing.[27]

Table 4 also aggregates the top buyers and sellers by gross notional amount of CDS contracts traded in 2012. The qualitative implications are similar to those concerning the number of contracts. For example, the top 20 buyers of CDS protection purchased 77.04% of the notional amount of all contracts in 2012, whereas the top 20 sellers of CDS protection sold 82.61% of the notional amount of all contracts.

Next, we tabulated the average number of contracts traded per counterparty. **Table 5** reports the average daily number of contracts bought or sold by counterparty grouping in 2012. We grouped counterparties into tiers, with tier 1 representing the top five counterparties sorted on the average number of contracts bought or sold per day and tier 7 representing counterparties with the fewest number of

Table 5. Average Daily Number of Contracts Bought or Sold by Counterparty Grouping

Top Buyers	Average Daily Number of Contracts	Top Sellers	Average Daily Number of Contracts
Tier 1 (top 5)	244.73	Tier 1 (top 5)	266.33
Tier 2 (6–10)	176.14	Tier 2 (6–10)	184.49
Tier 3 (11–15)	64.52	Tier 3 (11–15)	67.19
Tier 4 (16–20)	20.23	Tier 4 (16–20)	22.93
Tier 5 (21–100)	3.32	Tier 5 (21–100)	1.92
Tier 6 (101–500)	0.27	Tier 6 (101–500)	0.14
Tier 7 (501–1,298)	0.02	Tier 7 (501–1,100)	0.01

Notes: This table reports the average daily number of contracts traded in 2012. The top buyers and sellers are sorted into seven tiers on the basis of the average number of contracts traded per day. The first four tiers contain the 20 most active counterparties, tiers 5 and 6 contain the next 80 and 400 most active counterparties, and tier 7 includes all other counterparties (501–1,298 for buyers and 501–1,100 for sellers).

daily transactions. Table 5 demonstrates that daily buying and selling is also concentrated among the top 20 counterparties. In 2012, the top buyers (sellers) transacted, on average, 244.73 (266.33) contracts a day. Activity levels drop for counterparties below tier 4; for these tiers, the majority of counterparties bought or sold less than one contract a day. These results indicate that much of the activity is concentrated among a select number of counterparties. Moreover, the number of trades suggests that there is less liquidity in these markets than is typically found in equity markets. The relatively large size of individual trades, coupled with low transaction volume, is more consistent with trading levels in fixed-income markets, which remain over the counter for the most part.

Trading among Counterparties and Network Connectivity. We then characterized, on the basis of trading activity, the network connections across all counterparties. **Table 6** reports the number of connections—that is, the number of counterparties with which each entity (dealer, nondealer, or ICE Clear Credit/ICE Clear Europe) traded CDS contracts. In 2012, there were 8,196 unique connections between 1,536 counterparties.

In describing network connectivity, the concept of density is frequently used to characterize the nature of the connections. Density is defined as the number of actual connections relative to the number of possible connections. The network of CDS connections has a low density (8,196/1,178,880 = 0.0070) because the number of actual links is small compared with the number of all possible links. In 2012, the vast majority of counterparties had no direct bilateral links. The top 5 counterparties had a total of 2,283 buy-side connections with distinct counterparties, whereas the top 20 counterparties had 3,923 buy-side connections. Given the nature of this market, this result makes intuitive sense because the top 5 counterparties are always dealers. We found similar results for both the sell-side and the buy-side/sell-side unique connections.

Table 6 indicates that although the vast majority of trading activity was funneled through the top 10 dealers (Table 4), the top 10 dealers engaged with a large number of nondealer counterparties. The simplest way to illustrate this point is to compute the average number of connections per counterparty from Table 6. Even though the majority of CDS transactions were conducted by dealers only (Table 4), the number of unique counterparties that each dealer engaged with is very high. On average, each of the top 10 dealers had 347.6 buy-side connections [(2,283 + 1,193)/10] and 421.8 sell-side connections [(2,803 + 1,415)/10]. This finding implies a high degree of interconnectivity and a tendency to sell to more counterparties than are bought from. In contrast, "other nondealers" had an average number of buy-side and sell-side connections of 2.8 and 2.3, respectively, which suggests a low degree of interconnectivity and a tendency to buy from more counterparties than are sold to.

Consistent with Peltonen et al. (2013), the picture that emerges from Table 6 is one of a network in which only a small number of all possible links actually exist because the vast majority of the connections are between core counterparties (top 10 dealers) and nondealers. In terms of stability and contagion, this finding suggests that the CDS network may be relatively robust to the disappearance of a random node but could be vulnerable if a few highly connected dealers failed.

