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Abstract

The rapid growth of the credit default swap (CDS) market and the increased number of defaults in recent years have led to major changes in the way CDS contracts are settled when default occurs. Auctions are increasingly the mechanism used to settle these contracts, replacing physical transfers of defaulted bonds between CDS sellers and buyers. Indeed, auctions will become a standard feature of all recent CDS contracts from now on. In this paper, we examine all of the CDS auctions conducted to date and evaluate their efficacy by comparing the auction outcomes to prices of the underlying bonds in the secondary market. The auctions appear to have served their purpose, as we find no evidence of inefficiency in the process: Participation is high, open interest is low, and the auction prices are close to the prices observed in the bond market before and after each auction has occurred. We qualify our conclusions by noting that relatively few auctions have taken place thus far.

Key words: credit default swaps, settlement, auctions, recovery basis, corporate bonds, default

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A credit default swap (CDS) is essentially an insurance policy on corporate debt (i.e. a bond or a loan) where the CDS buyer pays a quarterly premium and the CDS seller promises to cover the losses on the debt should it go into default (see top panel of Figure 1). The CDS market is the second largest over-the-counter market in the US, according to the Bank for International Settlements (BIS) data.[1] Trading in this market also has important implications for systemic risk. In particular, the opaqueness of the market means that participants often do not know the true credit risk exposure of CDS sellers, creating further uncertainty at times of crisis. For example, following the bankruptcy of Lehman Brothers in September 2008, market participants feared that sellers of CDS contracts would face large losses based on the gross notional value of Lehman's CDS contracts, even though the net value of the positions was substantially smaller.[2]

The rapid development of the CDS market has led to a situation where some entities have more CDS protection on them than there are actual bonds. This is because, while the CDS buyer may desire to pay a premium to insure the value of the bond he owns, there is no requirement that he own the bond.[3] For example, the Depository Trust and Clearing Corporation (DTCC), which collects data on a large fraction of the CDS market, recently reported that the notional value of CDS contracts on General Motors' debt summed to $65 billion, which is about $20 billion more than the face value of the debt owed by GM. Many of the CDS contracts were not purchased by debt investors but by other investors, who may have purchased GM's stock (and hedged the default risk with the CDS) or who hold strong views on GM's ability to repay its

[1] See Gyntelberg and Mallo (2008).
[2] This is because many dealers and hedge funds were holding both long and short CDS positions on Lehman, and so these positions offset one another. The opaqueness of the CDS market created additional problems as market participants did not know the gross notional value of Lehman's CDS contracts.
[3] Instead, the investor may purchase a CDS contract to place a bet on the credit quality of the bond (i.e., that it will decline) or to hedge his position in the firm's stock.

debt. The disconnect between the size of claims owed by the defaulting corporation and the aggregate notional value of CDS contracts covering the firm's obligations complicates the way in which CDS claims are settled. In the event of default, one way to settle up the CDS contract is for the buyer to hand over the bond and receive the face value of the bond in cash. If this method of settlement were the only way for the CDS buyer to receive his payment in default, there might be a mad scramble among CDS buyers to get their hands on the limited number of bonds outstanding. The use of auctions to settle CDS contracts should allow for more transparency in the process and could lead to recovery rates that are closer to the true economic risk involved in the contracts. However, it is an empirical issue as to how well they work in practice.

In this edition of *Current Issues*, we discuss the use of auctions to settle CDS claims of defaulted firms. The auctions establish a market price of the defaulted bonds and thereby determine the payment from the CDS seller to the CDS buyer. To the extent that CDS contracts are settled through the auction, the auction makes it more likely that all CDS contracts will be settled at a single price. In addition, the auctions improve the efficiency of the settlement process by reducing the cash flow required to settle the CDS contracts, as the net value tends to be substantially smaller than the gross value of these contracts. While participation in the auctions is currently on an ad hoc basis, auction mechanisms will be "hardwired" into all CDS contracts from now on, meaning all counterparties will be required to participate in the auctions.[4]

We discuss how CDS auctions work, and assess the efficacy of the auctions by examining results from the 43 CDS settlement auctions that have been held since 2005 (such as those of Lehman Brothers, Fannie Mae and Freddie Mac). CDS auctions establish the expected

[4] The International Swaps and Derivatives Association (ISDA), whose rules are followed in the vast majority of CDS contracts, adopted a protocol in April 2009 that requires all future CDS contract defaults to be settled via an auction.

recovery rate of the underlying debt, but so do secondary debt market prices, and these two rates need not be equal. We investigate recoveries on defaulted bonds and assess how much the implied recovery diverges from those established in the CDS auctions. Our study shows that the CDS settlement auctions tend to have settlements that imply recovery prices similar to those for bond investors. That is, in most of the auctions we examine, the recovery price established was close to that implied by the secondary bond market prices immediately prior to the auctions.

