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Abstract

Based on individual CDS transactions cleared by the Depository Trust & Clearing Corporation, we show that illiquidity strongly affects credit default swap premiums. We identify the following effects: First, transaction direction affects prices, as buy (sell) orders lead to premium increases (decreases). Second, larger transactions have a higher price impact. This finding stands in stark contrast to corporate bond markets. Third, traders charge higher premiums as a price for liquidity provision, not as compensation for asymmetric information. Fourth, buy-side investors pay significantly higher prices than dealers for demanding liquidity. Last, inventory risk seems to matter little in explaining liquidity premiums.

JEL-Classification: G12, G14

Keywords: CDS; illiquidity; temporary price impact; market power; immediacy; DTCC.

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1. Introduction

Are credit default swap (CDS) premiums a fair measure of the underlying reference entity's default risk? If the market for credit risk were complete and frictionless, CDS premiums would reflect only the credit risk of the reference entity. Since CDS are derivatives, many empirical studies claim that the impact of frictions is limited, and therefore use the CDS premium as a credit risk proxy (e.g., Norden and Weber, 2004, Blanco et al., 2005, Longstaff et al., 2005). Recent theoretical models, however, show that even assets in zero net supply, such as CDS, can be materially affected by illiquidity (e.g., Bongaerts et al., 2011, Garleanu et al., 2009). Since illiquidity premiums are usually either due to real and informational frictions (see, e.g., Stoll 2000), these frictions may well affect CDS premiums. Consistent with this view, recent empirical studies (e.g., Tang and Yan, 2007, Bühler and Trapp, 2014, Badaoui et al., 2013, Corò et al., 2013) document an impact of illiquidity on CDS markets.

In this paper, we show that CDS premiums contain a sizeable, counterparty-specific liquidity premium. The major innovation is that we can precisely attribute these liquidity premiums to specific market frictions. Our analyses are based on a proprietary set of individual CDS transactions on German reference entities cleared by the Depository Trust and Clearing Corporation (DTCC) that spans inter-dealer trades and trades between dealers and buy-side investors.

We first show that traders who sell (buy) protection increase (decrease) their CDS premiums relative to the last trading price by 1.3 bp, or 18% of the average CDS premium change. Compared to the market-average CDS premium, these traders charge a mark-up of 0.9 bps.

Second, we investigate how transactions with different volumes affect premiums. Standard market microstructure theory (see, for example, Kyle, 1985, Keim and Madhavan, 1996) suggest that larger transactions should have a higher price impact. Studies of corporate bond markets, however, have found smaller transaction costs for larger trades (Edwards et al., 2007). We show that CDS markets do not exhibit the same behavior as bond markets: Large trades lead to significantly higher premium changes.

Third, we separate the price impact of a trade into its permanent and transitory components in order to explore whether asymmetric information or real frictions cause the price impact. Following Hasbrouck (1991), we find that transaction direction and order flow have no permanent effect, which allows us to rule out the impact of informational frictions. Hence, we identify the premium adjustments as the price traders charge for providing liquidity.

Fourth, to examine the impact of market power, we distinguish between dealer and buy-side investor trades. Duffie et al. (2005, 2007) show that search costs and bargaining power matter in CDS markets. If buy-side investors in CDS markets have higher search costs than dealers (Feldhütter, 2012, argues that this is the case for corporate bond markets), they are likely to trade at less attractive prices since looking for better trading conditions is too costly. Consistent with this conjecture, we find that buy-side investors pay a significantly higher price for demanding liquidity, while dealers face flat price impact functions.

Last, we explore whether dealers earn the liquidity premiums they charge for taking on higher inventory risk. Even when dealers are behaving competitively, higher inventory risk should result in higher bid-ask spreads and transaction costs (Ho and Stoll, 1983, Dennert, 1993). We address this question by interacting transaction direction and order flow with proxies for the fundamental risk a given transaction entails, and do not find a consistently positive and significant impact.

To summarize, we find that CDS dealers possess market power which allows them to extract rents from buy-side investors. These rents increase in trading volume, but are not a compensation for risks (asymmetric information or fundamental risks) that dealers incur when trading. Rather, they reflect a compensation for liquidity provision services, suggesting that limited competition allows dealers to extract monopolistic rents from their clients (Dunne et al., 2012).

Overall, we are the first to show a significant price of liquidity provision in CDS markets at the transaction level. To our knowledge, only two other papers study the relation between trades and CDS premiums at the transaction level. In contrast to our study, Tang and Yan (2011) do not detect a significant relation between changes in CDS prices and transaction volume. This is presumably because their study is restricted to inter-dealer trades, where differences in market power do not lead to increasing price impact functions. Shachar (2012) also uses DTCC data but examines the impact of financial firms' aggregate end-of-day inventory changes on end-of-day average CDS Markit quotes. Her results differ from ours because (i) she focuses solely on financial firms that are frequently dealers, and (ii) she aggregates transaction level data.

Most other studies use indirect proxies for frictions and/or do not find a sizeable price impact. On the one hand, studies like Acharya and Johnson (2007) find evidence of informed trading in CDS markets, but no price impact. As a potential explanation, they cite their use of bid-ask spreads as the illiquidity measure. We show that the price impact of trading in the CDS market is not consistent with asymmetric information.

On the other hand, studies that measure frictions indirectly via bid-ask spreads (e.g., Tang and Yan, 2007, Bongaerts et al., 2011, Badaoui et al., 2013) typically show a significant relation between spreads and CDS premium levels. However, these studies face two issues. First, they cannot separate fundamental risk from the friction-based component in bid-ask spreads. Therefore, the measure of friction is unreliable and likely to produce biased results. Second, they cannot identify which type of friction is priced. We provide the missing link between both approaches by documenting the price impact of trading in CDS markets measured directly, and attributing it to the price charged by traders when providing liquidity.

We also contribute in two ways to the broader field of derivatives market efficiency and market microstructure. First, we extend the growing literature on price informativeness in derivatives markets. CDS premiums are frequently used as a market-implied credit risk measure because the CDS market is believed to be relatively efficient (e.g., Norden and Weber, 2004, Blanco et al., 2005). Our results, however, indicate that a significant part of consensus CDS prices[1] reflects large transactions by the contributing dealers rather than fundamentals.[2] On a similar note, several recent studies (Garleanu et al., 2009, Bongaerts et al., 2011, Duffie, 2010a) address the impact of price pressure on derivatives markets, but are limited to inferring price impact via aggregate net demand or supply. The question of how elastic CDS prices are is part of the broader topic of derivatives market efficiency, and whether traders have the potential to affect prices via demand-based price pressure (Duffie, 2010a, 2010b, Stulz, 2010). Our data allows us to answer this question at the individual trader level: demand and supply-based price pressure play a significant role in price formation in derivatives markets, and dealers have considerable market power.[3]

The remainder of the paper is structured as follows. In Section 2, we describe the DTCC dataset and how we construct the premium changes and order flows. Section 3 develops the

[1] Among the most frequently used CDS data providers are CMA and Markit, who base their consensus prices on contributions from dealers.

[2] Corò et al. (2013) show that firm-specific and aggregate liquidity proxies affect CDS price variations.

[3] This is of particular importance as empirical evidence such as Blanco et al. (2005) shows that (corporate) bond yield spreads follow CDS premiums. Avino et al. (2013) differentiate between tranquil and volatile periods and show that CDS price leadership is especially strong in calm conditions. Forte and Pena (2009), Norden and Weber (2009), Narayan et al. (2014), and Hilscher et al. (2014) find that equity markets lead CDS markets in price discovery. These results are consistent with CDS markets being more informationally efficient than bond markets, but less so than equity markets.

hypotheses and presents the results. Section 4 displays the results of several robustness checks. Section 5 summarizes and concludes.

2. Data

2.1. The DTCC dataset

Our unique dataset comes from the Depository Trust & Clearing Corporation (DTCC), which provides clearing and settlement services for over-the-counter credit derivatives through its subsidiary DTCC Deriv/SERV LLC.[4] The DTCC estimates that its coverage of credit derivatives amounts to 95% of single-name CDS in terms of the number of contracts, and 99% of single-name CDS with respect to notional amounts.

We study CDS transaction premiums, instead of quotes. This has the advantage that we use reliable, confirmed prices at which traders buy and sell protection via CDS contracts. The European Central Bank endorses this view in its 2009 CDS report: "As the [DTCC] data are based on actual settlement instructions, this may currently be the most accurate data source available."[5] Conversely, studying bid and ask quotes might bias our results towards extreme and unrealistic quotes at which no trades occur.

The DTCC granted us access to its Trade Information Warehouse (TIW) database on all

[4] "DTCC Deriv/SERV provides automated repository and asset servicing for over-the counter (OTC) credit derivatives trades. It also provides related matching of payment flows and bilateral netting services. Deriv/SERV's customer base, which includes dealers and buy-side firms from more than 52 countries, is the market's largest post-trade service provider for OTC derivatives. In 2009, Deriv/SERV processed a record 11.5 million transactions." http://www.dtcc.com/about/businesses-and-subsidiaries/derivserv-llc.aspx

[5] See ECB (2009), p. 11.

single-name CDS transactions (new trades, assignments, and terminations)[6] with German companies as the reference entity starting from late 2001. Our dataset thus fully covers the CDS activities involving German reference entities after the TIW initiation. For each transaction, we have information on: the legal name of the protection buyer and protection seller, a DTCC-specific classification of the buyer and seller as a dealer[7] or buy-side investor, the submitter of the transaction to the DTCC (both buyer and seller submit the transaction details once), the legal name and Markit RED pair code of the reference entity, the ISIN of the standard reference obligation, which allows us to infer the seniority of the CDS, the contract termination date (maturity date), the currency and notional volume of the transaction, the transaction date, and the submission time and date. The data additionally contains a trade-specific conventional CDS premium for new trades, which constitute approximately one-third of all transactions. Even though the data contains no information on the restructuring type, DTCC confirmed that almost all contracts on German reference entities specify modified-modified (MM) restructuring. This convention conforms with the standards suggested by the small bang protocol adopted in June 2009 (Markit, 2009).

[6] Transaction types such as assignments are described in detail in the appendix. Amendments are not included in our dataset, as the DTCC is currently unable to indicate which part of the original CDS contract has been amended.

[7] DTCC defines a dealer as any trader "who is in the business of making markets or dealing in credit derivative products" (http://www.dtcc.com/~/media/Files/Downloads/Settlement-Asset-Services/DerivSERV/tiw_data_explanation.pdf). The financial institutions that DTCC tags as dealers include the G14 dealers: Bank of America-Merrill Lynch, Barclays Capital, BNP Paribas, Citi, Credit Suisse, Deutsche Bank, Goldman Sachs, HSBC, JP Morgan, Morgan Stanley, RBS, Societé Générale, UBS, and Wells Fargo Bank.

Overall, the initial dataset contains 432,560 observations for which 595 market participants (out of which 22 are dealers) submit information on CDS transactions (new trades, assignments, and terminations) for 70 German reference entities. 26 of the 70 reference entities are members of the DAX, the index of the 30 largest German companies in terms of equity market capitalization. The remaining 43 companies are mostly members of the MDAX, and hence rank immediately below the DAX companies. The most frequently traded reference entities are Daimler, Deutsche Telekom, and Volkswagen, representing more than 20,000 transactions each.[8] Around half of the CDS contracts have a five-year maturity on initiation, and 91% of all contracts are senior CDS. 80% of the trades are denominated in EUR, while USD-denominated trades constitute 19% of the sample. The overall transaction volume adds up to EUR 2.8 trillion, of which EUR 1 trillion are new trades.

To verify that the full data is representative of the CDS market as a whole and comparable to the data used in other studies,[9] we compare our data to the full TIW universe of single-name CDS contracts[10] by industry breakdown, dealer participation, transaction frequency, and outstanding and transaction volume. The results are displayed in Table 1.

Insert Table 1 about here.

Panel A of Table 1 shows that our sample is roughly comparable to the full TIW universe by industry breakdown of the underlying reference entity. For our sample, consumer goods and

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[8] These companies are also among the top five when we rank all companies by market capitalization, total debt, or outstanding bond volume as of 2011. We obtain this information from the companies' annual statements and from CRSP.

[9] For instance, Corò et al. (2013) analyze 24,713 transactions on 135 European reference entities.

[10] Data on the full TIW universe is obtained from the DTCC's TIW weekly stock and volume report for the last week of June, 2011. (http://www.dtcc.com/repository-otc-data.aspx)

financials are the most frequent underlying industries, compared to financials and consumer services for the full sample. The least frequent underlying industries in both samples are healthcare, other, and oil & gas. The distribution across industries suggests that neither our sample nor the full TIW universe are dominated by one industry only. Panel A of Table 1 also shows that dealers act as protection buyers in 85% and as protection sellers for 89% of transactions in our dataset, compared to 89% (both as buyers and sellers) for the full TIW universe. The large dealer market share implies the existence of dealer market power (Gündüz et al., 2007) both for our dataset and the full TIW universe.