We further investigated the bilateral relationships between market participants. **Table 7** shows the aggregate gross notional amounts of CDS protection

Table 6. Number of Unique Connections by Counterparty Grouping

	Buy-Side Connections		Sell-Side Connections		Buy- and Sell-Side Connections	
Grouping	Amount (no.)	Total (%)	Amount (no.)	Total (%)	Amount (no.)	Total (%)
Tier 1 (top 5)	2,283	27.86	2,803	34.20	1,735	31.99
Tier 2 (6–10)	1,193	14.56	1,415	17.26	855	15.77
Tier 3 (11–15)	311	3.79	339	4.14	207	3.82
Tier 4 (16–20)	136	1.66	114	1.39	126	2.32
Other dealers	58	0.71	50	0.61	49	0.90
Other nondealers	4,186	51.07	3,446	42.04	2432	44.85
Central clearing	29	0.35	29	0.35	19	0.35
Grand total	8,196	100.00	8,196	100.00	5,423	100.00

Notes: This table reports the number of distinct connections by counterparty grouping for 2012. The top 20 counterparties of single-name CDS contracts are grouped into four tiers on the basis of the number of unique connections: (1) exclusively buys protection from the other counterparty (buy-side connections), (2) exclusively sells protection to the other counterparty (sell-side connections), and (3) exclusively buys protection from and sells protection to the other counterparty (buy- and sell-side connections). The table also reports the number of connections for the remaining dealer and nondealer counterparties and for all contracts that are centrally cleared.

Table 7. Aggregate Gross Notional Amounts of CDS Protection Bought and Sold
($ millions, except HHI)

	1	2	3	4	5	6	7	8	9	10	Other Dealers	Nondealers	Centrally Cleared	Total	HHI
1	—	9,907	36,123	16,928	17,412	51,533	43,823	34,462	44,520	13,835	13,954	73,941	57,806	414,244	0.11
2	9,888	—	18,869	5,822	5,338	33,386	32,599	18,990	23,306	8,796	6,329	15,740	44,766	223,828	0.12
3	37,347	20,433	—	22,697	27,214	51,790	43,606	23,871	27,141	36,522	43,618	87,537	67,874	489,650	0.10
4	14,166	6,833	16,673	—	11,709	28,926	23,400	17,989	21,563	8,695	9,694	45,586	36,996	242,231	0.11
5	18,452	6,272	28,965	9,184	—	39,566	41,244	32,950	28,168	8,882	9,083	39,646	47,492	309,906	0.11
6	52,752	34,038	55,911	31,466	44,176	—	54,260	37,627	39,790	53,517	50,814	118,461	100,149	672,962	0.10
7	50,236	28,906	47,510	27,413	41,837	64,353	—	33,151	34,093	35,926	45,925	3,312	79,301	491,962	0.10
8	34,266	21,219	24,831	18,362	28,248	38,285	29,560	—	31,661	30,953	41,937	46,699	76,182	422,202	0.10
9	41,201	20,471	26,615	23,564	26,207	41,946	28,294	30,581	—	24,690	73,411	50,119	57,242	444,340	0.10
10	13,166	10,746	39,103	11,379	9,668	53,866	38,901	29,402	30,324	—	24,012	21,746	50,095	332,408	0.11
Other dealers	17,162	6,133	43,922	8,993	10,694	53,877	47,830	40,388	82,501	26,374	7,743	23,781	64,179	433,578	0.11
Nondealers	79,613	18,574	98,277	38,422	46,005	136,400	5,300	59,341	60,808	28,337	22,316	631	—	594,022	0.13
Centrally cleared	58,851	40,035	71,386	35,925	48,620	105,092	74,771	79,394	62,934	43,997	58,603	—	—	679,607	0.10
Total	427,099	223,567	508,186	250,156	317,125	699,020	463,588	438,146	486,809	320,524	407,438	527,199	682,082	5,750,938	**0.08**
Average															**0.11**

Notes: This table reports the network of buyer bilateral transactions for the top 10 dealers, other dealers, nondealers, and centrally cleared contracts (ICE) across all reference entities in 2012. Each row shows the gross notional amount of CDS purchases by a top 10 dealer, other dealers, nondealers, and ICE from other top 10 dealers, other dealers, nondealers, and ICE. HHI is a concentration index.

that was bought and sold in 2012. It reports notional amounts for the top 10 dealers, other dealers, and nondealers; the amounts that were centrally cleared; and the grand total.[28] The top 10 dealers were those that had traded the largest gross notional amounts in 2012.[29]

To understand the table's content, note that each row reports the aggregate gross notional amounts of CDS protection purchased by one counterparty from others, with the counterparties consisting of the top 10 dealers, other dealers, nondealers, and ICE. Each column reports the aggregate notional amounts of CDS protection sold by that counterparty to other counterparties. For example, the first row of Table 7 reports that Dealer 1 purchased $9.907 billion and $43.823 billion of credit protection from Dealers 2 and 7, respectively.[30] It also shows that $79.613 billion of Dealer 1's CDS protection sales were to accommodate the demand from nondealers.[31] Of the $414.244 billion of gross notional protection purchased by Dealer 1 in 2012, only 14% (57,806/414,244) was centrally cleared (i.e., purchased by ICE).