Why is an Auction Necessary to Settle CDS Contracts?

When a bondholder purchases a CDS contract as protection against the risk of default of the bond, he will be reimbursed in full for the face value of the bond when default occurs. Like an automobile owner whose car is "totaled," once he is paid off he no longer cares about the true value of the bond. If that value changes because the asset value of the distressed firm or the position of the bond in the liability structure changes after default, the bondholder cares little about the effects on the recovery value of the bond. However, the CDS seller cares very much about getting the best value for the defaulted bond because the lower the bond price, the more the CDS seller must pay out. One way to ensure that the CDS seller is most favorably treated upon default is to have the bond investor give the bond to the CDS seller upon default, in exchange for its face value. In this scenario, the CDS seller would become the bondholder and he would have a great incentive to maximize the recovery rate.

This approach, called *physical settlement*, is incorporated in standard CDS contracts. The second panel of Figure 1 provides an illustration. Suppose an investor buys protection on $10 million of bonds from a CDS seller. Assume that, in the event of default, the recovery rate on

the bond is 40%. Then, with physical settlement, the CDS buyer gives the bond (which is now worth $4 million) to the CDS seller and receives a payment of $10 million in exchange.

Drawbacks of this approach became apparent with the rapid growth of CDS indexes because a firm's debt obligations can be included in a number of different indexes. Consequently, the notional value of the CDS contracts referenced to a firm often exceeds the value of its debt. For example, only about a third of Lehman's CDS contracts could have been written to hedge the underlying bonds, while the remaining two-thirds were pure derivative positions. Physical settlement is not desirable for CDS buyers with pure derivative positions since they would need to source the bond in the open market.

When there are more contracts than bonds outstanding, a defaulted bond can be obtained only in a roundabout way: A bond would be handed over upon default to a CDS seller who would then sell the bond, at which point another CDS buyer could buy the bond to use it in physical settlement of his contract. This desire to get one's hands on the scarce bonds is likely to drive up the price artificially beyond its expected recovery value, reducing the value of the CDS contract to its buyers. A "squeeze" on the bond markets is made more likely by the requirement that the physical settlement process must begin within 30 calendar days of the credit event.[5] With so much trading of a short supply of bonds, the law of one price would not hold: CDS contracts on the same underlying risk would settle for different prices, depending on how successful the CDS buyer was at obtaining the physical bond at a low price.

An alternative to physical settlement is *cash settlement*. In this case, if the CDS seller and the CDS buyer can agree on the value of the defaulted bond (i.e. its recovery rate), then the

[5] Another consideration in the case of physical settlement is whether having the CDS seller engaged in the workout of the debt is the most effective way to maximize recovery rates. Investing in distressed default requires good credit analysis skills as well as strong negotiating ability, and it may be that the bondholder is better suited to this work than the CDS seller.

contract can be settled simply by having the seller pay the buyer the loss given default. This is illustrated in the bottom panel of Figure 1. Assuming a recovery rate of 40%, the CDS seller pays a compensation of $6 million to the CDS buyer if the company defaults.

A difficulty with cash settlement is the need for a reference price of the defaulted bond. Even in the best of times, obtaining reliable prices for corporate bonds is difficult as the market is quite thin.[6] Trading may be equally sloppy or worse following default and volatility from information may make it is even more difficult to obtain a reference price for the bond. CDS contracts can also be written on bank loans, and this debt market has even more severe problems with thin trading and lack of price transparency. The CDS auction provides a method for all CDS contracts to be settled at the same recovery for the same bond (or loan). In practice, following a credit event, interested CDS buyers and sellers send a notice to the ISDA prior to a "cut-off" date agreeing to adhere to a "protocol." The protocol amends the existing CDS documentation to allow settlement at a single "final price" for all adhering parties.

The Auction Mechanism

The auction mechanism in use today is designed to discover a *uniform* recovery price for the underlying debt and to allow investors the option to either *cash settle* or (effectively) *physically settle* (until 2006, ISDA auctions only allowed physical settlement). The uniform price eliminates "recovery basis risk" which would otherwise occur if the recovery were different for different instruments. For example, an investor may have hedged a CDS position on a single firm with another position on a CDS index that included the firm. If the investor were to

[6] Until the mid-1990s, with the advent of published data on insurance company transactions, transaction bond prices were not readily available to market participants and the best indicator of value was a dealer quote (see Sarig and Warga (1989)). More recently, transaction price data are available from filings required by the SEC in the TRACE system, but sparse trading still affects reliability of the prices.

physically settle these trades, he may have to source or sell bonds at different times and at different prices, leading to unexpected profit or loss on a position that is theoretically supposed to have zero profit or loss. The single recovery price for all of the investor's positions eliminates this economic uncertainty.