In Panel B of Table 1, we compare the transaction volume for our dataset to the transaction volume of the full TIW universe. To do so, we sort the underlying reference entities of our dataset into aggregate transaction volume quintiles (where quintile 1 contains the 70/5=14 reference entities with the highest aggregate transaction volume in our dataset, and quintile 5 the 14 reference entities with the lowest aggregate transaction volume in our dataset). We then collect the top 1,000 reference entities from the stock and volume reports for the last week of June, 2011. We then determine whether a reference entity in our dataset is among these top 1,000 reference entities and, if yes, into which transaction volume quintile it falls compared to all top 1,000 reference entities (e.g., whether a top 14 reference entity in our data set is among the top 200 reference entities for the full TIW universe). Panel B of Table 1 displays the proportion of reference entities in a given quintile of our dataset that fall into a specific TIW quintile, e.g., 86% of reference entities in our top transaction volume quintile are also in the top transaction volume quintile compared to the TIW top 1,000 reference entities. Reference entities which fall into our quintile 2 are almost evenly distributed between the TIW top 1,000 quintiles 1 and 2, which indicate a higher trading volume. In contrast, the 28 reference entities which constitute quintile 4 and 5 of our dataset are not among the TIW top 1,000 reference entities. In summary, our dataset comprises not only very actively traded references entities but also less actively traded ones, compared to the top traded ones in the TIW universe.

Last, Panel C of Table 1 indicates how large a market share of single-name CDS contracts our dataset covers. We display the ratio of the outstanding volume and the transaction volume between German reference entities (our dataset) and all European reference entities in the TIW universe reported in the stock and volume reports for the last week of June, 2011. Irrespective of whether we consider outstanding volume or transaction volume, our dataset comprises around 20% of all European reference entities. Consistent with the results from Panel A, the market share of dealer-buy positions is smaller than that for dealer-sell positions. Overall, we conclude from Table 1 that our dataset covers a sizeable and representative share of the CDS market.

2.2. Order flow and transaction premiums

DTCC has been operatively active in building the Trade Information Warehouse database since 2009. Transactions entered into prior to January 2009 have sequentially been frontloaded to the TIW, i.e., open transactions were transferred to the database at some date after the inception date. Using the early period data could bias our results, since transactions cancelled, assigned or terminated prior to the frontloading date would not show up in the data. We therefore choose January 2009 as our starting date for time series construction.

For our empirical analysis, we construct separate submitter-specific time series for each reference entity / ISIN / seniority / currency / maturity combination.[11] This gives us a total of

[11] We might thus overstate or understate the submitter-specific order flows because different term structures and currencies for CDS on the same reference entity constitute comparable credit risk exposures. However, since the correct aggregation procedure is by no means apparent, we prefer to provide a distinct treatment for every individual time series at the lowest possible aggregation level.

9,265 time series for 595 submitters. For each of these time series, we assign a positive sign to notional volumes of transactions when the submitter acts as protection seller and a negative sign when the submitter acts as protection buyer. To synchronize order flow and premium observations at the submitter level (recall that only new trades are associated with a transaction premium), we add up the signed notional volumes of all transactions between two new trades. We standardize the resulting order flow time series as in Hansch et al. (1998) by subtracting the time-series average from the aggregate order flow at each new trade date, and then standardize by dividing this quantity by the standard deviation.

In addition to the DTCC trade-specific CDS premium, we collect Credit Market Analysis (CMA) benchmark market prices from Bloomberg for a CDS contract with the same currency, maturity, and seniority as the DTCC trade CDS. This allows us to benchmark DTCC premiums to market premium quote averages. We use these benchmark premiums and compute the premium change between two new trades in two ways: the premium change (premium of the current trade minus premium of the most recent trade), and the premium mark-up (difference between the current trade premium and the Bloomberg mid CDS premium). We relate these premium changes to the standardized order flow between two new trade dates in Section 3, and present the descriptive statistics for order flows and premiums in Table 2.

Insert Table 2 about here.

Panel A of Table 2 shows the descriptive statistics for order flow. When taking absolute values of the (unstandardized) order flow between new trades, we obtain a mean size of EUR 9.47 million and a median of EUR 5 million, which is of the order of magnitude of the notional volume for new trades. When aggregating across all order flows, we obtain a mean value of EUR -80,000, suggesting that order flow evens out over submitters and time, but the large minimum and maximum values imply that order flow at the individual level and one point-in-time can be sizeable. Normalized order flow by definition has mean zero and standard deviation one, since we demean and standardize order flow at the individual submitter and contract (one specific reference entity / ISIN / seniority / currency / maturity combination) level.

With respect to trading activity, Panel B of Table 2 shows that an individual submitter enters into a new trade for each contract on average once every 28 days. This large mean value, however, is greatly affected by the less frequently traded contracts: the median time between two new trades of each contract at the individual submitter level equals five days. Aggregating across contracts, we find a mean time between trades of one day; the median of zero implies that most contracts are (newly) traded more than once a day. Similarly, aggregating across submitters, we find that mean and median time between new trades equals zero days.

We display descriptive statistics for premiums in Panel C of Table 2. Across all new trades, we observe a mean premium of 185 bps and a median of 95 bps. Compared to the market premium quote average of 205 bps, we obtain a negative average abnormal premium of -13 bps, or -9% of the market premium (relative abnormal premium). The median abnormal premium, however, is much closer to zero with a value of -2 bps, or -1% of the market premium. The large minimum and maximum values for the abnormal premium indicate that actual trades can occur at conditions that deviate considerably from market quotes[12]. Regarding the premium evolution over time, we observe a negative trend over time of -7 bps in our data set, -6 bps for the market premium quote average. These negative values are consistent with a decrease in credit risk in the aftermath of the financial crisis. The negative mean values for the absolute and relative abnormal premium change indicate that the spread between transaction prices and

[12] These large deviations are rare, but not unique: 1,070 observations exhibit an abnormal premium below -250 bps, 1,014 an abnormal premium above 75 bps. This asymmetry agrees with the negative average abnormal premium: average quotes tend to be higher than transaction prices.

quotes is widening over time. Note that the large minimum and maximum values are associated with infrequently traded contracts (compare Panel B); e.g,, the two trades associated with the most negative premium change of -2,589 bps occur on July 14, 2009 and April 4, 2010.

3. Hypotheses development and empirical results

3.1. Does trading affect CDS premiums?

The price impact function is at the core of our analysis. In general, the price at which a trader is willing to sell protection (her ask quote) should be higher than the price at which she is willing to buy protection (her bid quote). Hence, if liquidity plays a role in CDS markets, protection sales should occur at higher prices than protection buys. Since we do not observe quotes, but transaction prices, we take the difference between the current transaction premium submitted by a trader and the last transaction premium submitted by this trader as the dependent variable (premium change). Alternatively, we consider the premium change since the previous transaction in excess of the Bloomberg mid premium change during the same time interval (markup change). We formulate the following hypothesis:

H1: Transaction direction

CDS traders increase (decrease) their CDS premium when selling (buying) protection.

$$\Delta prem_t = a + b \cdot \left(1_{\text{submitter=seller}} - 1_{\text{submitter=buyer}}\right) + \varepsilon_t, \qquad (1)$$

where Δprem_t is the premium change (markup change) since the most recent trade of the same CDS contract (same underlying, currency, maturity, and seniority) by the same submitter, $1_{\text{submitter=seller}}$ is a dummy variable equal to 1 if the CDS trader sells protection, and $1_{\text{submitter=buyer}}$

is a dummy variable equal to 1 if the CDS trader buys protection in the current transaction.[13] If liquidity plays a role, we expect $b > 0$.

Our regression equations require that the time series of CDS premium changes and order flows are stationary. In order to minimize the impact of outliers (recall from Table 2 that two trades can be as much as 679 days apart), we only include submitter/contract combinations for which we observe at least 20 new trades in our observation interval. Non-stationarity is rejected for all remaining time series in an Augmented Dickey-Fuller test. We use pooled OLS to estimate the regression equations and control for time-invariant differences between the time series by including submitter, underlying, currency, and maturity fixed effects separately and simultaneously. The estimation results are presented in Table 3.

Insert Table 3 about here.

Consistent with Hypothesis 1, Panel A of Table 3 documents a statistically significant premium increase when CDS traders sell protection and a statistically significant premium decrease when they buy protection. Regarding the economic significance, a CDS sale

[13] Equation (1) gives rise to three econometric concerns. First, we do not use the dummy variables separately. However, Equation (1) is still well-specified since the two dummy variables are complementary. We use the difference between the two dummy variables to obtain a unique sign of the factor loading. Second, the DTCC records one submission each from protection buyer and protection seller. However, the left-hand side of Equation (1) will still differ between buyer and seller in most cases, since the last transaction prior to the current one is unlikely to have occurred at the same premium for both. We address the correlation this double-counting might induce through the use of fixed effects and Newey-West standard errors. Third, Equation (1) specifies premium changes over time as the dependent variable. Thus, we might also obtain a positive estimate for b if (i) premia increase over time and dealers, who trade more frequently, tend to be protection sellers, or (ii) premia decrease over time, and dealers tend to be protection buyers. We address this concern via the use of submitter-fixed effects as explanatory variables and our use of the abnormal premium changes as dependent variables.

(purchase) increases (decreases) the premium change by 1.10 to 1.29 bps. Compared to the mean premium change of 7 bps, this value corresponds to an increase of 16% to 18%. Including fixed effects reduces the effect only slightly. For the markup change, the coefficient estimates in Panel B of Table 3 are slightly smaller with values between 0.91 and 0.87 bps, but remain positive and statistically significant. Compared to the mean markup change of 1.07, these values correspond to increases of 81% to 85%.

Next, we consider the effect not only of the direction, but also of the size of the order flow. Price impact functions in equity markets are usually upwards-sloping[14], which is consistent with the economic intuition that higher demand for liquidity should lead to larger price surcharges (or discounts if sales are considered). In contrast, Edwards et al. (2007) document smaller transaction (roundtrip) costs for larger corporate bond trades. They interpret this puzzling outcome as a sign that investors with more market power usually engage in larger trades, and obtain better conditions than small retail investors. We reformulate Hypothesis 1 to explore whether larger transactions are associated with stronger premium adjustments:

H2: Order flow

The higher (lower) the size of an order, the higher (lower) is the premium adjustment.

$$\Delta prem_t = a + b \cdot OF_t + \varepsilon_t, \qquad (2)$$

$\Delta \mathrm{prem}_t$ is defined as in Equation (1), and OF_t is the normalized order flow as described in Section 2. If larger transactions, which constitute a larger demand for liquidity, lead to stronger premium adjustments, we assume that b>0. As in Table 3, we consider submitter,

[14] See, e.g., Easley and O'Hara (1987), Hasbrouck (1991), Chen, Stanzl, and Watanabe (2002), Weber and Rosenow (2005), and Cont, Kukanov, Stoikov (2013).

underlying, currency, and maturity fixed effects separately and jointly, and display the estimation results in Table 4.

Insert Table 4 about here.

The results in Table 4 confirm the economic intuition that larger trades lead to larger premium adjustments. The coefficient estimate for the factor loading on the order flow is significantly larger than 0 in all specifications both in Panel A (where the dependent variable is the premium change) and in Panel B (where the dependent variable is the markup change). Hence, price impact functions in CDS markets are upwards-sloping. Regarding the economic magnitude of the effect, a protection sale within one standard deviation of the (normalized) order, which corresponds to a notional volume of EUR 19.78 million, leads to a trade price that is, on average, higher than the previous transaction price by 1.1 to 1.2 bps.[15]

In Section 3.3, we analyze whether the fact that our results are consistent with findings for equity markets, rather than with those for corporate bond markets, can be attributed to dealer market power.

3.2. Liquidity costs or asymmetric information?

In the previous section, we document the price impact of a CDS transaction. However, the above analysis does not allow us to identify the reasons for such a price impact. On the one hand, the price impact may simply be due to the fact that CDS traders demand liquidity when entering into a transaction. On the other hand, if CDS trades convey information, the price impact of a CDS transaction might be due to asymmetric information (Glosten and Milgrom, 1985). Hence, we identify whether the price impact is permanent and arises through asymmetric

[15] We compute this quantity by multiplying the coefficient estimates for b in Table 4 with 0.73, the standard deviation of the normalized order flow.

information, or whether it is temporary and arises through pure liquidity shocks. We follow the approach by Hasbrouck (1991) and run a regression of the premium (markup) change on the current and lagged transaction direction and the lagged premium (markup) changes. The larger the impact of the lagged transaction direction is and the less it decreases over time, the stronger is the permanent price impact of a transaction. We therefore formulate the following hypothesis:

H3: Permanent transaction direction price impact

CDS traders increase (decrease) CDS premiums between time t-1 and t as a reaction to selling (buying) protection at time t-k, k>0.

$$\Delta prem_t = a + \sum_{k=0}^{4} b_k \cdot \left(1_{\text{submitter=seller}} - 1_{\text{submitter=buyer}}\right)_{t-k} + \sum_{l=1}^{5} c_l \cdot \Delta prem_{t-l} + \varepsilon_t, \qquad (3)$$

where Δprem_t is the premium (markup) change between the trade at time t and the last previous trade, $\Delta prem_{t-l}$ is the lagged premium or markup change, $1_{\text{submitter=seller}}$ and $1_{\text{submitter=buyer}}$ are defined as in Equation (1), and $\left(1_{\text{submitter=seller}} - 1_{\text{submitter=buyer}}\right)_{t-k}$ takes on a value of +1 (-1) if the submitter sold (bought) protection k transactions ago.