Table 7 shows that most transactions were between dealers that might have been managing their inventories after entering into initial transactions with nondealers. We also found some evidence of dealer-to-dealer clienteles, which can be seen in Table 7 as a tendency for dealers to direct a greater fraction of trades to specific dealers. None of the top 10 dealers, however, traded exclusively with any particular counterparty. For example, the largest percentage of both buy and sell transactions for a given dealer was 16.2% (53,866/332,408)—the amount of CDSs that Dealer 10 bought from Dealer 6 as a percentage of the total notional amount of its CDS purchases. On the basis of each counterparty's HHI (ranging from 0.10 to 0.12), there is no evidence of a significant concentration of transactions among the top 10 dealers. We obtained qualitatively similar results using the entropy concentration index as an alternative concentration measure. In unreported results, we split the sample into corporate financial and nonfinancial reference entities and, once again, obtained qualitatively similar results.[32]

Because this analysis focused on gross notional amounts, a corresponding analysis of net notional exposure allowed us to differentiate between market participants that were net buyers and net sellers. This approach afforded us a better understanding of how much credit risk is transferred between market participants and the economic exposure related to counterparty risk. For example, Dealer 1 purchased protection for an aggregate gross notional amount of $9.907 billion from Dealer 2 and sold Dealer 2 protection for a gross notional amount of $9.888 billion. Netting these amounts indicates that across all CDS contracts, Dealer 1 was a net protection seller ($9.907 billion – $9.888 billion = $19 million) to Dealer 2. The small size of the net trades relative to the gross amounts suggests that in the aggregate, their trading activity was fairly flat. We then investigated more closely the net outstanding exposures among market participants.

Network Connectivity with Gross and Net Positions. We characterized network connections across all counterparties on the basis of aggregate gross and net notional positions. By incorporating positions data into our analysis, we were able to evaluate whether the network picture changed relative to our transaction-based analysis.

Table 8 reports aggregate gross notional positions for CDS protection bought and sold as of 28 December 2012. It has the same format as Table 7. Each row shows the aggregate gross notional positions that a particular counterparty has purchased from all the other counterparties, and each column reports the aggregate notional positions that each counterparty has sold. For example, the first row shows that Dealer 1 held $610.284 billion of notional credit protection that it purchased from other counterparties. To accumulate this position, Dealer 1 purchased and continued to own $19.562 billion and $89.025 billion of notional protection from Dealers 2 and 7, respectively. It also sold aggregate notional protection to these same counterparties for $17.430 billion and $89.397 billion.

This analysis tracks the historical accumulation of positions and can be used to determine the most active market participants. Because CDS trades are bilateral contracts that remain open until their expiration date, past transaction activity is reflected in gross notional amounts for an extended period even though the economic exposure may already have been unwound. For example, Dealer 7 was a net protection seller, having accumulated $2.428 trillion of open positions ($1.190 trillion protection bought + $1.238 trillion protection sold), with an aggregate net exposure of –$0.48 trillion. In contrast, Dealer 6 was a net protection buyer, with $2.413 trillion of open positions and an aggregate net exposure of $0.25 trillion. The small net notional exposures relative to the size of the open positions suggest that dealers maintain relatively flat books.[33]

Table 9 nets the aggregate gross notional amounts and reports the net notional positions as of 28 December 2012. Rather than focus on the aggregate net exposure of each counterparty category with respect to itself, Table 9 computes the aggregate net exposure of market participants with respect to one another. For example, the first row shows that Dealer 1 was a net protection buyer from Dealer 2 ($19.562 billion – $17.430 billion = $2.132 billion) and a net

Table 8. Aggregate Gross Notional Positions for CDS Protection Bought and Sold, 28 December 2012
($ millions)

	1	2	3	4	5	6	7	8	9	10	Other Dealers	Nondealers	Centrally Cleared	Total
1	—	19,562	60,133	13,345	32,699	85,153	89,025	60,301	80,369	22,519	67,338	31,732	48,108	610,284
2	17,430	—	34,765	8,476	13,114	61,833	63,593	40,241	48,558	18,123	22,815	10,381	62,337	401,664
3	64,958	39,394	—	38,845	60,913	98,655	83,210	55,813	70,039	53,026	113,524	42,105	66,490	786,972
4	16,460	10,684	33,120	—	19,851	53,366	47,715	37,942	40,757	11,334	22,242	38,759	28,020	360,251
5	36,750	15,048	60,403	19,795	—	94,926	108,848	79,854	87,064	24,280	41,379	36,459	53,804	658,610
6	92,911	62,536	96,645	50,170	94,771	—	143,920	98,193	117,907	101,578	187,275	67,424	105,639	1,218,968
7	89,397	60,477	76,519	45,411	91,046	138,313	—	91,405	111,421	85,717	141,359	133,068	125,980	1,190,113
8	63,730	40,131	53,614	38,802	66,566	87,537	84,222	—	78,230	61,085	140,039	47,491	105,646	867,094
9	75,623	48,511	64,907	39,539	78,078	103,811	109,522	72,623	—	64,424	163,608	81,147	111,940	1,013,733
10	23,611	19,410	52,590	14,881	20,579	91,222	87,048	58,411	74,421	—	48,379	12,443	45,712	548,707
Other dealers	55,371	22,159	97,690	22,583	37,732	169,561	174,627	123,146	189,869	39,708	68,326	203,751	36,485	1,241,011
Nondealers	40,159	18,772	43,573	28,982	45,520	104,486	132,414	57,393	49,661	20,511	144,283	5,813	—	691,569
Centrally cleared	47,796	65,734	73,888	27,533	71,532	105,220	114,119	110,973	108,192	31,004	36,291	—	—	792,283
Total	624,195	422,418	747,849	348,363	632,403	1,194,083	1,238,262	886,294	1,056,488	533,309	1,196,859	710,573	790,162	10,381,258

Notes: This table reports the network of bilateral gross outstanding positions across all reference entities as of 28 December 2012. Each row shows the gross notional amount of CDS outstanding positions by a top 10 dealer, other dealers, nondealers, and centrally cleared contracts (ICE) with respect to other top 10 dealers, other dealers, nondealers, and ICE.