Firms may have many bonds outstanding before default occurs and the prices at which these bonds trade depend on a number of factors besides the default risk of the firm. Bonds that are more senior in the liability structure should receive higher recoveries in default. Further, bonds differ in their coupons and maturity and face value (which proxies for the liquidity of the bond), which also affect their trading value. However, once a firm goes into bankruptcy, the only relevant feature of the bond that would cause its value to differ from that of another is seniority. CDS auctions treat all of a firm's debt obligations with the same seniority as if they were the same security and assign the same recovery rate to all of the obligations in that class. The auctions held to date have been for loans (which are usually the most senior obligation owed by a company), senior bonds, and subordinated bonds.

The option to cash or physically settle is made possible by incorporating the trading of bonds or loans into the auction process. All the actual CDS trades in the auction are cash-settled at the final auction price. Cash settlement eliminates the need for investors with derivatives-only positions to source bonds, and mitigates the problem of "squeeze" that arises from the volume of CDS outstanding being greater than that of the underlying. Investors who choose to cash settle do not make a physical settlement request. The physical settlement option allows the investor's net bond position after auction settlement to be the same as their position after physical settlement. The advantage of the auction is that physical settlement occurs only on the net open

position of investors, which reduces considerably the amount of bond or loan trades required to physically settle the CDS trades.

The physical settlement segment of the auction is made up by trading the underlying cash obligation so that a protection buyer pays a net amount that adds up to par (defined as the actual principal balance outstanding for the bonds), and also gets the equivalent par amount of obligations off of their books. For example, an investor that bought protection for $10m sells $10m par of bonds in the auction and, assuming a recovery rate of 40%, is compensated $6m (i.e. 60% of $10m). As the bond trades that occur in the auctions take place at the final auction price (equal to the assumed recovery rate), the investor receives $4m for the bonds/loans, in total receiving $10m, and pass off $10m par of bonds to a buyer in the auction. Protection sellers make requests to buy bonds in the auction (as normally they would be delivered bonds in physical settlement).[7]

The auction process has two stages (we provide a detailed numerical example in Box 1 based on the Lehman bankruptcy).[8] In stage one, dealers post bid and offer prices for the underlying debt for a pre-defined amount and a pre-defined spread (the amount may vary by auction) resulting in an initial recovery rate ("*inside market mid-point*"). The initial rate is used to constrain the final (second stage) auction price. In addition, participants who wish to physically settle make requests to buy or sell debt at the final (second-stage) price. Then, the open interest (the net of buy and sell requests) is calculated.

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[7] The documentation for the auctions legally associates physical settlement request trades with the derivative trades such that the two transactions are legally one transaction. The physical settlement requests are constrained by the investor's derivative position –the request an investor can make is between zero and the amount of bonds/loans they would trade to fully physical settle their position. For example, a protection seller who needs to deliver $10m of the underlying bond or loan can only submit a sell request between 0 and $10m face value of underlying.

[8] The procedures described here, which have been in place since the Delphi CDS auction of 2005, apply to bonds. When the underlying debt is a loan, rather than a bond, the auction mechanism involves additional procedures. The interested reader is referred to Gross and Saperia (2008).

The first stage process is typically completed in 15 minutes. Within 30 minutes of the end of the first period, Markit (a major vendor of CDS data) publishes on www.creditfixings.com a number of metrics from the first stage auction, of which the key ones are:

- The inside market mid-point (average of the highest offers and the lowest bids)
- The size and direction of open interest

Following publication of the initial results, dealers have two to three hours to decide whether to submit limit orders (i.e. orders to buy or sell an amount at a firm price) for the second part of the auction, and at what terms. If the open interest is zero, then there are no limit orders and the final recovery price is equal to the initial market mid-point. If the open interest is to sell (buy), then dealers place new limit orders to buy (sell). In addition, the open interest in the first stage is carried over into the second stage of the auction as limit orders.