As for the transaction direction, we analyze the impact of the lagged order flow:

H4: Permanent order flow price impact

CDS traders increase (decrease) CDS premiums between time t-1 and t as a response to a higher (lower) order flow at time t-k, k>0.

$$\Delta prem_t = a + \sum_{k=0}^{4} b_k \cdot OF_{t-k} + \sum_{l=1}^{5} c_l \cdot \Delta prem_{t-l} + \varepsilon_t. \qquad (4)$$

If asymmetric information plays a role, we would expect that the impact of transactions and order flow does not decay over time. In addition to the individual estimates $b_0,\ldots,b_4$ and their significances, we therefore also perform an F-test to assess whether $b = b_0+\ldots+b_4 = 0$. To do so, we compare the residual sum of squares of the unrestricted model in Equation (3) and (4) to the residual sum of squares of a restricted model where we set $b_4 = -(b_0+\ldots+b_3)$. We include lagged premium changes in Equations (3) and (4) to control for premium (markup) change autocorrelation. As in Table 3 and 4, we consider different fixed effects specifications, and display the estimation results in Table 5 and 6.

Insert Table 5 about here.

Insert Table 6 about here.

Table 5 and 6 show that the price impact of a transaction is almost exclusively temporary. When the dependent variable is the premium change, transactions prior to the current one (Table 5, Panel A) and prior order flow (Table 6, Panel A) have no significant impact, while the current impact remains positive and significant. When we use the markup change as the dependent variable, lagged transactions (Table 5, Panel B) and lagged order flow (Table 6, Panel B) partially have a significant negative impact. This reversion of the impact of a trade is also supported by the F-statistics: They are only significantly different from 0 when we fail to include underlying fixed effects. This suggests that we cannot in general reject the hypothesis that $b= b_0+\ldots+b_4 = 0$. Overall, we find little evidence for an impact of asymmetric information on CDS premium and markup changes.

The potential benefit of trading on asymmetric information is higher around corporate news events. All companies publicly listed under the prime standard of Deutsche Börse (including all DAX, MDAX, TecDAX, and SDAX companies) are required to publish quarterly earnings. Hence, we focus on these companies (which leads to an exclusion of three underlying reference entities) and only on transactions which take place in the month prior to an earnings announcement. This reduces our initial sample by 65%. When we re-estimate Equations (3) and (4) on this subset, we obtain no positive and statistically significant estimates for $b_1,\ldots,b_4$. This outcome further strengthens our evidence that premium changes and markup changes do not reflect asymmetric information.

Since a trade only affects the current transaction conditions, we can therefore rule out the price impact being caused by asymmetric information. Instead, higher (lower) premiums and markups associated with a submitter selling (buying) protection are apparently due to the price that traders charge for providing liquidity. In the next section, we explore whether the costs of providing liquidity are charged equally to dealers and buy-side investors. The results of Feldhütter (2012) for liquidity premiums in corporate bond markets suggest that buy-side investors may pay a higher price than dealers for liquidity, since they face higher search costs in opaque OTC markets.

3.3. Liquidity provision and market power

Many empirical studies, such as Edwards et al. (2007), document a price wedge between institutional and retail investors. Market power is one explanation for the wedge: price competition in opaque OTC markets is lower, and search costs are high, allowing institutional investors to extract rents from retail investors. Feldhütter (2012) argues that these search costs are a potential explanation for the different liquidity premiums in corporate bonds' yield spreads in inter-dealer trades and trades between dealers and investors. Duffie et al. (2005, 2007) show that search costs and bargaining power are important in CDS markets. As a consequence, CDS traders with little market power may pay a higher price when demanding liquidity because their outside options are lower than those of a trader with high market power.

We exploit variation in trader type to assess the impact of market power. We assume that CDS dealers have more market power than CDS buy-side investors. This assumption is plausible, since most transactions we observe report dealers as one counterparty, and the number of dealers is relatively small.[16] Potential causes for dealer market power are, e.g., dealers' access to financing, information via order flow, reputation, repeat relations with investors, access to interdealer markets, etc. Without exploring the specific mechanism which gives dealers market power, we formulate the following hypothesis.

H5: Market power

When trading with a dealer, the submitter of a specific trade charges a smaller liquidity premium than for a trade with a buy-side counterparty. In particular, the submitter charges a smaller premium surcharge / markup when selling protection to a dealer, and pays a larger premium surcharge / markup when buying protection from a dealer:

$$\Delta prem_t = a + b \cdot \left(1_{\text{submitter=seller}} - 1_{\text{submitter=buyer}}\right) + c \cdot \left(1_{\text{submitter=seller}} - 1_{\text{submitter=buyer}}\right) \cdot 1_{\text{counterparty=dealer}} + \varepsilon_t, \quad (5)$$

$$\Delta prem_t = a + b \cdot OF_t + c \cdot OF_t \cdot 1_{\text{counterparty=dealer}} + \varepsilon_t, \quad (6)$$

where Δprem_t, $1_{\text{submitter=seller}}$, and $1_{\text{submitter=buyer}}$ are defined as in Equation (1), and $1_{\text{counterparty=dealer}}$ is a dummy variable equal to 1 if the submitter's counterparty is a dealer. If market power increases the wedge in the premium between dealers and buy-side counterparties, we expect that $c < 0$. The estimation results for the different fixed effects specifications are presented in Table 7 and 8.

[16] Studies on asymmetric information, e.g., Osler et al. (2011), also use the distinction between dealer and buy-side investor to differentiate between uninformed (dealers) and informed (buy-side) investors. However, since dealers in CDS markets are large, financial institutions, we do not believe that they have an informational disadvantage compared to buy-side investors. In addition, if order flow is informative, dealers should observe more, not less, information than buy-side investors.

Insert Table 7 about here.

Insert Table 8 about here.

As Table 7 and 8 show, transactions with CDS dealers are associated with premium and markup changes which are significantly lower than those in transactions with CDS buy-side investors. While a sale to a buy-side investor increases the premium by 3.5 bps, the sale to a dealer increases the premium by only 3.5 bps – 2.5 bps = 1 bp (Table 7, Panel A, no fixed effects). Similarly, the markup increases by only 2.6 bps – 2.0 bps = 0.6 bps (Table 7, Panel B, no fixed effects). For a standard order flow, we obtain similar premium changes of 6.3 bps – 5.3 bps = 1bp (Table 8, Panel A, no fixed effects) and markup changes of 5.0 bps -4.2 bps = 0.8 bps (Table 8, Panel B, no fixed effects).

Overall, our finding is consistent with the economic intuition that CDS dealers have market power, and pay a lower price for liquidity than buy-side investors.

3.4. The impact of intertrade time

Numerous empirical studies (e.g., Hausman et al., 1992, Easley et al., 1993, Dufour and Engle, 2000, Chung et al., 2005) have shown that intertrade time affects the price impact of a trade. The motivation for this price impact is twofold. First, if asymmetric information prevails, a longer length of time between trades can be indicative of bad news (Diamond and Verrecchia, 1987) or no news (Easley and O'Hara, 1992), such that intertrade time is negatively correlated with a high number of informed traders. In this case, the impact of intertrade time on the price impact should be negative. Second, if trades are further apart, CDS traders may be less willing to provide liquidity, because search costs for a counterparty that allows them to reduce exposures are higher. Hence, in this case, trades with longer intertrade time will have a larger impact on prices. We formulate the following hypothesis:

H6: Intertrade time

If intertrade time is longer, the submitter charges a larger liquidity premium than when intertrade time is shorter.

$$\Delta prem_t = a + b \cdot \left(1_{\text{submitter=seller}} - 1_{\text{submitter=buyer}}\right) + c \cdot \left(1_{\text{submitter=seller}} - 1_{\text{submitter=buyer}}\right) \cdot \Delta T_t + \varepsilon_t, \quad (7)$$

$$\Delta prem_t = a + b \cdot OF_t + c \cdot OF_t \cdot \Delta T_t + \varepsilon_t, \quad (8)$$

where Δprem_t , $1_{\text{submitter=seller}}$, $1_{\text{submitter=buyer}}$, and OF_t are defined as above, and ΔT_t measures the time in days since the last trade. Since our results in Section 3.2 do not indicate a price impact due to asymmetric information, we expect that c>0. The results of the estimation with all fixed effects specifications are given in Table 9 and 10.

Insert Table 9 about here.

Insert Table 10 about here.

Table 9 and 10 show that intertrade time plays only a limited role: the impact on premium changes is only statistically significant in Panel A of Table 9. When the premium change is measured as the markup change (Panel B of Table 9), and when the explanatory variable is the order flow (Table 10), intertrade time does not significantly affect premium changes. Hence, a longer time between trades does not cause CDS traders to charge a higher price for providing liquidity. Recall from Section 3.1 that larger transactions had a higher price impact. Therefore, it is optimal to split them up into smaller blocks, while the intertrade time can be chosen arbitrarily. Overall, Table 9 and 10 are in line with our earlier result that the price impact of a trade on CDS premiums does not arise through asymmetric information. In addition, the positive coefficient estimates suggests that traders do not strategically decrease CDS quotes to attract trades.

3.5. The impact of fundamental risk

To conclude this section, we analyze the impact of fundamental risk on the price for liquidity. The intuition for this analysis is as follows. When providing liquidity, a CDS trader takes on inventory risk. If, for example, she sells protection on a reference entity for 100 bps, and the market premium for this reference entity subsequently increases to 150 bps, the value of her inventory drops because she can only offset her exposure through a cash outflow. A trader will increase the price for providing liquidity if she is exposed to such fluctuations in the fundamental value of the underlying (e.g., Demsetz, 1968 and Stoll, 1978). We therefore formulate the following hypothesis:

H7: Fundamental risk

If the market premium has increased (decreased) prior to the current transaction, the submitter charges a larger liquidity premium when selling (buying) protection.

$$\begin{aligned}\Delta prem_t = a + b \cdot \left(1_{\text{submitter=seller}} - 1_{\text{submitter=buyer}}\right) \\ + c \cdot \left(1_{\text{submitter=seller}} - 1_{\text{submitter=buyer}}\right) \cdot \Delta\text{market}_{t-1} + \varepsilon_t,\end{aligned} \tag{9}$$

$$\Delta prem_t = a + b \cdot OF_t + c \cdot OF_t \cdot \Delta\text{market}_{t-1} + \varepsilon_t, \tag{10}$$

where Δprem_t, $1_{\text{submitter=seller}}$, $1_{\text{submitter=buyer}}$, and OF_t are defined as above, and $\Delta\text{market}_{t-1}$ denotes the change of the Bloomberg mid premium between the day prior to the current trade date and the day of the submitter's previous trade in the same CDS contract. We report the estimation results for the different fixed effects specifications in Table 11 and 12.

Insert Table 11 about here.

Insert Table 12 about here.

Table 11 and 12 show that fundamental risk increases the price of liquidity, but that the effect is not robust to different specifications. When the explanatory variable is the trade direction, we find a significant impact on the premium change only when we use one fixed effect (Panel A of Table 11), and on the markup change only when we use no fixed effects

(Panel B of Table 11). When the explanatory variable is the order flow size, the impact on the premium change remains positive, but becomes insignificant in all specifications (Panel A of Table 12). For the markup change, on the other hand, the effect becomes significantly positive for all model specifications.

These results are consistent with the limited impact of the intertrade time in Section 3.4. Demsetz (1968) uses the trade frequency (which is inversely related to intertrade time) as a proxy for inventory holding costs. Therefore, it is sensible that both proxies for inventory risk lead to a similar conclusion: inventory risk only has a very limited effect on the price of liquidity in CDS markets.

4. Robustness

In this section, we explore the robustness of our empirical results. First, we include two types of controls: In Section 4.1, we use the contemporaneous market premium change to show that our findings are not caused by variations in the market-wide CDS premium. In Section 4.2, we include lagged premium and markup changes as additional explanatory variables to adjust for autocorrelation in the premium changes. Second, we expand our sample period and show that we find similar results when using a longer time series of new trades that extends until October 2014 in Section 4.3. In order to explore the impact of the European sovereign debt crisis, we additionally focus major crisis events in Section 4.4.

4.1. Including market premium changes

The results of Tables 11 and 12 indicate that market premium changes affect premium and markup changes. This finding could imply that we omit a central variable in the regressions: contemporaneous changes in the underlying reference entity's default risk. For example, it could be argued that an increase in a reference entity's default risk might lead to i) higher premiums charged by protection sellers, and ii) an increasing demand for protection through hedgers.

Even though our use of the markup change alleviates this concern, we perform two robustness checks. First, we include the market premium change as an explanatory variable on the right-hand side in Equations (1) to (10) and re-run the regressions. Second, we compute the relative premium change (current transaction premium divided by the Bloomberg mid premium, minus the submitter's previous trade premium divided by the Bloomberg mid premium on the previous trade date), and use this as the dependent variable in Equations (1) to (10).[17]

In Table 13, we report the most important variables only and the most conservative specification including all fixed effects. The results are similar for the other specifications.

Insert Table 13 about here.