Table 9. Net Notional Positions, 28 December 2012
($ millions)

	1	2	3	4	5	6	7	8	9	10	Other Dealers	Nondealers	Centrally Cleared	Total
1	—	2,132	(4,825)	(3,114)	(4,052)	(7,757)	(372)	(3,428)	4,746	(1,092)	11,967	(8,428)	313	(13,911)
2	(2,132)	—	(4,629)	(2,208)	(1,933)	(703)	3,116	110	47	(1,288)	656	(8,391)	(3,398)	(20,753)
3	4,825	4,629	—	5,725	510	2,009	6,690	2,199	5,132	436	15,834	(1,468)	(7,398)	39,123
4	3,114	2,208	(5,725)	—	56	3,197	2,303	(860)	1,219	(3,547)	(341)	9,777	487	11,888
5	4,052	1,933	(510)	(56)	—	155	17,802	13,287	8,986	3,701	3,647	(9,062)	(17,728)	26,207
6	7,757	703	(2,009)	(3,197)	(155)	—	5,607	10,657	14,095	10,356	17,713	(37,062)	419	24,885
7	372	(3,116)	(6,690)	(2,303)	(17,802)	(5,607)	—	7,183	1,899	(1,330)	(33,268)	654	11,861	(48,149)
8	3,428	(110)	(2,199)	860	(13,287)	(10,657)	(7,183)	—	5,607	2,675	16,893	(9,903)	(5,326)	(19,200)
9	(4,746)	(47)	(5,132)	(1,219)	(8,986)	(14,095)	(1,899)	(5,607)	—	(9,997)	(26,261)	31,486	3,748	(42,756)
10	1,092	1,288	(436)	3,547	(3,701)	(10,356)	1,330	(2,675)	9,997	—	8,671	(8,068)	14,708	15,397
Other dealers	(11,967)	(656)	(15,834)	341	(3,647)	(17,713)	33,268	(16,893)	26,261	(8,671)	—	59,468	194	44,152
Nondealers	8,428	8,391	1,468	(9,777)	9,062	37,062	(654)	9,903	(31,486)	8,068	(59,468)	—	—	(19,004)
Centrally cleared	(313)	3,398	7,398	(487)	17,728	(419)	(11,861)	5,326	(3,748)	(14,708)	(194)	—	—	2,120
Total	13,911	20,753	(39,123)	(11,888)	(26,207)	(24,885)	48,149	19,200	42,756	(15,397)	(44,152)	19,004	(2,120)	163,773

Notes: This table reports the network of bilateral net outstanding positions across all reference entities as of 28 December 2012. Each row shows the gross notional amount of CDS outstanding positions by a top 10 dealer, other dealers, nondealers, and centrally cleared contracts (ICE) with respect to other top 10 dealers, other dealers, nondealers, and ICE.

protection seller to Dealer 7 ($89.025 billion – $89.397 billion = –$372 million). This finding indicates that even though Dealer 1 traded more often with Dealer 7 ($89.025 billion + $89.397 billion = $178.422 billion) than with Dealer 2 ($19.562 billion + $17.430 billion = $36.992 billion), Dealer 1 actually had less economic exposure to Dealer 7. Thus, it is important to emphasize that gross and net positions provide differing views about counterparty risk exposures and the amount of inventory on hand.

Table 10 converts the net dollar positions into proportions based on aggregate gross notional exposure. For example, the nondealer net positions outstanding as a percentage of gross positions outstanding is only –1.4%. Moreover, the largest percentage of net to gross positions is only 2.5%. The results suggest that market participants tend to adjust net exposures dynamically.

Table 11 reports buy-side gross and net notional positions and the net notional as a percentage of total gross positions for five snapshots of the 2012 database: 6 January, 30 March, 29 June, 28 September, and 28 December. The change in net positions over time reveals an interesting trend during our sample period. Although dealers (both top 10 dealers and other dealers) began the year as net protection sellers, they became net protection buyers by year-end ($16.883 billion). Nondealers (e.g., hedge funds, asset managers, and insurers) served as counterparties to these trades and became net protection sellers (–$19.004 billion).[34] Table 11 also shows that both dealers and nondealers decreased their net exposure to CDS contracts. Because more contracts were being centrally cleared by year-end, dealers also had reduced counterparty risk.

Dodd–Frank regulations and SIFI (systemically important financial institution) designations for many banks may have been one of the causes of a general decrease in risks taken by CDS dealers operating as part of a bank holding company. The biggest change seems to have occurred for other dealers and nondealers, which, almost in parallel and with similar magnitude, decreased and increased their net selling, respectively.[35]

Graphical Depiction of Network Connectivity.

Figure 1 captures the overall gross notional amounts traded between counterparties as identified in Table 7. It depicts the connections for the top 10 dealers, other dealers, nondealers, and ICE. The thickness of connections between two counterparties is indicative of the notional amount of CDS contracts traded. Thicker lines indicate larger notional amounts of CDS contracts traded between two counterparties. The size of the nodes reflects the overall amount traded by the particular counterparty. Similar to the results reported in Table 7, most of the transactions were conducted by top 10 dealers and most bilateral transactions were between these top 10 counterparties. Note that many dealers chose to clear their transactions through ICE, although most of their transactions still occurred over the counter.