At the second stage Dutch auction, the open interest is matched to the limit orders to establish a price that eliminates the excess demand for or supply of bonds. If the open interest is to buy, the lowest 'sell' limit order submitted is matched to the amount of open interest equal to the size of the limit order. For example, if the limit order is to sell $10m of bonds, then this is matched against $10m of open interest to buy. If the open interest is to sell, then the highest 'buy' limit orders are used. The next step is to take the second lowest sell order (in the case of buy open interest) or the second highest buy order (when the open interest is to sell) and match these. The process continues until all the open interest is matched, or the limit orders are exhausted. In the former case, the last limit order used to match against the open interest is the final price. If the limit orders are exhausted, then the final price is the par when the open interest is to buy and zero when open interest is to sell. The second stage auction price is the final recovery price.

Auction Results

We review the results of the ISDA auctions that have been held to date in Table 1. Since the first auction in 2005, the ISDA has reported the results of 43 auctions, most of which occurred in 2008 or 2009. A few of these involve obligations issued by foreign firms or government-sponsored enterprises (Fannie Mae (Federal National Mortgage Association) and Freddie Mac (Federal Home Loan Mortgage Corporation). The latter are quite unusual because, even though these firms were placed in conservatorship (triggering a default event as defined by the ISDA), theoretically the bonds should have had full recovery considering their backing from the U.S. government. Although defaults could lead to auctions at all levels of seniority, most of the U.S. firms' auctions only involved senior bonds. A few also had auctions for subordinated bonds and a handful of auctions on U.S. firms' debt only settled CDS contracts on loans. Loans, being more senior, tend to have higher recovery rates compared to senior bonds, which in turn have higher recoveries than subordinated bonds.[9] Therefore, we report results separately in Panels A, B, and C of Table 1 for U.S. firms' senior bonds, other bonds, and loans, respectively.

According to Moody's, the average recovery rate between 1982 and 2007 has ranged between 38% and 80for senior secured bonds, with an average of 52%. In comparison, the average final recovery was 30% for senior bond auctions following corporate bankruptcies (Panel A of Table 1). Senior bond auctions in 2009 exhibit particularly low recovery rates, perhaps reflecting the severity of the current recession. For senior secured bank loans, Moody's recovery rates have varied between 51% and 88% between 1990 and 2007, with an average of

[9] Absolute priority rule, an important element of bankruptcy law, states that subordinated and unsecured creditors only get paid after senior and secured creditors are paid in full, so we expect lower recovery on these debts. See Moody's Global Corporate Finance (2008).

70%. This compares to an average of 31% for loan auctions (Panel C of Table 1), with recoveries for 2009 again being particularly low.[10]

Are the recovery rates arrived at through the auction reasonably fair prices for buyers and sellers of CDS contracts? One piece of evidence of the auctions' success comes from a survey of auction participants by the G7 Senior Supervisors Group. Respondents to this survey indicated satisfaction with the auctions' mechanism.[11] Participation in the auctions was high, according to the survey, representing 95% of eligible parties. Those few who chose to settle outside the auctions process did so either because they wanted to close out positions earlier or because they had too small a number of affected CDS trades to invest resources in participation. The majority of participants elected to cash-settle. The second column of Panel A of Table 1 shows that nearly all of the U.S. firms' bond auctions included more than 300 participants. Dealer participation in the auctions has also been fairly steady, with between 12 to 14 dealers participating in most auctions.

A primary goal of the auctions is to improve the efficiency of CDS settlement. Increased efficiency should result in large reductions in payments required for settlement due to "netting" or offsetting of long and short positions against the same firm. We do not have numbers for all of the auctions but available data indicates a more than 12-fold reduction in required payments. According to DTCC figures, $72 billion of gross notional value of CDS contracts written on Lehman was reduced to a net cash flow of $5.2 billion from CDS sellers to buyers in the auctions. Similarly, $12 billion of CDS contracts written on Fannie Mae, Freddie Mac and

[10] We do not provide averages for the auctions in Panel B due to the heterogeneous nature of the firms.
[11] See the Senior Supervisors Group (2009).

Tembec was reduced to net payments of $429 million.[12] The large reduction due to netting reflects the high participation rate in the auctions.

Another goal of the auctions is to establish a fair recovery price for the underlying debt. Was the final recovery price reflective of underlying demand/supply conditions? We interpret a negative open interest in the first round as indicative of an excess supply of bonds that should tend to make the final price lower than the initial (first-stage) price. Conversely, a positive open interest should result in a final recovery price higher than the initial estimate. This appears to have been the case (Table 1): the correlation between the open interest and the difference between the final and initial prices is 0.29 for senior bond auctions and 0.71 for loan auctions. Thus the first stage process played an informative role in determining the final recovery price.