Table 13 confirms our main conclusions. Sell (buy) transactions increase (decrease) premium changes (Panel A and B), and more so if the counterparty is a buy-side investor (Panel E and F). Past transactions do not have a positive impact on future premium changes – on the contrary, we observe a negative and significant impact of transactions up to two lags (Panel C and D). Hence, asymmetric information does not matter for CDS premium adjustments. Similarly, inventory risk as measured by intertrade time and lagged market premium changes do not play a consistent role: three out of four coefficient estimates for intertrade time (Panel G and H) and two out of four for lagged market premium changes (Panel I and J) are insignificant.

4.2. Including lagged premium changes

[17] We do not repeat the analyses for the markup changes, as including the market premium change and taking relative premium changes leads to identical coefficient estimates in both regressions.

In our analysis of the temporary and permanent price impact in Equations (3) and (4), we show that lagged premium and markup changes significantly affect current premium and markup changes. In all other analyses, we only adjust for the negative autocorrelation by using Newey-West standard errors. If trade direction, as Shachar (2012) shows, is also autocorrelated, it could be argued that the positive estimates of the trade direction and order flow are in fact due to these unmodelled autocorrelations. In this section, we therefore include lagged changes up to a lag of 5 trades as additional explanatory variables in Equations (5) to (10). We report the results of the regressions including the lagged premium and markup changes in Table 14, again focusing only on the most important variables and the most conservative specification including all fixed effects.

Insert Table 14 about here.

Again, Table 14 confirms our main conclusions. Differences between the original and new estimates go in the hypothesized direction in two out of three cases: in Panel A, second column, we now also have a significantly lower impact of a transaction with a dealer on the premium change, which was also negative, but not significant, in Table 7. Similarly, an order flow following a market premium increase now also significantly increases the liquidity premium (Panel F, second column) compared to a positive but insignificant estimate in Table 12. Conversely, the impact of the intertrade time on the premium change becomes insignificant in Panel C compared to a significant positive impact in Table 9. However, this is in line with the (also originally) insignificant impact on the markup change. Overall, including lagged changes aligns our results for the premium and markup changes in all cases where they differed in the original analyses (in Tables 7, 9, and 12).

4.3. Extended time series

In our original analyses, we compiled submitted-specific order flow for a particular reference entity/maturity/currency/seniority combination by adding up the signed notional of all transactions (assignments and terminations) between two new trades, and adding this to the volume of the current new trade. However, the time series only covered 2.5 years from January 2009 to June 2011. This is, arguably, a short and very specific time period regarding overall market conditions. To show that our results are not due to this limitation, we repeat our analyses from Section 3 using an extended data set from DTCC that contains all new trades from January 2009 to October 2014. The caveat of using this dataset is that we cannot observe the order flow between two new trades. Instead, we proxy for the order flow between two new trades with the notional volume of the current new trade. Since this is likely to be a noisy and potentially biased proxy for the true order flow, we expect a decrease in the coefficient sizes, and a reduction in significance. We compute premium and markup changes for the extended time series, standardize the signed notional amounts as described in Section 2. We report the results of the regressions for the extended time series in Table 15, again focusing only on the most important variables and the most conservative specification including all fixed effects.

Insert Table 15 about here.

Table 15 shows that our main conclusions still hold in the extended time series. Coefficient estimates go down by approximately 50% when using transaction direction, which is consistent with a higher CDS liquidity from mid-2012 to October 2014 (bid-ask spreads from Bloomberg indicative quotes decrease by on average 4 bps), but do not change their signs and remain statistically significant. For the order flow, the reduction is of a larger order of magnitude, consistent with the potential observation error described above. If anything, we observe less evidence of asymmetric information since the impact of lagged trades decays more quickly (Panels C and D), a larger relative reduction of liquidity premia for trades with dealers (Panels E and F), a smaller impact of intertrade time (Panel G and H), and no impact of fundamental risk (Panels I and J).

4.4. European debt crisis

Both our original data set and the extended time series cover a unique time period in fixed income markets: the European sovereign debt crisis. It is easily conceivable that protection buyers may be paying different liquidity premiums due to the exceptional risks during this specific period.[18] To explore this hypothesis, we repeat our analyses from Section 3, now focusing only on trading around major events of the European sovereign debt crisis. To identify such events, we first refer to the key dates of the financial crisis as collected by the European Central Bank.[19] We then collect all press releases, communiques, and statements that pertain to the European sovereign debt crisis between January 2009 and October 2014. We manually screen all communications to determine whether they are potentially relevant events (e.g., "Greece seeks financial support" on April 23, 2010 vs. "EU Council start 'European semester' " on January 18, 2011). This leads to a list of potentially relevant events on 23 different calendar dates from June 2009 to July 2012. To assess whether these events actually affected financial markets, we explore whether any major stock indices experienced an extremely negative daily return in the week spanning these events. As indices, we choose the S&P500, the STOXX Europe 600, and the DAX30 as well as their bank subindices. We define a return as extremely negative when it falls below the 10% daily return quantile from January 2007 to December 2014. This gives a list of 14 major events of the European sovereign debt crisis which affect financial markets. A list of the event dates is provided in the appendix.

To explore the effect of these events on CDS liquidity, we use event windows starting two weeks prior and ending two weeks after the event. Since seven of the 14 events occur after June 2011, we focus on the extended time series from Section 4.3. We then drop all observations which do not occur within these event windows, and repeat our analyses from Section 3. The

[18] We thank the referee for pointing this out.

[19] Among several alternative European debt crisis timelines, we have chosen to work with the one by ECB. https://www.ecb.europa.eu/ecb/html/crisis.en.html

results are reported in Table 16, again focusing only on the most important variables and the most conservative specification including all fixed effects.

Insert Table 16 about here.

Table 16 shows that the effect of major crisis events on CDS liquidity premiums is not fully clear. On one hand, transaction direction affects premium and markup changes more strongly than in the original data set (Panel A, C, G, I) and dealers get fewer liquidity premium concession (Panel E). On the other hand, the impact of order flow is reduced (Panel B, D, F, H, and J). As Table 15 shows, this is not due to more noisy proxy for order flow. Hence, larger transactions lead to smaller surcharges than in regular times. One possible reason for the diminished impact of the order flow could be the higher market activity around crisis events, resulting in more and/or larger transactions and smaller coefficient estimates for their impact.

5. Conclusion

We use a unique, proprietary dataset to test the price impact of trades in CDS markets. We show that CDS trades have a significant price impact, and that the price impact functions are upwards-sloping. This finding stands in sharp contrast to the smaller price impact of larger transactions documented for corporate bond markets. To our knowledge, we are the first to provide evidence on such price pressure in CDS markets. Second, we show that the price impact of a trade can be attributed to the price that traders charge for providing liquidity in CDS markets. Third, we exploit variation in trader type to examine the effect of market power, and find that buy-side traders pay significantly higher mark-ups than dealers. This finding is consistent with the notion that a lack of competition in CDS markets gives rise to dealer market power. Last, we show that inventory risk, measured through intertrade time and variations in the creditworthiness of the underlying, have only a limited impact on the price dealers' charge for providing liquidity.

Our results have the following implications. First, buy-side investors should split up large CDS transactions into smaller blocks to minimize the price impact of their trades. Second, since CDS premiums are affected by order flows, we cannot rule out demand-based price manipulation. Whether manipulation strategies are profitable depends on the relative elasticity of purchase versus sale transactions, and is the subject of ongoing research. Third, our results imply that price discrimination is prevalent in the CDS market, and that dealers use their market power to extract monopolistic rents from buy-side investors. Hence, the introduction of a centralized exchange or a reporting system that enhances post-trade transparency for CDS would potentially help to make risk sharing in CDS markets more efficient by increasing competition between CDS dealers.

Appendix

Data Matching. First, we identify the submitter of the CDS contract in the DTCC dataset. A typical CDS contract is submitted to the DTCC once by the buyer and once by the seller. Therefore, if we use the submitter information pivotally, we are able to observe each transaction from the both the buyer's and the seller's perspective. We treat each counterparty at the parent entity level. For example, we consider the New York and London branches of Deutsche Bank as a single party. Entity names are defined such that they have a unique CDS price time series. We only consider CDS series with a reference entity for which we know the ISIN. We remove all compression trades. These are netting trades, where a new price was not negotiated, and are tied only to the specific administrative process.

Assignments. These types of transactions define three roles for three counterparties. There is a step-out party, who transfers his/her role to the step-in party, and a remaining party. If the step-out party is a buyer (seller), then the new buyer (seller) for the transactions is the step-in party. Naturally, the role of the remaining party is not affected. We consider assignments where the step-out party is a seller, to decrease the step-out party's credit risk inventory and increase the step-in party's inventory, while the remaining party's inventory remains unaffected.

Time stamps. The DTCC provides a date, not a time stamp, for each transaction. Therefore, we order our transactions according to three identifiers. (i) First, transactions are ordered by the ”Trade Date” (calendar date on which the transaction took place). (ii) If two transactions occur on the same date, we order them according to the “Submit Date” identifier, the date at which the information is submitted to the DTCC. Naturally, we identify all block trades as a single trade, although they may have differing submit dates (see section ”Block trades”). (iii) If two transactions have the same trade and the same submit date, as a third identifier, we order them according to “Submit Time” (clock time in hh:mm:ss format). For example, we assume that a trade on 1/10/10 that was submitted to the DTCC on 3/10/10 at 12:00:00 happened before a trade on 1/10/10 that was submitted to the DTCC on 3/10/10 at 16:00:00).

Block trades. The DTCC collects allocated level volumes instead of the original volume of the block transaction. This can be problematic if, for example, a parent fund buys protection with a notional volume of EUR 10 million, and subsequently allocates EUR 1 million to ten different sub-funds. Since we treat each counterparty at the parent entity level, our initial dataset would show ten transactions with a notional volume of EUR 1 million under the parent fund's name. Therefore, we aggregate all the trades with the same submitter (buyer or seller), entity, maturity, trade date, and price into a block trade (under the parent entity), so as not to be misled by the split dataset.

European sovereign debt crisis events

Date	Event
04.06.2009	Launch of first covered bonds programme by ECB
23.04.2010	Greece seeks financial support
10.05.2010	ECB introduces Securities Markets Programme
07.06.2010	EFSF established

23.07.2010	Publication of bank stress tests results
23.06.2011	EFSF boosted
15.07.2011	Stress test results published
06.10.2011	ECB announces second covered bond burchase programme
22.12.2011	ECB allots €489 billion to 523 banks in first 36-month longer-term refinancing operation
21.02.2012	Eurogroup agrees on second financial aid package for Greece
01.03.2012	ECB allots €530 bn to 800 banks in second 36-month longer-term refinancing operation
08.03.2012	ECB reactivates eligibility of Greek bonds as collateral
27.06.2012	Spain seeks financial support
20.07.2012	Eurogroup grants financial assistance to Spain's banking sector

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Table 1. Sample comparison

The table shows a comparison of our dataset (single-name CDS on German reference entities) to the full TIW universe (single-name CDS on all reference entities). In Panel A, we present a breakdown with respect to the industry of underlying reference entity for all transactions, dealer-buy transactions and dealer-sell transactions. The percentages for our data are computed as the number of contracts for which we observe a transaction by June 2011 for a given industry, relative to all contracts for which we observe a transaction by June 2011. The percentages for the full TIW universe are computed from the number of contracts reported to be active in the last week of June 2011. In Panel B, we assign reference entities into transaction volume quintiles (by June 2011) for our dataset, and indicate which fraction of these reference entities fall in a given quintile in the last week of June 2011 for the full TIW universe most actively traded 1,000 reference entities. In Panel C, we present the total outstanding volume and the transaction volume of all German reference entities relative to all European reference entities in the last week of June 2011 as reported in the TIW. Gross notional indicates that long and short position volume (for outstanding volume) and buy and sell volume (for transaction volume) at the counterparty level are added up. Net notional indicates that long and short positions (for outstanding volume) and buy and sell volume (for transaction volume) are netted against each other at the counterparty level.