Figure 2 depicts counterparty topology for all reference entities on the basis of positions data at the beginning of 2012 (6 January 2012). Both network diagrams reflect gross outstanding positions and net outstanding positions. Regarding gross outstanding positions, the top 10 dealers clearly accumulated and held the largest number of gross outstanding positions. Specifically, nodes 6, 7, 8, and 9 are the largest in the network, with ICE representing a significant portion of total gross outstanding positions. Interestingly, the picture for net (buy minus sell) positions is very different. Most of the top 10 dealers (except Dealer 7) had relatively small net exposures to CDS contracts. Instead, several nondealers and other dealers emerged as major net sellers of such contracts—among the top 10 net sellers, 2 were nondealers (ranked 3rd and 8th), 3 were other dealers (ranked 1st, 4th, and 10th), and 5 were top 10 dealers.

Figure 3 is analogous to Figure 2. It provides the same network diagrams as of 28 December 2012. The main takeaway corroborates our findings that dealers lowered their economic exposure and some nondealers emerged as large net protection sellers. Indeed, the two largest net sellers of CDS protection were nondealers. A few top 10 dealers continued to be large net sellers, whereas other dealers noticeably reduced their exposures (ranked 5th, 8th, and 10th among the largest protection sellers).

Conclusion

In this article, we presented the results of our study of the OTC market for credit default swaps. Using network methodology, we mapped the network of connections between dealers and nondealers of CDS contracts. We found that the network of dealers is highly concentrated for different kinds of CDS contracts. More than 70% of all CDS contracts are bought or sold by the top 10 counterparties, all of which are dealers. This finding suggests that there is significant activity among dealers that probably arises from managing net risk exposures. In addition to dealer activity, a number of large nondealers transact at sufficient levels to put them among the top 20 counterparties (based on total CDS contract volume). Overall, the interconnectedness of the CDS market is largely attributable to end users that transact with a relatively small number of dealers, who then manage net exposures by trading among themselves. The picture that emerges is one of a network that is relatively robust to the disappearance of a random node but potentially vulnerable if

Table 10. Gross Notional Amount of CDS Outstanding Positions as a Percentage of Gross Outstanding Positions, 28 December 2012
(all numbers in percentages)

	1	2	3	4	5	6	7	8	9	10	Other Dealers	Nondealers	Centrally Cleared	Total
1	—	5.8	–3.9	–10.4	–5.8	–4.4	–0.2	–2.8	3.0	–2.4	9.8	–11.7	0.3	–1.1
2	–5.8	—	–6.2	–11.5	–6.9	–0.6	2.5	0.1	0.0	–3.4	1.5	–28.8	–2.7	–2.5
3	3.9	6.2	—	8.0	0.4	1.0	4.2	2.0	3.8	0.4	7.5	–1.7	–5.3	2.5
4	10.4	11.5	–8.0	—	0.1	3.1	2.5	–1.1	1.5	–13.5	–0.8	14.4	0.9	1.7
5	5.8	6.9	–0.4	–0.1	—	0.1	8.9	9.1	5.4	8.3	4.6	–11.1	–14.1	2.0
6	4.4	0.6	–1.0	–3.1	–0.1	—	2.0	5.7	6.4	5.4	5.0	–21.6	0.2	1.0
7	0.2	–2.5	–4.2	–2.5	–8.9	–2.0	—	4.1	0.9	–0.8	–10.5	0.2	4.9	–2.0
8	2.8	–0.1	–2.0	1.1	–9.1	–5.7	–4.1	—	3.7	2.2	6.4	–9.4	–2.5	–1.1
9	–3.0	0.0	–3.8	–1.5	–5.4	–6.4	–0.9	–3.7	—	–7.2	–7.4	24.1	1.7	–2.1
10	2.4	3.4	–0.4	13.5	–8.3	–5.4	0.8	–2.2	7.2	—	9.8	–24.5	19.2	1.4
Other dealers	–9.8	–1.5	–7.5	0.8	–4.6	–5.0	10.5	–6.4	7.4	–9.8	0.0	17.1	0.3	1.8
Nondealers	11.7	28.8	1.7	–14.4	11.1	21.6	–0.2	9.4	–24.1	24.5	–17.1	0.0	—	–1.4
Centrally cleared	–0.3	2.7	5.3	–0.9	14.1	–0.2	–4.9	2.5	–1.7	–19.2	–0.3	—	—	0.1
Total	1.1	2.5	–2.5	–1.7	–2.0	–1.0	2.0	1.1	2.1	–1.4	–1.8	1.4	–0.1	

Notes: This table reports the network of bilateral net outstanding positions as a percentage of gross outstanding positions across all reference entities as of 28 December 2012. Each row shows the gross notional amount of CDS outstanding positions as a percentage of gross outstanding positions by a top 10 dealer, other dealers, nondealers, and centrally cleared contracts (ICE) with respect to other top 10 dealers, other dealers, nondealers, and ICE.