In situations of extreme uncertainty, the two-stage process may lead to strange results in the second stage. This happens if the participants revise their initial beliefs strongly. An example is the Fannie Mae auction. The demand for Fannie subordinated debt in the first stage was strong, as indicated by the positive open interest of more than $6 billion (Panel B of Table 1). This resulted in the final recovery rate of Fannie's secondary debt being more than 4% higher than initial estimates; so high, in fact, that the resulting recovery rate of the *subordinated* debt was, perversely, *higher* than that of Fannie *senior* debt (Panel B of Table 1).

In contrast to Fannie, the volume of open interest has been moderate for a majority of the auctions so far, resulting in final recoveries being close to initial estimates. The final minus initial recovery estimates has averaged -2% for the entire sample of senior bond auctions following corporate bankruptcies (Panel A of Table 1).

Implications for Creditor Recovery

[12] See DTCC (2008).

Because both bondholders and CDS sellers are exposed to losses when a firm defaults on its debt obligations, the two instruments reveal the market's opinion of the firm's credit risk. The difference between CDS and bond recovery is known as the "recovery basis." In this section, we estimate the recovery basis by examining the bonds for which transaction data are available in TRACE (those associated with U.S. firms' auctions that took place before 2009). In particular, we are interested in whether the recovery basis is sufficiently large to drive apart the pricing of credit risk in the bond and CDS markets.

Under fairly innocuous assumptions, one can show that the spread on a floating rate corporate bond should be, by arbitrage, equal to the premium on a CDS contract on the same firm (see Box 2). Of course, most bonds are not floating rate, but if interest rates do not move dramatically, the spread on a fixed rate bond and that on a floating rate bond are very similar. A critical assumption in showing the arbitrage relationship between CDS premium and bond spreads is that the loss given default to the bondholder when he does not have credit insurance is exactly equal to the loss experienced by the CDS seller.

If these two figures do not line up, the arbitrage argument fails and it would be inappropriate to consider CDS premium as equivalent to bond spreads as measures of credit risk. In particular, if the CDS seller's losses always exceed bondholder losses in default, we would expect the CDS premium to exceed the bond spread (assuming that only credit risk affects the bond spread and not liquidity). Conversely, the CDS seller's losses may be smaller than that implied by the bond price, perhaps because the bond market is more illiquid than the CDS market and so the CDS auction leads to a more efficient price. In this case, the CDS premium would be smaller than the bond spread on average.

Longstaff, Mithal and Neis (2005) suggest that bond spreads are considerably more sensitive to illiquidity than CDS spreads, implying that CDS auction results are better indicators of actual recovery rates than bond prices at default.[13] A contrary view is that the high liquidity of the CDS market does not carry over to the CDS auction setting, and both recovery rates could be affected by illiquidity or market inefficiencies.

In estimating the recovery basis, we exclude loan defaults, subordinated bond defaults, and bond defaults by foreign firms for lack of data. For the remaining 10 corporate defaults, we identify bond prices on the day of default, the day before the CDS auction, and the day of the CDS auction. We then compare these prices with CDS auction prices. Our analysis is restricted to bonds identified as "deliverable" in the CDS auction that also have transaction data on TRACE.

We find that implied recoveries from CDS auctions and recoveries implicit in bond market transaction prices are generally close (Table 2). The bond price either the day before the auction or the day of the auction is essentially the same as the final recovery price in the CDS auction. Moreover, the bond price on the day of default is a fairly accurate predictor of the CDS auction price, with the important exceptions of Lehman and Washington Mutual. These results suggest that effective price discovery occurred in the bond market.

Price discovery appears to have been less effective in the Calpine auction. The bond price the day before the auction is $33 but drops to $21 on the day of the auction, comparable to the CDS final auction price of $19. Moreover, analysis of Calpine bond trading reveals that the bond price has fluctuated from its level on the day of default, indicating some uncertainty about the recovery value.

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[13] See Longstaff, Mithal, and Neiss (2005).

We noted earlier that reliable bond prices are not easily obtained, in part because corporate bonds do not trade often. Previous studies of corporate bond trades focus on the number of times a single bond trades, but in the case of the auction we need only focus on the number of trades for a *class* of bonds, which by definition will be higher. Table 2 indicates that trading in these defaulted bonds is quite high on the day of default, as nearly all the bonds in the table have hundreds of trades and for Lehman and Washington Mutual the number of trades is in the thousands. Nonetheless, trading drops off sharply by the time the auction occurs, to the point that most bonds only trade dozens of times, not hundreds of times, and some trade only a handful of times. Yet, the lower liquidity of the bond market does not appear to affect the accuracy of the bond prices, as the trading activity level does not appear to be related to how closely the bond market price tracks the auction price.