Panel A: Sample breakdown by industry

	German reference entities			Full TIW universe		
	All	Dealer-buy	Dealer-sell	All	Dealer-buy	Dealer-sell
Basic materials [%]	14.70	86.55	91.65	8.34	89.12	90.03
Consumer goods [%]	23.77	87.48	88.38	13.50	89.58	91.10
Consumer services [%]	12.94	87.16	88.59	18.51	89.27	91.40
Financials [%]	15.27	79.26	88.80	22.48	90.53	91.58
Healthcare [%]	4.68	90.97	91.79	3.15	91.67	92.04
Industrials [%]	12.28	87.91	90.68	11.58	90.01	91.64
Oil&Gas [%]	0.00	-	-	4.54	91.25	89.83
Technology&Telecom.[%]	5.22	88.19	91.09	10.65	88.66	89.64
Utilities [%]	6.63	89.69	90.21	6.44	88.25	88.45
Other [%]	4.50	59.02	81.95	0.80	93.93	92.98
All [%]	100.00	85.16	89.37	100.00	88.76	89.40

Panel B: Transaction volume quintiles

	German reference entities quintiles				
	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
TIW quintile 1 [%]	85.71	57.14	7.14	-	-
TIW quintile 2 [%]	14.29	42.86	35.71	-	-
TIW quintile 3 [%]	-	-	21.43	-	-
TIW quintile 4 [%]	-	-	14.29	-	-
TIW quintile 5 [%]	-	-	21.43	-	-
Not in TIW top 1,000 [%]	-	-	-	100.00	100.00

Panel C: Outstanding volume and trade volume as of June 2011

	Outstanding volume			Transaction volume		
	All	Dealer-buy	Dealer-sell	All	Dealer-buy	Dealer-sell
Ratio German to European reference entities [%]	19.77	18.00	19.03	19.93	14.37	18.07

Table 2. Order flow and premium summary statistics

The table shows summary statistics for our sample. Premium denotes the DTCC transaction premium in bps, Premium change the change in the DTCC transaction premium between two new trades. Market premium (Bloomberg) and Market premium change (Bloomberg) denote the corresponding statistics using CMA average mid-quotes downloaded via the Bloomberg system. Abnormal premium denotes the difference between the DTCC transaction premium and the same-day CMA average mid-quote in bps, Abnormal premium change the change in this quantity between two new trades. Relative abnormal premium denotes the abnormal premium relative to the same-day CMA average mid-quote, Relative abnormal premium change the change in this quantity between two new trades. Order flow denotes the submitter-specific order flow for a particular reference entity/maturity/currency/seniority combination in EUR million between two new trades. Normalized order flow denotes the order flow standardized as in Hansch et al. (1998) by subtracting the time-series average order flow at each date, and then standardizing by dividing the mean-0 order flow by the standard deviation.

	Mean	Median	Minimum	Maximum	Std. Dev.	N
Panel A: Order flow statistics						
Absolute order flow	9.47	5.00	0.00	181.40	7.77	90,526
Trade size (new trades)	7.73	5.00	0.01	305.00	11.41	99,791
Order flow	-0.08	0.00	-956.82	950.00	19.79	90,526
Normalized order flow	0.00	0.00	-5.45	5.33	1.00	90,526
Panel B: Trading activity						
Time between trades (days) (submitter and contract-specific)	27.74	5.00	0.00	679.00	57.45	90,526
Time between trades (days) (submitter-specific)	0.94	0.00	0.00	555.00	9.45	287
Time between trades (days) (contract-specific)	0.33	0.00	0.00	247.00	2.56	70
Panel C: Premium statistics						
Premium	185.41	95.00	0.10	3,334.17	258.67	99,791
Market premium (Bloomberg)	204.51	103.57	16.83	2,410.57	258.15	91,599
Abnormal premium	-13.19	-1.75	-938.75	947.44	59.62	91,599
Relative abnormal premium	-0.09	-0.01	-1.00	5.56	0.20	91,599
Premium change	-7.00	0.00	-2,589.35	1,255.12	68.76	90,526
Market premium change (Bloomberg)	-5.90	0.00	-1.798.06	772.27	55.23	82,334
Abnormal premium change	-1.07	0.00	-1,010.20	800.22	32.29	82,334
Relative abnormal premium change	-0.01	0.00	-5.79	3.99	0.11	82,334

Table 3. Transaction direction

The table shows coefficient estimates (and t-statistics in parentheses) for Equation (1), the regression of the premium change (Panel A) and the markup change (Panel B) on the direction of the transaction. The premium change is measured as the premium of the current trade minus the premium of the most recent trade for the submitter for a particular CDS contract. The markup change is measured as the difference between the premium change for the submitter and contract currently considered, and the Bloomberg mid CDS premium change on the same contract during the same time interval. We identify a particular CDS contract by the underlying reference entity, the currency, the maturity, and the seniority (senior vs. subordinated). The direction of the transaction is given as +1 if the transaction submitter sells protection in the current transaction and as -1 if the transaction submitter buys protection in the current transaction. We use Newey-West standard errors, adjusted for the different lengths between two trade dates. Bold format indicates significance at the 10% level or less.

$$\Delta prem_t = a + b \cdot \left(1_{\text{submitter=seller}} - 1_{\text{submitter=buyer}}\right) + \varepsilon_t$$

Panel A: Dependent variable premium change

Fixed effects	None	Submitter	Underlying	Currency	Maturity	All
a	**-4.3566**	1.6835	5.7657	-0.0320	0.7892	11.1915
	(-17.53)	(0.18)	(1.48)	(-0.03)	(0.25)	(0.95)
b	**1.2890**	**1.2879**	**1.1087**	**1.2613**	**1.2402**	**1.1007**
	(5.19)	**(5.16)**	**(4.50)**	**(5.07)**	**(5.00)**	**(4.46)**
Adj. R^2 [%]	0.0507	0.1954	2.2042	0.0876	0.5891	2.6998
N	53,000					

Panel B: Dependent variable markup change

Fixed effects	None	Submitter	Underlying	Currency	Maturity	All
a	-0.7959	0.4031	-1.3463	-0.0716	0.4731	-0.0229
	(-5.49)	(0.07)	(-0.59)	(-0.12)	(0.25)	(0.00)
b	**0.8976**	**0.9084**	**0.8675**	**0.8926**	**0.8857**	**0.8737**
	(6.20)	**(6.24)**	**(5.99)**	**(6.16)**	**(6.12)**	**(6.00)**
Adj. R^2 [%]	0.0713	0.0283	0.2618	0.0724	0.1626	0.2887
N	52,423					

Table 4. Order flow impact

The table shows coefficient estimates (and t-statistics in parentheses) for Equation (2), the regression of the premium change (Panel A) and the markup change (Panel B) on the order flow. The premium change is measured as the premium of the current trade minus the premium of the most recent trade for the submitter for a particular CDS contract. The markup change is measured as the difference between the premium change for the submitter and contract currently considered, and the Bloomberg mid CDS premium change on the same contract during the same time interval. We identify a particular CDS contract by the underlying reference entity, the currency, the maturity, and the seniority (senior vs. subordinated). The order flow is measured as the change in the normalized order flow through the current trade. We use Newey-West standard errors, adjusted for the different lengths between two trade dates. Bold format indicates significance at the 10% level or less.

$$\Delta prem_t = a + b \cdot OF_t + \varepsilon_t$$

Panel A: Dependent variable premium change

Fixed effects	None	Submitter	Underlying	Currency	Maturity	All
a	**-4.3332**	1.1391	5.8843	0.1108	0.9191	10.7319
	(-17.43)	(0.12)	(1.51)	(0.11)	(0.29)	(0.91)
b	**1.5695**	**1.5987**	**1.5598**	**1.5648**	**1.5869**	**1.5922**
	(2.81)	**(2.87)**	**(2.83)**	**(2.81)**	**(2.85)**	**(2.89)**
Adj. R^2 [%]	0.0149	0.1607	2.1815	0.0539	0.5574	2.6785
N	53,000					

Panel B: Dependent variable markup change

Fixed effects	None	Submitter	Underlying	Currency	Maturity	All
a	**-0.7794**	0.0197	-1.2540	0.0364	0.5668	0.0498
	(-5.38)	(0.00)	(-0.55)	(0.06)	(0.30)	(0.01)
b	**1.1568**	**1.1633**	**1.1577**	**1.1555**	**1.1591**	**1.1638**
	(3.54)	**(3.56)**	**(3.54)**	**(3.53)**	**(3.55)**	**(3.56)**
Adj. R^2 [%]	0.0220	0.0219	0.2175	0.0239	0.1153	0.2442
N	52,423					

Table 5. Permanent vs. transitory impact of transaction direction

The table shows coefficient estimates (and t-statistics in parentheses) for Equation (3), the regression of the premium and markup change on the current and lagged direction of the transaction, and the lagged premium and markup changes. The premium change is measured as the premium of the current trade minus the premium of the most recent trade for the submitter for a particular CDS contract. The markup change is measured as the difference between the premium change for the submitter and contract currently considered, and the Bloomberg mid CDS premium change on the same contract during the same time interval. We identify a particular CDS contract by the underlying reference entity, the currency, the maturity, and the seniority (senior vs. subordinated). The direction of the transaction is given as +1 if the transaction submitter sells protection in the transaction and as -1 if the transaction submitter buys protection. We use four lags for the transaction direction, and five for the premium changes. We use Newey-West standard errors, adjusted for the different lengths between two trade dates. The last row shows F-statistics for the test $b = b_0 + b_1 + b_2 + b_3 + b_4 = 0$. Bold format indicates significance at the 10% level or less.

$$\Delta prem_t = a + \sum_{k=0}^{4} b_k \cdot \left(1_{\text{submitter=seller}} - 1_{\text{submitter=buyer}}\right)_{t-k} + \sum_{l=1}^{5} c_k \cdot \Delta prem_{t-l} + \varepsilon_t$$

Panel A: Dependent variable premium change

Fixed effects	None	Submitter	Underlying	Currency	Maturity	All
a	**-2.9920**	1.9741	**6.3479**	-0.0012	1.1221	11.6032
	(-14.56)	(0.24)	**(1.89)**	(0.00)	(0.42)	(1.17)
	Explanatory variables: Transaction direction					
b_0	**0.8463**	**0.8623**	**0.7003**	**0.8281**	**0.8127**	**0.6993**
	(4.17)	**(4.24)**	**(3.48)**	**(4.08)**	**(4.01)**	**(3.48)**
b_1	0.0660	0.0838	-0.0578	0.0483	0.0404	-0.0504
	(0.32)	(0.41)	(-0.29)	(0.24)	(0.1993)	(-0.25)
b_2	0.0187	0.0326	-0.0996	0.0019	-0.0064	-0.0968
	(0.09)	(0.16)	(-0.49)	(0.01)	(-0.03)	(-0.48)
b_3	0.2887	0.3015	0.1805	0.2716	0.2624	0.1810
	(1.42)	(1.48)	(0.90)	(1.34)	(1.29)	(0.90)
b_4	0.0329	0.0414	-0.0709	0.0153	0.0074	-0.0703
	(0.16)	(0.20)	(-0.35)	(0.08)	(0.04)	(-0.35)
	Control variables: Lagged premium changes					
c_1	**-0.0855**	**-0.0870**	**-0.1072**	**-0.0858**	**-0.0911**	**-0.1136**
	(-19.66)	**(-19.99)**	**(-24.59)**	**(-19.73)**	**(-20.92)**	**(-26.05)**
c_2	-0.0057	**-0.0070**	**-0.0279**	-0.0060	**-0.0112**	**-0.0341**
	(-1.39)	**(-1.69)**	**(-6.75)**	(-1.47)	**(-2.71)**	**(-8.24)**
c_3	**0.0394**	**0.0383**	**0.0174**	**0.0391**	**0.0340**	**0.0113**
	(10.11)	**(9.82)**	**(4.43)**	**(10.02)**	**(8.70)**	**(0.00)**
c_4	**0.0142**	**0.0133**	-0.0052	**0.0139**	**0.0094**	**-0.0106**
	(3.86)	**(3.63)**	(-1.42)	**(3.77)**	**(2.55)**	**(-2.86)**
c_5	**0.0299**	**0.0289**	**0.0129**	**0.0296**	**0.0256**	**0.0080**
	(8.75)	**(8.47)**	**(3.77)**	**(8.68)**	**(7.49)**	**(2.35)**
Adj. R^2 [%]	1.1983	1.2836	3.2029	1.2267	1.7218	3.7522
N			47,565			
F-statistic	**8.99**	**9.63**	2.47	**7.75**	**7.18**	2.46

Panel B: Dependent variable markup change						
Fixed effects	None	Submitter	Underlying	Currency	Maturity	All
a	**-0.9398**	0.2598	-2.7332	0.0002	0.9418	-1.6200
	(-7.94)	(0.06)	(-1.40)	(0.00)	(0.61)	(-0.21)
Explanatory variables: Transaction direction						
b_0	**0.5813**	**0.5836**	**0.5464**	**0.5753**	**0.5669**	**0.5392**
	(4.91)	**(4.91)**	**(4.63)**	**(4.86)**	**(4.80)**	**(4.56)**
b_1	-0.1527	-0.1499	-1.1835	-0.1585	-0.1646	-0.1878
	(-1.29)	(-1.26)	(-1.55)	(-1.34)	(-1.39)	(-1.59)
b_2	-0.1667	-0.1642	**-0.1979**	-0.1722	-0.1786	**-0.2026**
	(-1.41)	(-1.38)	**(-1.67)**	(-1.45)	(-1.51)	**(-1.71)**
b_3	0.1151	0.1176	0.0855	0.1095	0.1015	0.0791
	(0.97)	(0.99)	(0.72)	(0.92)	(0.86)	(0.67)
b_4	0.0657	0.0678	0.0355	0.0599	0.0535	0.0315
	(0.55)	(0.57)	(0.30)	(0.51)	(0.45)	(0.27)
Control variables: Lagged markup changes						
c_1	**-0.4117**	**-0.4121**	**-0.4186**	**-0.4118**	**-0.4163**	**-0.4236**
	(-93.15)	**(-92.30)**	**(-94.65)**	**(-93.17)**	**(-94.16)**	**(-95.73)**
c_2	**-0.3249**	**-0.3253**	**-0.3337**	**-0.3250**	**-0.3306**	**-0.3401**
	(-70.66)	**(-70.70)**	**(-72.39)**	**(-70.68)**	**(-71.82)**	**(-73.62)**
c_3	**-0.1414**	**-0.1419**	**-0.1515**	**-0.1415**	**-0.1477**	**-0.1584**
	(-31.24)	**(-31.32)**	**(-33.32)**	**(-31.27)**	**(-32.55)**	**(-34.73)**
c_4	**-0.1059**	**-0.1062**	**-0.1145**	**-0.1060**	**-0.1110**	**-0.1201**
	(-25.28)	**(-25.35)**	**(-27.25)**	**(-25.30)**	**(-26.47)**	**(-28.53)**
c_5	**-0.0350**	**-0.0353**	**-0.0419**	**-0.0351**	**-0.0387**	**-0.0459**
	(-9.36)	**(-9.44)**	**(-11.19)**	**(-9.39)**	**(-10.37)**	**(-12.25)**
Adj. R^2 [%]	18.0093	18.0581	18.5174	18.0148	18.3773	18.8625
N	47,076					
F-statistic	**3.34**	**3.39**	1.39	**2.91**	**2.46**	1.11