Table 11. Buy-Side Gross and Net Notional Positions for Five Snapshots of the 2012 Database

	Buy-Side Gross Notional Positions ($ millions)					Buy-Side Net Notional Positions ($ millions)					Net Notional as Percentage of Total Gross Positions				
	06 Jan	30 Mar	29 Jun	28 Sep	28 Dec	06 Jan	30 Mar	29 Jun	28 Sep	28 Dec	06 Jan	30 Mar	29 Jun	28 Sep	28 Dec
1	691,966	686,108	642,258	628,145	610,284	(12,498)	(14,082)	(21,733)	(17,668)	(13,911)	–0.9%	–1.0%	–1.7%	–1.4%	–1.1%
2	403,782	401,521	404,273	396,647	401,664	(25,481)	(27,270)	(25,273)	(23,359)	(20,753)	–3.1	–3.3	–3.0	–2.9	–2.5
3	812,802	840,858	828,053	820,184	786,972	47,623	49,549	55,896	52,904	39,123	3.0	3.0	3.5	3.3	2.5
4	404,654	406,929	395,084	377,651	360,251	18,636	14,806	11,962	10,437	11,888	2.4	1.9	1.5	1.4	1.7
5	810,031	792,385	731,989	699,803	658,610	30,613	31,058	22,272	19,240	26,207	1.9	2.0	1.5	1.4	2.0
6	1,341,547	1,341,669	1,287,077	1,257,631	1,218,968	34,938	36,872	31,372	24,074	24,885	1.3	1.4	1.2	1.0	1.0
7	1,312,836	1,325,821	1,257,710	1,242,193	1,190,113	(86,492)	(75,092)	(55,264)	(46,910)	(48,149)	–3.2	–2.8	–2.1	–1.9	–2.0
8	954,932	956,204	906,787	899,242	867,094	(15,401)	(14,262)	(17,850)	(15,359)	(19,200)	–0.8	–0.7	–1.0	–0.8	–1.1
9	1,270,818	1,238,093	1,112,660	1,084,680	1,013,733	(21,651)	(29,681)	(35,706)	(46,312)	(42,756)	–0.8	–1.2	–1.6	–2.1	–2.1
10	643,641	656,234	638,415	601,352	548,707	30,151	27,936	33,898	38,316	15,397	2.4	2.2	2.7	3.3	1.4
Other dealers	1,393,007	1,509,916	1,453,769	1,402,390	1,241,011	(126,498)	(82,823)	(61,075)	(48,095)	44,152	–4.3	–2.7	–2.1	–1.7	1.8
Nondealers	647,177	891,833	791,527	768,098	691,569	141,556	98,580	72,525	54,826	(19,004)	12.3	5.9	4.8	3.7	–1.4
Centrally cleared	771,088	790,073	793,882	768,754	792,283	(15,495)	(15,590)	(11,026)	(2,094)	2,120	–1.0	–1.0	–0.7	–0.1	0.1
Total	11,458,281	11,837,643	11,243,485	10,946,771	10,381,258	303,517	258,800	227,926	199,798	163,773					

Notes: This table reports buy-side gross notional positions and net notional positions across all reference entities as a percentage of total gross positions as of 6 January, 30 March, 29 June, 28 September, and 28 December 2012. Each row shows different counterparties: top 10 dealers, other dealers, nondealers, and centrally cleared contracts (ICE).

a few highly connected dealers should fail. We note that the transition to central clearing will be gradual owing to the large number of open bilateral positions currently held by dealers, which will probably take years to be unwound. In the meantime, we believe that tracking gross and net notional exposures is an important barometer of the safety and soundness of large security-based swap dealers.

In addition to analyzing transaction data, we conducted an analysis using quarterly positions data for 2012. We found that, on average, both dealers and nondealers tend to have a small net risk exposure to CDS contracts relative to their gross exposures. This distinction is important because even though firms may have small economic exposures (net positions), counterparty risk is determined by gross exposures. Regarding gross outstanding positions, top 10 dealers clearly accumulate and hold the largest number of gross (both buy and sell) outstanding positions. Interestingly, the picture for net positions is very different. Although most dealers have a very small net exposure to CDS contracts, several nondealers have emerged that are major net sellers of CDSs. On average, dealers are net sellers; however, by the end of our sample period, a number of significant nondealers were selling CDS protection, indicating a potential change of roles in the industry and in the CDS market. This finding suggests that dealers at large bank holding companies reduced their exposure in 2012, possibly to comply with the Volcker rule, which prohibits proprietary trading; other counterparties, such as hedge funds, have filled this gap.

With our data, we were also able to capture the beginning of contract clearing through ICE. We found that contracts tended to be cleared at an increasing rate over the sample period. As more and more contracts are cleared, it becomes increasingly important to study the network relationships of clearable and cleared contracts to see whether risk is being concentrated in certain entities. Understanding the dynamics of network topology and the effect on dealer connections of an eventual migration to central clearing will lead to a better understanding of the fragility and potential contagion of the CDS network. This knowledge can help academics and regulators identify factors necessary to prevent network fragility, and it can help practitioners learn how to incorporate the effect of dealer connections into their decision making.

We thank Troy Causey, Benjamin Huston, and Roman Ivanchenko for excellent research assistance.