Of the ten auctions analyzed in Table 2, only four (Dura, Quebecor, Lehman and Washington Mutual) allowed both cash and physical settlement. If the physical settlement auctions were more likely to spur purchases of bonds by CDS buyers who were not hedging, we might see a run-up in the bond prices of the six earlier defaults between the default date and the CDS auction date a month later. The returns for the bonds involved in the earlier (physical settlement only) auctions have uniformly positive returns from the default date to the auction, suggestive of buying pressure that drove up bond prices (last column of Table 2), but the small sample and extreme effect of Washington Mutual's results mean that the run-up in earlier auctions is not significantly different from that of the later auctions.[14] More likely, the price movements reflect information effects during those months.

[14] Washington Mutual's price change reflects new information about the possibility of a higher recovery rate if a deposit at its bank subsidiary is reverted back to the holding company. The t-statistic for the difference in the means of the two groups' returns is only 0.26.

Concluding Remarks

Auctions are increasingly used to settle CDS trades of defaulting firms and they are now a standard feature of all CDS contracts. The purpose of the auctions is to improve settlement efficiency by reducing the net cash flow from the CDS protection seller to the CDS protection buyer required to settle outstanding positions. Further, the auctions establish a uniform recovery price for all of the underlying debt of the defaulting company. Based on auction results for 43 credit events since 2005, we find that the auctions generally served their purpose, as they appear to have allowed participants to settle their positions efficiently, with high participation and low levels of open interest.

The CDS auctions and the bond market provide alternative estimates of credit recovery. If these estimates are far apart, then investors will face recovery basis risk, which is likely to impair confidence in the credit markets. Using historical data, we find little evidence of a large recovery basis, in that estimates of recovery from secondary bond market prices and the CDS auction prices are close. Indeed, in most cases, the bond market price on the day of default is a fairly accurate indicator of the CDS auction price.

The CDS market has played an important, if controversial, role in the pricing of credit risk in recent times. Regulators have been pushing CDS market participants to improve the infrastructure of the markets, in part by encouraging the use of auctions as a settlement device. Our study indicates that CDS auctions indeed have the potential to enhance the efficiency of settlement. However, given the small number of auctions conducted so far, it would be advisable to further study the auctions results in a variety of market conditions.

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Table 1: CDS settlement auction results

Note: Prices are expressed relative to a par value of 100. The initial price is the inside market midpoint from the first stage of the auction. The final price is determined in the second stage by matching the open interest to limit orders. The number of participants is the number of parties adhering to the auction protocol; participants in loan auctions are not required to adhere to a protocol. The open interest is equal to the quantity demanded minus the amount offered of the underlying debt, denominated in either US dollars or Euros. Data is from ISDA, Creditex, and Markit.

Panel A: Senior bond auctions following corporate bankruptcies

Debt issuer	Final price	Number of participants	Initial price	Final minus initial	Open interest (millions)
2009 (through March)					
Smurfit Stone	9	452	8	1	$ -129
Nortel Networks Corp.	12	435	12	0	-290
Nortel Networks Ltd.	7	435	8	-1	-13
Equistar Chemicals	28	309	30	-2	-33
Lyondell Chemical	16	309	23	-8	-143
Millennium America	7	309	6	1	-10
Tribune	2	481	4	-2	-765
2008					
Washington Mutual	57	519	64	-7	-988
Lehman Brothers	9	358	10	-1	-4290
Tembec Industries	83	321	86	-3	-60
Quebecor World	41	589	42	-1	-66
2006					
Dura Automotive	24	327	25	-1	-20
Dana	75	340	75	0	-41
2005					
Calpine	19	323	20	-1	-45
Delphi	63	577	66	-3	-99
Delta Air Lines	18	71	--	--	--
Northwest Airlines	28	71	--	--	--
Collins & Aikman	44	454	--	--	--
Overall Average					
	30	*371*	*32*	*-2*	*-508*

Panel B: Subordinated bonds and non-standard defaults

Debt issuer and description	Final price	Number of participants	Initial price	Final minus initial	Open interest (millions)
2009 (through March)					
Ecuador (senior)	31	42	32	-1	$ 77
2008					
Kaupthing (senior)	7	152	6	1	€ -974
Kaupthing (sub.)	2	152	1	1	-11
Glitnr (senior)	3	134	2	1	-187
Glitnir (sub.)	0	134	1	-1	-55
Landsbanki (senior)	1	137	3	-2	-454
Landsbanki (sub.)	0	137	1	-1	-63
Fannie Mae (senior)	92	652	92	0	$ 12
Fannie Mae (sub.)	100	652	93	7	608
Freddie Mac (senior)	94	652	94	0	79
Freddie Mac (sub.)	98	652	94	4	542
2006					
Dura Automotive (sub.)	4	327	4	0	-77
2005					
Collins & Aikman (sub.)	6	454	--	--	--