Table 6. Permanent vs. transitory impact of order flow

The table shows coefficient estimates (and t-statistics in parentheses) for Equation (4), the regression of the premium and markup change on the current and lagged order flow, and on the lagged premium and markup changes. The premium change is measured as the premium of the current trade minus the premium of the most recent trade for the submitter for a particular CDS contract. The markup change is measured as the difference between the premium change for the submitter and contract currently considered, and the Bloomberg mid CDS premium change on the same contract during the same time interval. We identify a particular CDS contract by the underlying reference entity, the currency, the maturity, and the seniority (senior vs. subordinated). The order flow is measured as the change in the normalized order flow through the trade. We use four lags for the order flow, and five for the premium changes. We use Newey-West standard errors, adjusted for the different lengths between two trade dates. The last row shows the F-statistics for the test $b = b_0 + b_1 + b_2 + b_3 + b_4 = 0$. Bold format indicates significance at the 10% level or less.

$$\Delta prem_t = a + \sum_{k=0}^{4} b_k \cdot OF_{t-k} + \sum_{l=1}^{5} c_k \cdot \Delta prem_{t-l} + \varepsilon_t$$

Panel A: Dependent variable premium change

Fixed effects	None	Submitter	Underlying	Currency	Maturity	All
a	**-2.9687**	1.2116	**6.4128**	0.1406	1.2055	11.1939
	(-14.46)	(0.15)	**(1.91)**	(0.17)	(0.45)	(1.12)
	Explanatory variables: Order flow					
b_0	**0.8728**	**0.9277**	**0.8588**	**0.8689**	**0.8888**	**0.9276**
	(1.83)	**(1.94)**	**(1.82)**	**(1.82)**	**(1.87)**	**(1.97)**
b_1	0.0045	0.0595	0.0124	-0.0013	0.0475	0.1129
	(0.01)	(0.12)	(0.03)	(0.00)	(0.10)	(0.24)
b_2	-0.7246	-0.6750	-0.7046	-0.7306	-0.6851	-0.6207
	(-1.51)	(-1.41)	(-1.49)	(-1.53)	(-1.44)	(-1.31)
b_3	-0.3057	-0.2577	-0.2883	-0.3116	-0.2685	-0.2092
	(-0.64)	(-0.54)	(-0.61)	(-0.66)	(-0.57)	(-0.45)
b_4	0.2874	0.3400	0.3118	0.2829	0.3033	0.3648
	(0.61)	(0.72)	(0.67)	(0.60)	(0.65)	(0.78)
	Control variables: Lagged premium changes					
c_1	**-0.0855**	**-0.0870**	**-0.1073**	**-0.0859**	**-0.0911**	**-0.1137**
	(-19.65)	**(-19.98)**	**(-24.61)**	**(-19.73)**	**(-20.93)**	**(-26.07)**
c_2	-0.0058	**-0.0070**	**-0.0280**	-0.0061	**-0.0112**	**-0.0342**
	(-1.40)	**(-1.70)**	**(-6.78)**	(-1.49)	**(-2.73)**	**(-8.26)**
c_3	**0.0394**	**0.0383**	**0.0173**	**0.0391**	**0.0339**	**0.0112**
	(10.11)	**(9.82)**	**(4.42)**	**(10.02)**	**(8.70)**	**(2.87)**
c_4	**0.0141**	**0.0132**	-0.0054	**0.0138**	**0.0093**	**-0.0107**
	(3.84)	**(3.60)**	(-1.46)	**(3.75)**	**(2.52)**	**(-2.90)**
c_5	**0.0299**	**0.0289**	**0.0129**	**0.0296**	**0.0256**	**0.0080**
	(8.74)	**(8.45)**	**(3.76)**	**(8.66)**	**(7.48)**	**(2.33)**
Adj. R^2 [%]	1.1701	1.2543	3.1895	1.2011	1.6975	3.7392
N			47,565			
F-statistic	1.43	2.00	0.14	0.52	0.76	0.10

Panel B: Dependent variable markup change						
Fixed effects	None	Submitter	Underlying	Currency	Maturity	All
a	**-0.9312**	0.0018	-2.7124	0.0547	0.9790	-1.6095
	(-7.87)	(0.00)	(-1.38)	(0.12)	(0.63)	(-0.21)
	Explanatory variables: Order flow					
b_0	**0.7755**	**0.7823**	**0.7818**	**0.7738**	**0.7708**	**0.7806**
	(2.77)	**(2.79)**	**(2.80)**	**(2.76)**	**(2.76)**	**(2.80)**
b_1	-0.1235	-0.1205	-0.1157	-0.1259	-0.1236	-0.1154
	(-0.44)	(-0.43)	(-0.41)	(-0.45)	(-0.44)	(-0.41)
b_2	**-0.4843**	**-0.4788**	**-0.4772**	**-0.4866**	**-0.4793**	**-0.4703**
	(-1.73)	**(-1.71)**	**(-1.71)**	**(-1.74)**	**(-1.71)**	**(-1.69)**
b_3	-0.1346	-0.1320	-0.1277	-0.1369	-0.1256	-0.1197
	(-0.48)	(-0.47)	(-0.46)	(-0.49)	(-0.45)	(-0.43)
b_4	0.2150	0.2260	0.2211	0.2133	0.2149	0.2263
	(0.78)	(0.82)	(0.80)	(0.77)	(0.78)	(0.82)
	Control variables: Lagged premium changes					
c_1	**-0.4119**	**-0.4123**	**-0.4188**	**-0.412**	**-0.4165**	**-0.4238**
	(-93.19)	**(-93.23)**	**(-94.70)**	**(-93.21)**	**(-94.20)**	**(-95.77)**
c_2	**-0.3250**	**-0.3255**	**-0.3338**	**-0.3251**	**-0.3308**	**-0.3403**
	(-70.69)	**(-70.73)**	**(-72.43)**	**(-70.71)**	**(-71.85)**	**(-73.66)**
c_3	**-0.1414**	**-0.1419**	**-0.1515**	**-0.1416**	**-0.1477**	**-0.1584**
	(-31.24)	**(-31.33)**	**(-33.33)**	**(-31.27)**	**(-32.56)**	**(-34.74)**
c_4	**-0.1059**	**-0.1063**	**-0.1146**	**-0.1060**	**-0.1111**	**-0.1202**
	(-25.29)	**(-25.36)**	**(-27.26)**	**(-25.31)**	**(-26.49)**	**(-28.55)**
c_5	**-0.0350**	**-0.0353**	**-0.0419**	**-0.0351**	**-0.0388**	**-0.0459**
	(-9.37)	**(-9.45)**	**(-11.19)**	**(-9.39)**	**(-10.38)**	**(-12.26)**
Adj. R^2 [%]	**17.9820**	**17.9577**	**18.4937**	**17.9882**	**18.3515**	**18.8395**
N	47,076					
F-statistic	0.52	0.70	0.11	0.21	0.21	0.07

Table 7. Dealer vs. buy-side transaction direction

The table shows coefficient estimates (and t-statistics in parentheses) for Equation (5), the regression of the premium and markup change on the transaction direction and the transaction direction interacted with a dummy for whether the transaction is entered into with a dealer. The premium change is measured as the premium of the current trade minus the premium of the most recent trade for the submitter for a particular CDS contract. The markup change is measured as the difference between the premium change for the submitter and contract currently considered, and the Bloomberg mid CDS premium change on the same contract during the same time interval. We identify a particular CDS contract by the underlying reference entity, the currency, the maturity, and the seniority (senior vs. subordinated). The direction of the transaction is given as +1 if the transaction submitter sells protection in the current transaction and as -1 if the transaction submitter buys protection in the current transaction. The dummy variable takes on a value of 1 if the submitter entered into a transaction with a dealer, and 0 otherwise. We use Newey-West standard errors, adjusted for the different lengths between two trade dates. Bold format indicates significance at the 10% level or less.

$$\Delta prem_t = a + b \cdot \left(1_{\text{submitter=seller}} - 1_{\text{submitter=buyer}}\right) + c \cdot \left(1_{\text{submitter=seller}} - 1_{\text{submitter=buyer}}\right) \cdot 1_{\text{counterparty=dealer}} + \varepsilon_t$$

Panel A: Dependent variable premium change

Fixed effects	None	Submitter	Underlying	Currency	Maturity	All
a	**-4.4020**	1.5562	5.5891	-0.2608	0.6581	11.2491
	(-17.68)	(0.16)	(1.43)	(-0.26)	(0.21)	(0.95)
b	**3.5010**	**3.5512**	**2.3875**	**3.2768**	**3.0045**	**2.1108**
	(4.71)	**(4.77)**	**(3.23)**	**(4.40)**	**(4.05)**	**(2.85)**
c	**-2.4904**	**-2.5497**	**-1.4380**	**-2.2678**	**-1.9861**	-1.1364
	(-3.16)	**(-3.23)**	**(-1.83)**	**(-2.87)**	**(-2.52)**	(-1.45)
Adj. R^2 [%]	0.0695	0.2150	2.2104	0.1031	0.6010	2.7036
N			53,000			

Panel B: Dependent variable markup change

Fixed effects	None	Submitter	Underlying	Currency	Maturity	All
a	**-0.8325**	0.3049	-1.5678	-0.2790	0.3513	0.0262
	(-5.74)	(0.06)	(-0.69)	(-0.47)	(0.19)	(0.00)
b	**2.6405**	**2.6607**	**2.4718**	**2.6091**	**2.5245**	**2.4187**
	(6.09)	**(6.12)**	**(5.67)**	**(6.00)**	**(5.82)**	**(5.54)**
c	**-1.9616**	**-1.9732**	**-1.8033**	**-1.9305**	**-1.8441**	**-1.7376**
	(-4.26)	**(-4.28)**	**(-3.90)**	**(-4.18)**	**(-4.00)**	**(-3.75)**
Adj. R^2 [%]	0.1040	0.0613	0.2889	0.1038	0.1913	0.3136
N			52,423			

Table 8. Dealer vs. buy-side order flow

The table shows coefficient estimates (and t-statistics in parentheses) for Equation (6), the regression of the premium and markup change on the order flow and the order flow interacted with a dummy for whether the transaction is entered into with a dealer. The premium change is measured as the premium of the current trade minus the premium of the most recent trade for the submitter for a particular CDS contract. The markup change is measured as the difference between the premium change for the submitter and contract currently considered, and the Bloomberg mid CDS premium change on the same contract during the same time interval. We identify a particular CDS contract by the underlying reference entity, the currency, the maturity, and the seniority (senior vs. subordinated). The order flow is measured as the change in the normalized order flow through the current trade. The dummy variable takes on a value of 1 if the submitter entered into a transaction with a dealer, and 0 otherwise. We use Newey-West standard errors, adjusted for the different lengths between two trade dates. Bold format indicates significance at the 10% level or less.

$$\Delta prem_t = a + b \cdot OF_t + c \cdot OF_t \cdot 1_{\text{counterparty=dealer}} + \varepsilon_t$$

Panel A: Dependent variable premium change

Fixed effects	None	Submitter	Underlying	Currency	Maturity	All
a	**-4.3451**	1.1299	5.6685	0.0905	0.8920	10.5900
	(-17.48)	(0.12)	(1.45)	(0.09)	(0.28)	(0.89)
b	**6.3463**	**6.4316**	**5.1432**	**6.3178**	**5.9159**	**5.0166**
	(3.55)	**(3.60)**	**(2.91)**	**(3.54)**	**(3.32)**	**(2.84)**
c	**-5.2938**	**-5.3561**	**-3.9712**	**-5.2674**	**-4.7975**	**-3.7951**
	(-2.82)	**(-2.85)**	**(-2.13)**	**(-2.80)**	**(-2.56)**	**(-2.04)**
Adj. R^2 [%]	0.0261	0.1119	2.1178	0.0631	0.5509	2.5391
N			53,000			

Panel B: Dependent variable markup change

Fixed effects	None	Submitter	Underlying	Currency	Maturity	All
a	**-0.7893**	0.0127	-1.4734	0.0161	0.5442	-0.0788
	(-5.45)	(0.00)	(-0.64)	(0.03)	(0.29)	(-0.01)
b	**4.9874**	**5.0084**	**4.8145**	**4.9794**	**4.8587**	**4.7629**
	(4.69)	**(4.71)**	**(4.53)**	**(4.68)**	**(4.57)**	**(4.48)**
c	**-4.2308**	**-4.2469**	**-4.0388**	**-4.2233**	**-4.0861**	**-3.9753**
	(-3.79)	**(-3.80)**	**(-3.61)**	**(-3.78)**	**(-3.66)**	**(-3.55)**
Adj. R^2 [%]	0.0474	0.0038	0.2404	0.0492	0.1389	0.2664
N			52,423			