Notes

1. Dodd–Frank was enacted "to promote the financial stability of the United States by improving accountability and transparency in the financial system, to end 'too big to fail,' to protect the American taxpayer by ending bailouts, to protect consumers from abusive financial services practices, and for other purposes" (Pub. L. No. 111-203, preamble).
2. *Over the Counter Derivatives Reform and Addressing Systemic Risk: Hearings before the Senate Committee on Agriculture, Nutrition, and Forestry*, 111th Cong., S. Hrg. 111-803 (2 December 2009).
3. For purposes of this article, "swap" refers to (1) swaps regulated by the Commodity Futures Trading Commission (CFTC) and (2) security-based swaps regulated by the US SEC. The statutory requirements imposed on both markets by Title VII of the Dodd–Frank Act are similar, and in many cases, the rule-making efforts of both agencies have evolved in parallel.
4. According to Pirrong (2011, p. 6), "Widespread defaults on derivatives contracts may harm more than the counterparties on the defaulted contracts. The losses suffered by the victims of the original defaults may be so severe as to force those victims into financial distress, which harms those who have entered into financial contracts with them—including their creditors, and the counterparties to derivatives on which they owe money. Such a cascade of defaults can result in a systemic financial crisis."
5. See, for example, Gregory (2010); Duffie and Zhu (2011); Arora, Gandhi, and Longstaff (2012). Siriwardane (2015) demonstrated that the concentration of CDS protection sellers leads to higher volatility risk premiums; he also showed that capital fluctuations of the largest sellers are an important determinant in CDS spread movements.
6. Examining the 250 largest North American single-name contracts, Porter (2015) found that characteristics of many CDS reference entities that were ineligible for clearing were similar to those of other reference entities that had been approved for clearing.
7. Using a sample of 35 financial reference entities during the financial crisis (2007–2009), Shachar (2012) studied the role of dealers in providing liquidity. Using a snapshot of data for CDS positions on 30 December 2011, Peltonen, Scheicher, and Vuillemey (2013) examined the determinants of the network structure of CDS markets. Looking at all global CDS transactions between 1 May and 31 July 2010 in which at least one G14 dealer was a counterparty to the trade, Chen, Fleming, Jackson, Li, and Sarkar (2011) analyzed aggregate market liquidity and trading activity in the CDS market. Examining Federal Deposit Insurance Corporation (FDIC) call reports with off-balance-sheet bank data for the fourth quarter of 2007 and 2008, Markose, Giansante, and Shaghaghi (2012) reconstructed the network exposures of large bank holding companies.
8. The database provided by the DTCC included all transactions with at least one of the following: (1) a US reference entity, (2) a US counterparty, (3) a foreign branch of a US counterparty, or (4) a foreign affiliate of a US counterparty—all of which implies that neither foreign branches of US counterparties nor their foreign affiliates were excluded.
9. See Battiston, Delli Gatti, Gallegati, Greenwald, and Stiglitz (2009); Billio, Getmansky, Lo, and Pelizzon (2012); Acemoglu, Carvalho, Ozdaglar, and Tahbaz-Salehi (2012); Acemoglu, Ozdaglar, and Tahbaz-Salehi (2013); Diebold and Yilmaz (2014). Network approaches have also been used successfully in nonfinancial markets. Csermely, London, Wu, and Uzzi

(2013) conducted a comprehensive analysis of the structure and dynamics of core/periphery networks, showing that such networks are found in cellular functions, species adaptation, and social and market changes.