Panel C: Loans

Debt issuer and description	Final price	Number of participants	Initial price	Final minus initial	Open interest (millions)
2009 (through March)					
Aleris	8	--	4	4	$ 40
Ferretti	11	--	11	0	€ 0
Smurfit Stone	65	--	68	-3	$ -40
British Vita (1st lien)	16	--	17	-2	£ -11
British Vita (2nd lien)	3	--	3	0	0
Sanitec (1st lien)	34	--	34	0	€ 2
Sanitec (2nd lien)	4	--	4	0	0
Lyondell Chemical	21	--	23	-2	$ -138
Tribune	24	--	23	1	-2
2008					
Hawaiian Telecom	40	--	39	1	-9
Masonite	53	--	51	2	18
2007					
Movie Gallery	92	--	91	1	31
Overall Average					
	31	--	31	0	-9

Table 2: Secondary bond market data compared with auction prices

Note: Prices are expressed relative to a par value of 100. The initial price is the inside market midpoint from the first stage while the final price is determined in the second stage of the auction. Data are from TRACE, Creditex, and Markit.

	Bond prices *(trade counts in parentheses)*			CDS auction prices		Bond return from default to auction
	Day of default	Day before auction	Day of auction	Initial	Final	
2008						
Washington Mutual	28 *(3395)*	65 *(96)*	60 *(206)*	64	57	134%
Lehman Brothers	34 *(2511)*	13 *(246)*	10 *(242)*	10	9	-62%
Quebecor World	46 *(52)*	42 *(1)*	41 *(42)*	42	41	-9%
2006						
Dura Automotive	30 *(236)*	25 *(19)*	24 *(31)*	25	24	-16%
Dana Corp.	68 *(597)*	76 *(156)*	76 *(83)*	75	75	11%
2005						
Calpine Corp.	24 *(290)*	30 *(58)*	20 *(105)*	20	19	27%
Delphi Corp.	59 *(333)*	69 *(196)*	65 *(221)*	66	63	17%
Delta Air Lines Inc.	16 *(280)*	18 *(4)*	18 *(63)*	--	18	11%
Northwest Airlines Corp.	25 *(616)*	29 *(15)*	28 *(57)*	--	28	15%
Collins & Aikman Corp.	42 *(184)*	43 *(21)*	43 *(16)*	--	44	1%

Box 1: Lehman Brothers as an illustration of the CDS auction mechanism

The auction for Lehman Brothers senior bonds provides a good illustration of the general auction mechanism. Lehman Brothers entered Chapter 11 bankruptcy on September 15, 2008, and a CDS settlement auction was scheduled for October 10. In the days prior, 358 parties signed up to adhere to the terms of the auction protocol. These parties took part in the auction process as customers of 14 securities dealers who chose to participate directly in the auction.

Stage 1

On the morning of the auction, each dealer submitted a bid price and an offer price at which they were willing to trade the standard "quotation size" of $5 million (par value) in eligible Lehman bonds if necessary. Each dealer also submitted a physical settlement request to buy or sell bonds at the final auction price, for its own account and on behalf of its customers. Prices are expressed relative to a par value of 100. A dealer's bid and offer price may not differ by more than 2, and the pair is referred to as the dealer's "inside market". Physical settlement requests must be in the same direction as, and not in excess of, a party's market position.

Securities dealer	Bid	Offer	Physical settlement request ($ millions)
Barclays Bank PLC	8	10	buy: 130
Credit Suisse Securities (USA) LLC	8	10	sell: 755
Deutsche Bank AG	8	10	sell: 870
Merrill Lynch, Pierce, Fenner & Smith Inc.	8	10	sell: 141
Morgan Stanley & Co. Inc.	8.25	10.25	sell: 480
UBS Securities LLC	8.75	10.75	sell: 464
Goldman Sachs & Co	8.875	10.875	sell: 1470
BNP Paribas	9	11	sell: 390
JPMorgan Chase Bank, N.A.	9	11	buy: 612
Citigroup Global Markets Inc.	9.25	11	sell: 574
The Royal Bank of Scotland PLC	9.25	11.25	sell: 191
Banc of America Securities LLC	9.5	11.5	sell: 170
Dresdner Bank AG	9.5	11.5	buy: 30
HSBC Bank USA, N.A.	10	12	sell: 187

The auction administrators sort the bids and offers in ascending order. If the highest bid is greater than or equal to the lowest offer, both are removed from the pool, and this process is repeated until every remaining bid is lower than every remaining offer. Then the administrators calculate the arithmetic mean (rounded to the nearest 1/8) of the highest 50% of bids and the lowest 50% of offers (shaded above). This first-stage price is referred to as the "inside market midpoint", and it was equal to 9.75 in the Lehman Brothers auction. The net sum of all physical settlement requests is referred to as the "open interest". In this case, it was $4.92 billion to sell.