Table 9. The impact of intertrade time and transaction direction

The table shows coefficient estimates (and t-statistics in parentheses) for Equation (7), the regression of the premium and markup change on the transaction direction and the transaction direction interacted with the time since the last trade. The premium change is measured as the premium of the current trade minus the premium of the most recent trade for the submitter for a particular CDS contract. The markup change is measured as the difference between the premium change for the submitter and contract currently considered, and the Bloomberg mid CDS premium change on the same contract during the same time interval. We identify a particular CDS contract by the underlying reference entity, the currency, the maturity, and the seniority (senior vs. subordinated). The direction of the transaction is given as +1 if the transaction submitter sells protection in the current transaction and as -1 if the transaction submitter buys protection in the current transaction. The time since the last trade is measured in days. We use Newey-West standard errors, adjusted for the different lengths between two trade dates. Bold format indicates significance at the 10% level or less.

$$\Delta prem_t = a + b \cdot \left(1_{\text{submitter=seller}} - 1_{\text{submitter=buyer}}\right) + c \cdot \left(1_{\text{submitter=seller}} - 1_{\text{submitter=buyer}}\right) \cdot \Delta T_t + \varepsilon_t$$

Panel A: Dependent variable premium change

Fixed effects	None	Submitter	Underlying	Currency	Maturity	All
a	**-4.3573**	1.8336	5.7187	-0.0117	0.8046	11.1894
	(-17.53)	(0.19)	(1.46)	(-0.01)	(0.25)	(0.95)
b	**0.9074**	**0.8980**	**0.7126**	**0.8760**	**0.8669**	**0.7130**
	(3.29)	**(3.25)**	**(2.61)**	**(3.18)**	**(3.15)**	**(2.61)**
c	**0.0350**	**0.0359**	**0.0363**	**0.0353**	**0.0342**	**0.0357**
	(3.19)	**(3.27)**	**(3.34)**	**(3.22)**	**(3.13)**	**(3.29)**
Adj. R^2 [%]	0.0066	0.1515	2.1528	0.1015	0.5887	2.7197
N	53,000					

Panel B: Dependent variable markup change

Fixed effects	None	Submitter	Underlying	Currency	Maturity	All
a	**-0.7961**	0.4371	-1.3567	-0.0673	0.4764	-0.1062
	(-5.50)	(0.08)	(-0.59)	(-0.11)	(0.26)	(-0.01)
b	**0.8129**	**0.8216**	**0.7818**	**0.8074**	**0.8042**	**0.7908**
	(5.06)	**(5.10)**	**(4.87)**	**(5.02)**	**(5.01)**	**(4.91)**
c	0.0078	0.0081	0.0079	0.0079	0.0075	0.0077
	(1.22)	(1.25)	(1.23)	(1.23)	(1.17)	(1.20)
Adj. R^2 [%]	0.0722	0.0294	0.2628	0.0733	0.1633	0.2896
N	52,423					

Table 10. The impact of intertrade time and order flow

The table shows coefficient estimates (and t-statistics in parentheses) for Equation (8), the regression of the premium and markup change on the order flow and the order flow interacted with the time since the last trade. The premium change is measured as the premium of the current trade minus the premium of the most recent trade for the submitter for a particular CDS contract. The markup change is measured as the difference between the premium change for the submitter and contract currently considered, and the Bloomberg mid CDS premium change on the same contract during the same time interval. We identify a particular CDS contract by the underlying reference entity, the currency, the maturity, and the seniority (senior vs. subordinated). The order flow is measured as the change in the normalized order flow through the current trade. The time since the last trade is measured in days. We use Newey-West standard errors, adjusted for the different lengths between two trade dates. Bold format indicates significance at the 10% level or less.

$$\Delta prem_t = a + b \cdot OF_t + c \cdot OF_t \cdot \Delta T_t + \varepsilon_t$$

Panel A: Dependent variable premium change

Fixed effects	None	Submitter	Underlying	Currency	Maturity	All
a	**-4.3302**	1.1661	5.9293	0.1131	0.9295	10.7902
	(-17.42)	(0.12)	(1.52)	(0.11)	(0.29)	(0.91)
b	**1.1424**	**1.1557**	**1.1189**	**1.1385**	**1.1953**	**1.1848**
	(1.76)	**(1.78)**	**(1.74)**	**(1.76)**	**(1.85)**	**(1.85)**
c	0.0208	0.0215	0.0214	0.0207	0.019	0.0198
	(1.29)	(1.34)	(1.35)	(1.29)	(1.19)	(1.25)
Adj. R^2 [%]	0.0143	0.0100	2.1128	0.0514	0.5413	2.5343
N	53,000					

Panel B: Dependent variable markup change

Fixed effects	None	Submitter	Underlying	Currency	Maturity	All
a	**-0.7809**	0.0045	-1.2793	0.0348	0.5597	0.0729
	(-5.39)	(0.00)	(-0.56)	(0.06)	(0.30)	(0.01)
b	**1.3992**	**1.4067**	**1.4005**	**1.3978**	**1.4115**	**1.4191**
	(3.65)	**(3.67)**	**(3.66)**	**(3.65)**	**(3.68)**	**(3.70)**
c	-0.0120	-0.0121	-0.0120	-0.0120	-0.0125	-0.0127
	(-1.21)	(-1.21)	(-1.21)	(-1.21)	(-1.26)	(-1.28)
Adj. R^2 [%]	0.0229	-0.0210	0.2184	0.0248	0.1165	0.2454
N	52,423					

Table 11. The impact of fundamental risk and transaction direction

The table displays coefficient estimates (and t-statistics in parentheses) for Equation (9), the regression of the premium and markup change on the transaction direction and the transaction direction interacted with the lagged market premium change. The premium change is measured as the premium of the current trade minus the premium of the most recent trade for the submitter for a particular CDS contract. The markup change is measured as the difference between the premium change for the submitter and contract currently considered, and the Bloomberg mid CDS premium change on the same contract during the same time interval. We identify a particular CDS contract by the underlying reference entity, the currency, the maturity, and the seniority (senior vs. subordinated). The direction of the transaction is given as +1 if the transaction submitter sells protection in the current transaction and as -1 if the transaction submitter buys protection in the current transaction. The lagged market premium change is given as the change of the Bloomberg mid CDS premium between the day preceding the current trade, and the most recent trade. We use Newey-West standard errors, adjusted for the different lengths between two trade dates. Bold format indicates significance at the 10% level or less.

$$\Delta prem_t = a + b \cdot \left(1_{\text{submitter=seller}} - 1_{\text{submitter=buyer}}\right) + c \cdot \left(1_{\text{submitter=seller}} - 1_{\text{submitter=buyer}}\right) \cdot \Delta\text{market}_{t-1} + \varepsilon_t$$

Panel A: Dependent variable premium change

Fixed effects	None	Submitter	Underlying	Currency	Maturity	All
a	**-4.0801**	1.7134	5.7441	0.0383	0.9090	12.0339
	(-17.13)	(0.19)	(1.53)	(0.04)	(0.30)	(0.83)
b	**1.1221**	**1.1189**	**0.9418**	**1.0939**	**1.0743**	**0.9278**
	(4.69)	**(4.66)**	**(3.98)**	**(4.57)**	**(4.51)**	**(3.91)**
c	**0.0130**	**0.0127**	**0.0098**	**0.0128**	**0.0118**	0.0088
	(2.18)	**(2.14)**	**(1.67)**	**(2.16)**	**(1.99)**	(1.51)
Adj. R^2 [%]	0.0451	0.0676	2.1466	0.0800	0.5841	2.5619
N			51,350			

Panel B: Dependent variable markup change

Fixed effects	None	Submitter	Underlying	Currency	Maturity	All
a	**-0.6431**	0.4206	-1.5237	-0.0609	0.4916	-0.2296
	(-4.58)	(0.08)	(-0.68)	(-0.11)	(0.27)	(-0.03)
b	**0.8082**	**0.8163**	**0.7832**	**0.8042**	**0.7986**	**0.7870**
	(5.73)	**(5.76)**	**(5.55)**	**(5.70)**	**(5.66)**	**(5.55)**
c	**0.0058**	0.0057	0.0053	0.0058	0.0058	0.0053
	(1.66)	(1.63)	(1.52)	(1.65)	(1.65)	(1.50)
Adj. R^2 [%]	0.0625	0.0149	0.1661	0.0627	0.1506	0.2051
N			51,350			

Table 12. The impact of fundamental risk and order flow

The table displays coefficient estimates (and t-statistics in parentheses) for Equation (10), the regression of the premium and markup change on the order flow and the order flow interacted with the lagged market premium change. The premium change is measured as the premium of the current trade minus the premium of the most recent trade for the submitter for a particular CDS contract. The markup change is measured as the difference between the premium change for the submitter and contract currently considered, and the Bloomberg mid CDS premium change on the same contract during the same time interval. We identify a particular CDS contract by the underlying reference entity, the currency, the maturity, and the seniority (senior vs. subordinated). The order flow is measured as the change in the normalized order flow through the current trade. The lagged market premium change is given as the change of the Bloomberg mid CDS premium between the day preceding the current trade, and the most recent trade. We use Newey-West standard errors, adjusted for the different lengths between two trade dates. Bold format indicates significance at the 10% level or less.

$$\Delta prem_t = a + b \cdot OF_t + c \cdot OF_t \cdot \Delta \text{market}_{t-1} + \varepsilon_t$$

Panel A: Dependent variable premium change

Fixed effects	None	Submitter	Underlying	Currency	Maturity	All
a	**-4.0621**	1.1918	5.8760	0.1698	1.0085	12.0645
	(-17.06)	(0.13)	(1.56)	(0.17)	(0.33)	(0.83)
b	**1.3647**	**1.3891**	**1.3637**	**1.3586**	**1.3664**	**1.3687**
	(2.51)	**(2.56)**	**(2.54)**	**(2.50)**	**(2.52)**	**(2.55)**
c	0.0061	0.0063	0.0045	0.0060	0.0038	0.0029
	(0.49)	(0.51)	(0.37)	(0.49)	(0.31)	(0.24)
Adj. R^2 [%]	0.0085	0.0323	2.1254	0.0456	0.5522	2.5427
N	51,350					

Panel B: Dependent variable markup change

Fixed effects	None	Submitter	Underlying	Currency	Maturity	All
a	**-0.6277**	0.0637	-1.4684	0.0342	0.5724	-0.2611
	(-4.47)	(0.01)	(-0.66)	(0.06)	(0.32)	(-0.03)
b	**1.2339**	**1.2347**	**1.2355**	**1.2329**	**1.2331**	**1.2323**
	(3.85)	**(3.85)**	**(3.85)**	**(3.85)**	**(3.85)**	**(3.84)**
c	**0.0393**	**0.0391**	**0.0392**	**0.0393**	**0.0389**	**0.0387**
	(5.34)	**(5.31)**	**(5.33)**	**(5.34)**	**(5.29)**	**(5.26)**
Adj. R^2 [%]	0.0738	0.0250	0.1818	0.0746	0.1624	0.2193
N	51,350					

Table 13. The impact of the market premium change

The table displays coefficient estimates (and t-statistics in parentheses) for Equations (1) to (10) where we additionally account for the market premium change. The panel headers give the reference to the table to which the robustness check applies and the corresponding regression equation. For ease of comparison, we repeat the original results in the first column. In the second column, we re-estimate the original regression with the market premium change, measured as the change of the Bloomberg mid premium, as an additional explanatory variable. In the third column, we use the relative premium change as the dependent variable. The other explanatory variables are as in the original regression equations. The premium change is measured as the premium of the current trade minus the premium of the most recent trade by the same submitter on the same CDS contract. The relative premium change is measured as the premium of the current trade, divided by the Bloomberg mid premium, minus the premium of the most recent traded of the submitter on the same CDS contract, divided by the Bloomberg mid premium during the most recent trade. We use Newey-West standard errors, adjusted for the different lengths between two trade dates. Bold format indicates significance at the 10% level or less.