10. Networks can be constructed by using such direct connections as repayment of interbank loans (Acemoglu et al. 2013); interbank payment flows (Soramäki, Bech, Arnold, Glass, and Beyeler 2007); linkage of balance sheets (Shin 2008, 2009); municipal bond transactions (Li and Schurhoff 2012); and asset commonality (Allen, Babus, and Carletti 2012)—or by using indirect connections based on principal component analysis (PCA) or causality in equity returns (Billio et al. 2012) and CDS spreads (Billio, Getmansky, Gray, Lo, Merton, and Pelizzon 2015).
11. See 79 Fed. Reg. 21; 17 C.F.R. 255 (5536–5806).
12. The main point of contention among those required to comply with the Volcker rule centered on the difficulties in differentiating between legitimate market making and proprietary trading. Because outsize net notional exposures could be viewed as speculative risk taking, dealers are expected to face regulatory pressure to maintain relatively small net notional exposures.
13. ISDA has developed a standard legal documentation format for CDS contracts that includes a list of credit event situations (ranging from bankruptcy to debt restructuring). Although contract counterparties are free to amend the ISDA definitions, the vast majority of CDS trades are covered by the standard ISDA documentation.
14. Data for the analysis included "gold record" transactions submitted to the Trade Information Warehouse. A gold record is a record whose status in the TIW is "certain," which means that the transaction has been confirmed and has satisfied certain business validation rules and other requirements of the TIW. Under TIW rules, a gold record generally represents the definitive record of the transaction and supersedes any other documentation or understanding—whether written, oral, or electronic—between the parties. See "DTCC Derivatives Repository Ltd. Operating Procedures," Appendix on TIW records, rev. 2012-1 (1 August 2012): 4–5.
15. See www.swapsinfo.org/charts/swaps/notional-outstanding?date_start=2012-01-01&date_end=2012-12-28&products=snre&suggest=&search=&type=&submit=Update+Data.
16. Because this classification is based on DTCC data, the universe of dealers may not correspond to the same set of entities that the SEC requires to register as "security-based swap dealers."
17. Using the DTCC approach for reporting CDS gross and net notional amounts, we identified market participants on the basis of counterparty family. A counterparty family typically includes all the accounts of a particular asset manager or corporate affiliate rolled up to the holding-company level. For more information, see www.dtccdata.com/products/trade-information-warehouse.
18. Transactions are cleared by ICE Clear Credit. In 2009, ICE Clear Credit became the world's first central counterparty for CDS contracts. The full list of 28 clearing members that can clear contracts through ICE Clear Credit is available at www.theice.com/clear-credit/participants.
19. The DTCC labels novated transactions as "assigned" to a different counterparty and labels cash-settled transactions as "terminated."
20. We also excluded multi-name nonindex CDS trades from our analysis. The single-name corporate and sovereign CDS contracts in our analysis represent 74.15% of all CDS transactions in 2012.
21. There are a number of different concentration measures. All are similar in that they capture the dispersion of trades across different counterparties. Bikker and Haaf (2002) surveyed various concentration measures used in the banking industry—specifically, the *k* bank concentration ratio, the Herfindahl–Hirschman Index (Herfindahl 1950; Hirschman 1964), the Hall–Tideman Index (Hall and Tideman 1967), the Rosenbluth Index (Rosenbluth 1955), the Comprehensive Industrial Concentration Index (Horvath 1970), the Hannah and Kay Index (Hannah and Kay 1977), the U Index (Davies 1979), the multiplicative Hause Index and the additive Hause Index (Hause 1977), and the Entropy Concentration Index (Jacquemin 1975). Concentration measures can be classified according to their weighting scheme and structure (discrete versus cumulative). Marfels (1971) and Dickson (1981) discussed the weighting schemes of a number of concentration ratios.
22. To mask the identities of dealers and nondealers, *N* represents 12 different groupings: the top 10 dealers, the set of all other dealers, and the set of all nondealers. The concentration index thus ranges from 1/11 to 1.
23. Similarly, for each dealer and nondealer *i*, we constructed a sell-side concentration index using the fraction of CDS contract sales to other dealers and nondealers *j*. Note that the concentration index is directional (i.e., buy-side concentration need not be equal to sell-side concentration). Because in our analysis the buy side and the sell side share similar results, we do not report the sell-side results for the sake of conciseness.
24. Some contracts that originated as bilateral transactions were placed in central clearing at a later date. For purposes of the results in Tables 1–3, we treated these transactions as bilateral trades. For Tables 4–11, we treated these trades as if they were centrally cleared on the transaction date.
25. For the 2012 calendar year, we identified 271 distinct trading dates owing to some trading activity on weekends and holidays.
26. We grouped top counterparties into size tiers to preserve counterparty anonymity. We sorted the tier compositions on each characteristic (buy-side/sell-side number of contracts and gross notional traded). Thus, the identities of counterparties in each tier may change for each characteristic.
27. The numbers are not exactly the same because some of the trades that were cleared in Europe (involving foreign entities on foreign reference entities) were not part of our sample. A bilateral transaction with both a US and a foreign counterparty on a foreign reference entity would normally have been included in our data; however, transactions that were centrally cleared reported the counterparties only as the initiating US counterparty and the clearinghouse. To the extent that a foreign counterparty on a foreign reference entity cleared the trade in a foreign clearinghouse, it was excluded from the data and thus the aggregate buy and sell amounts are different.
28. As shown in Tables 4–6, the top 10 counterparties for buys and sells (based on the number of contracts and the gross notional amount) were all dealers.
29. We randomized the order of dealers to mask dealer identities. Note that the labeling for the top 10 dealers is consistent in Tables 7–11.
30. The positive values along the diagonal for some of the categories (nondealers and other dealers) are an artifact of the level at which we aggregated the counterparties. For example, if two wholly owned subsidiaries transacted with one another, it would appear as if the owning entity were buying protection from itself.
31. By construction, each row sums to 100%. Columns need not sum to 100%.
32. These results are available from the authors upon request.
33. This interpretation should be viewed with a certain amount of caution. That is, although the accumulation of positions shown in Table 8 provides us with a measure of historical activity, the net notional amounts reported in Table 9 provide a sense of the economic exposure that counterparties have with respect to one another—with one caveat: The ability to interpret the net positions as true economic exposure is confounded by aggregating across reference entities. Hence, even if, on average, all counterparties have a much smaller net exposure compared with the gross notional amounts, it would not necessarily follow that their true economic exposure is correspondingly flat.

34. This result is consistent with Siriwardane (2015).
35. A more careful inspection of Table 11 shows that the flattening of the books of the top 10 dealers took place more on the buy side than on the sell side of their portfolio (meaning that the top 10 dealers decreased their net long positions more than they decreased their net short positions). As a result, the top 10 dealers went from being flat (in aggregate) to becoming net sellers, whereas other dealers went from being large net sellers to net buyers. The combined net positions of the top 10 dealers went from $438 million on 6 January to –$27.269 billion on 28 December, whereas the combined net positions of other dealers went from –$126.498 billion to $44.152 billion.

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