Dealers are penalized if this consensus indicates that their original submission was unreasonable. Three conditions must be satisfied for this to happen: 1) the dealer's bid/offer must have been removed from the pool because it crossed with another submission; 2) either the bid must be higher than the inside market midpoint, or the offer lower; and 3) the direction of the open interest must suggest that a reasonable bid should not be higher, or a reasonable offer should not be lower.

In this case, HSBC's bid price of 10 was higher than the inside market midpoint of 9.75, and it crossed with offer prices from other dealers that were also 10. Furthermore, the open interest was to sell bonds, which suggests that dealers should be bidding below the inside market midpoint rather than above it. HSBC met all three conditions, so it had to pay a penalty to ISDA equal to the standard quotation size times the difference between its bid and the inside market midpoint (all told, $12,500).

Stage 2

If the open interest is zero, the inside market midpoint becomes the final auction settlement price. But otherwise, a second stage is conducted in which each dealer can submit any number of limit orders to meet a portion of the open interest at a particular price, either for its own account or on behalf of its customers. In the Lehman auction, the open interest was to sell bonds, so participants submitted limit orders in the form of offers to buy. Second-stage prices are capped at 1 unit above the inside market midpoint (or 1 unit below, if the open interest is to sell) in order to avoid manipulation of the final auction price.

In the Lehman Brother auction, participants submitted 453 offers to buy, ranging from small offers at the cap price of 10.75 to large and very optimistic offers at a price of only 0.125. The median price was 7.5 and the median volume was $50 million. These offers are sorted and then matched against the open interest in descending order. The price of the final matched offer becomes the final auction settlement price. In this case, there were second-stage limit orders summing to $4.92 billion (meeting the first-stage open interest) at prices of 8.625 or higher, so the final settlement price was 8.625. All physical settlements arranged in the auction were executed at this price, and all cash settlements of CDS contracts between parties adhering to the auction protocol were executed at this price too.

Note: Auction results are from Creditex and Markit. The description of the procedure is drawn from ISDA 2008 and Gross and Saperia (2008).

Box 2: Relationship between the CDS premium and the credit spread on a bond

CDS contracts typically state that the buyer will pay a quarterly premium to insure the bond. In the event of default, the CDS buyer receives the difference between the recovery rate on the bond and its face value. If we assume the underlying bond pays a quarterly coupon that floats over LIBOR, we can show that the CDS premium and the coupon are equal. Consider a bond investor who buys a one-year bond with a floating rate coupon of LIBOR plus 2% (annually). The face value of the bond is $10 million. To finance this investment, the bond buyer borrows $10 million at the rate of LIBOR and pays interest quarterly. In this example, we assume that the CDS contract covers one year and default, if it occurs, is at the beginning of the third quarter. The recovery rate is assumed to be 40%. If default occurs the bond investor repays his LIBOR loan immediately (hence no interest is paid in that quarter). Note that the bond investor's position is not insured here (it has no CDS contract on it). The table below shows that an investor who sells a CDS contract with a premium of 2% has the same payoff as one who invests in a portfolio that is long a bond with a spread of 2% and short LIBOR. Hence the premium is equal to the bond spread.

	Quarter 1	**Quarter 2**	**Quarter 3**	**Quarter 4**
No default				
CDS seller portfolio:				
CDS premium	$50,000	$50,000	$50,000	$50,000
CDS payout	0	0	0	0
Total value	$50,000	$50,000	$50,000	$50,000
Bond investor:				
Bond cash flow	L+$50,000	L+$50,000	L+$50,000	L+$50,000+$10 m.
Libor payments	-L	-L	-L	-L-$10 m.
Total value	$50,000	$50,000	$50,000	$50,000
Default occurs in Q3				
CDS seller portfolio:				
CDS premium	$50,000	$50,000	0	
CDS payout	0	0	-10 m. + $4 m.	
Total value	s	S	-$6m	
Bond investor:				
Bond cash flow	L+s	L+s	$4 m.	
Libor payments	-L	-L	-$10 m.	
Total value	$50,000	$50,000	-$6m	

Figure 1: Cash and Physical Settlement of CDS Contracts