Dependent variable premium change

	Original result	+ Explanatory variable Δ market premium	Dependent variable relative premium change [%]
	Panel A: Table 3, $\Delta prem_t = a + b \cdot \left(1_{\text{submitter=seller}} - 1_{\text{submitter=buyer}}\right) + \varepsilon_t$		
b	**1.1007**	**0.8280**	**0.3133**
	(4.46)	**(5.84)**	**(7.92)**
Adj. R^2 [%]	2.6998	68.5580	0.2459
N	53,000	52,423	52,423
	Panel B: Table 4, $\Delta prem_t = a + b \cdot OF_t + \varepsilon_t$		
b	**1.5922**	**1.0772**	**0.4992**
	(2.89)	**(3.39)**	**(5.62)**
Adj. R^2 [%]	2.6785	68.5444	0.1865
N	53,000	52,423	52,423
	Panel C: Table 5, $\Delta prem_t = a + \sum_{k=0}^{4} b_k \cdot \left(1_{\text{submitter=seller}} - 1_{\text{submitter=buyer}}\right)_{t-k} + \sum_{l=1}^{5} c_k \cdot \Delta prem_{t-l} + \varepsilon_t$		
b_0	**0.6993**	**0.6225**	**0.0029**
	(3.48)	**(4.92)**	**(7.12)**
b_1	-0.0504	**-0.3253**	**-0.0018**
	(-0.25)	**(-2.57)**	**(-4.36)**
b_2	-0.0968	-0.2161	**-0.0009**
	(-0.48)	(-1.71)	**(-2.31)**
b_3	0.1810	0.1703	0.0004
	(0.90)	(1.35)	(0.89)
b_4	-0.0703	0.0323	0.0004
	(-0.35)	(0.26)	(0.93)
Adj. R^2 [%]	3.7522	62.7375	2.21
N	47,565	47,076	47,076

Panel D: Table 6, $\Delta prem_t = a + \sum_{k=0}^{4} b_k \cdot OF_{t-k} + \sum_{l=1}^{5} c_k \cdot \Delta prem_{t-l} + \varepsilon_t$

b_0	**0.9276**	**0.9744**	**0.0049**
	(1.97)	**(3.27)**	**(5.14)**
b_1	0.1129	-0.2844	-0.0012
	(0.24)	(-0.95)	(-1.28)
b_2	-0.6207	-0.4521	**-0.0024**
	(-1.31)	(-1.52)	**(-2.51)**
b_3	-0.2092	0.0142	0.0000
	(-0.45)	(0.30)	(0.01)
b_4	0.3648	0.2932	-0.0004
	(0.78)	(1.00)	(-0.44)
Adj. R^2 [%]	3.7392	62.7231	2.1364
N	47,565	47,076	47,076

Panel E: Table 7,

$$\Delta prem_t = a + b \cdot \left(1_{\text{submitter=seller}} - 1_{\text{submitter=buyer}}\right) + c \cdot \left(1_{\text{submitter=seller}} - 1_{\text{submitter=buyer}}\right) \cdot 1_{\text{counterparty=dealer}} + \varepsilon_t$$

b	**2.1108**	**2.4805**	**1.3468**
	(2.85)	**(5.83)**	**(11.35)**
c	-1.1364	**-1.8583**	**-1.1622**
	(-1.45)	**(-4.12)**	**(-9.24)**
Adj. R^2 [%]	2.7036	68.5676	0.4063
N	53,000	52,423	52,423

Panel F: Table 8, $\Delta prem_t = a + b \cdot OF_t + c \cdot OF_t \cdot 1_{\text{counterparty=dealer}} + \varepsilon_t$

b	**5.0166**	**4.6582**	**0.0208**
	(2.84)	**(4.50)**	**(7.20)**
c	**-3.7951**	**-3.9552**	**-0.0175**
	(-2.04)	**(-3.63)**	**(-5.75)**
Adj. R^2 [%]	2.5391	68.5517	0.3640
N	53,000	52,423	52,423

Panel G: Table 9,

$$\Delta prem_t = a + b \cdot \left(1_{\text{submitter=seller}} - 1_{\text{submitter=buyer}}\right) + c \cdot \left(1_{\text{submitter=seller}} - 1_{\text{submitter=buyer}}\right) \cdot \Delta T_t + \varepsilon_t$$

b	**0.7130**	**0.8048**	**0.0034**
	(2.61)	**(5.13)**	**(7.78)**
c	0.0357	0.0022	-0.0026
	(3.29)	(0.34)	(-1.46)
Adj. R^2 [%]	2.7197	68.5575	0.2481
N	53,000	52,423	52,423

Panel H: Table 10, $\Delta prem_t = a + b \cdot OF_t + c \cdot OF_t \cdot \Delta T_t + \varepsilon_t$

b	**1.1848**	**1.4735**	**0.5717**
	(1.85)	**(3.95)**	**(5.49)**
c	0.0198	**-0.0197**	-0.0036
	(1.25)	**(-2.03)**	(-1.33)
Adj. R^2 [%]	2.5343	68.5463	0.1880
N	53,000	52,423	52,423

Panel I: Table 11

$$\Delta prem_t = a + b \cdot \left(1_{\text{submitter=seller}} - 1_{\text{submitter=buyer}}\right) + c \cdot \left(1_{\text{submitter=seller}} - 1_{\text{submitter=buyer}}\right) \cdot \Delta \text{market}_{t-1} + \varepsilon_t$$

b	**0.9278**	**0.7551**	**0.3144**
	(3.91)	**(5.46)**	**(7.85)**
c	0.0088	0.0046	0.0007
	(1.51)	(1.34)	(0.69)
Adj. R^2 [%]	2.5619	66.5741	0.1158
N	51,350	51,350	51,350

Panel J: Table 12, $\Delta prem_t = a + b \cdot OF_t + c \cdot OF_t \cdot \Delta \text{market}_{t-1} + \varepsilon_t$

b	**1.3687**	**1.2117**	**0.5296**
	(2.55)	**(3.86)**	**(5.82)**
c	0.0029	**0.0449**	**0.0046**
	(0.24)	**(6.22)**	**(2.18)**
Adj. R^2 [%]	2.5427	66.5865	0.0673
N	51,350	51,350	51,350

Table 14. The impact of lagged changes

The table displays coefficient estimates (and t-statistics in parentheses) for Equations (1) to (10) where we additionally adjust for lagged premium and markup changes. The panel headers give the reference to the table to which the robustness check applies and the corresponding regression equation. For ease of comparison, we again repeat the original results for the premium change in the first column and for the markup change in the third column. In the second column, we re-estimate the original regression with the lagged premium changes as additional explanatory variables. In the fourth column, we re-estimate the original regression with the lagged markup changes as additional explanatory variables. We consider five lags. The premium and markup changes and the other explanatory variables are as in the original regression equations. We use Newey-West standard errors, adjusted for the different lengths between two trade dates. Bold format indicates significance at the 10% level or less.

	Dependent variable premium change		*Dependent variable markup change*	
	Original result	+ Explanatory variable lagged premium changes	Original result	+ Explanatory variable lagged markup changes
	Panel A: Table 7, $\Delta prem_t = a + b \cdot \left(1_{\text{submitter=seller}} - 1_{\text{submitter=buyer}}\right) + c \cdot \left(1_{\text{submitter=seller}} - 1_{\text{submitter=buyer}}\right) \cdot 1_{\text{counterparty=dealer}} + \varepsilon_t$			
b	**2.1108**	**1.6425**	**2.4187**	**1.8799**
	(2.85)	**(2.76)**	**(5.54)**	**(4.97)**
c	-1.1364	**-1.0686**	**-1.7376**	**-1.4275**
	(-1.45)	**(-1.69)**	**(-3.75)**	**(-3.55)**
Adj. R^2 [%]	2.7036	3.7617	0.3136	5.4398
N	53,000	47,565	52,423	47,076
	Panel B: Table 8, $\Delta prem_t = a + b \cdot OF_t + c \cdot OF_t \cdot 1_{\text{counterparty=dealer}} + \varepsilon_t$			
b	**5.0166**	**3.7378**	**4.7629**	**3.7494**
	(2.84)	**(2.65)**	**(4.48)**	**(4.00)**
c	**-3.7951**	**-3.2442**	**-3.9753**	**-3.0431**
	(-2.04)	**(-2.12)**	**(-3.55)**	**(-3.07)**
Adj. R^2 [%]	2.5391	3.7488	0.2664	5.4099
N	53,000	47,565	52,423	47,076
	Panel C: Table 9, $\Delta prem_t = a + b \cdot \left(1_{\text{submitter=seller}} - 1_{\text{submitter=buyer}}\right) + c \cdot \left(1_{\text{submitter=seller}} - 1_{\text{submitter=buyer}}\right) \cdot \Delta T_t + \varepsilon_t$			
b	**0.7130**	**0.8179**	**0.7908**	**0.6306**
	(2.61)	**(3.69)**	**(4.91)**	**(4.49)**
c	**0.0357**	-0.0119	0.0077	-0.0016
	(3.29)	(-1.31)	(1.20)	(-0.27)
Adj. R^2 [%]	2.7197	3.5794	0.2896	5.4145
N	53,000	47,565	52,423	47,076

Panel D: Table 10, $\Delta prem_t = a + b \cdot OF_t + c \cdot OF_t \cdot \Delta T_t + \varepsilon_t$

b	**1.1848**	**1.0236**	**1.4191**	**1.0482**
	(1.85)	**(1.88)**	**(3.70)**	**(3.02)**
c	0.0198	-0.0046	-0.0127	-0.0018
	(1.25)	(-0.32)	(-1.28)	(-0.19)
Adj. R^2 [%]	2.5343	3.7399	0.2454	5.3910
N	53,000	47,565	52,423	47,076

Panel E: Table 11,

$$\Delta prem_t = a + b \cdot \left(1_{\text{submitter=seller}} - 1_{\text{submitter=buyer}}\right) + c \cdot \left(1_{\text{submitter=seller}} - 1_{\text{submitter=buyer}}\right) \cdot \Delta \text{market}_{t-1} + \varepsilon_t$$

b	**0.9278**	**0.8680**	**0.7870**	**1.1463**
	(3.91)	**(4.23)**	**(5.55)**	**(4.84)**
c	0.0088	0.0007	0.0053	0.0010
	(1.51)	(0.10)	(1.50)	(0.27)
Adj. R^2 [%]	2.5619	1.1951	0.2051	18.0063
N	51,350	47,076	51,350	47,076

Panel F: Table 12, $\Delta prem_t = a + b \cdot OF_t + c \cdot OF_t \cdot \Delta \text{market}_{t-1} + \varepsilon_t$

b	**1.3687**	**1.0739**	**1.2323**	**0.9476**
	(2.55)	**(2.23)**	**(3.84)**	**(3.41)**
c	0.0029	**0.0571**	**0.0387**	**0.0508**
	(0.24)	**(4.54)**	**(5.26)**	**(7.04)**
Adj. R^2 [%]	2.5427	1.2084	0.2193	18.0667
N	51,350	47,076	51,350	47,076

Table 15. Extended time series results

The table displays coefficient estimates (and t-statistics in parentheses) for Equations (1) to (10) for the extended interval from January 2009 to October 2014. The panel headers give the reference to the table to which the robustness check applies and the corresponding regression equation. For ease of comparison, we again repeat the original results for the premium change in the first column and for the markup change in the third column. In the second and fourth column, we re-estimate the original regression for the extended time series, but since assignments and terminations are unavailable, the explanatory variables are fully determined by new trades. All variables are defined as in the original regression equations. We use Newey-West standard errors, adjusted for the different lengths between two trade dates. Bold format indicates significance at the 10% level or less.

	Dependent variable premium change		*Dependent variable markup change*	
	Original result	Extended time series, new trades only	Original result	Extended time series, new trades only
	Panel A: Table 3, $\Delta prem_t = a + b \cdot \left(1_{\text{submitter=seller}} - 1_{\text{submitter=buyer}}\right) + \varepsilon_t$			
b	**1.1007**	**0.3404**	**0.8737**	**0.4454**
	(4.46)	**(2.55)**	**(6.00)**	**(6.62)**
Adj. R^2 [%]	2.6998	0.3693	0.2887	0.2872
N	53,000	149,141	52,423	149,108
	Panel B: Table 4, $\Delta prem_t = a + b \cdot OF_t + \varepsilon_t$			
b	**1.5922**	**0.3190**	**1.1638**	**0.3472**
	(2.89)	**(2.35)**	**(3.56)**	**(5.08)**
Adj. R^2 [%]	2.6785	0.3040	0.2442	0.1661
N	53,000	149,141	52,423	149,108
	Panel C: Table 5, $\Delta prem_t = a + \sum_{k=0}^{4} b_k \cdot \left(1_{\text{submitter=seller}} - 1_{\text{submitter=buyer}}\right)_{t-k} + \sum_{l=1}^{5} c_k \cdot \Delta prem_{t-l} + \varepsilon_t$			
b_0	**0.6993**	**0.5030**	**0.5392**	**0.4989**
	(3.48)	**(4.38)**	**(4.56)**	**(8.99)**
b_1	-0.0504	-0.1446	-0.1878	**-0.1897**
	(-0.25)	(-1.25)	(-1.59)	**(-3.40)**
b_2	-0.0968	**-0.1984**	**-0.2026**	**-0.1614**
	(-0.48)	**(-1.71)**	**(-1.71)**	**(-2.88)**
b_3	0.1810	0.1579	0.0791	-0.0566
	(0.90)	(1.37)	(0.67)	(-1.01)
b_4	-0.0703	0.1138	0.0315	-0.0225
	(-0.35)	(0.99)	(0.27)	(-0.40)
Adj. R^2 [%]	3.7522	1.9802	18.8625	26.6965
N	47,565	138,013	47,076	137,980

Panel D: Table 6, $\Delta prem_t = a + \sum_{k=0}^{4} b_k \cdot OF_{t-k} + \sum_{l=1}^{5} c_k \cdot \Delta prem_{t-l} + \varepsilon_t$

b_0	**0.9276**	**0.3740**	**0.7806**	**0.3835**
	(1.97)	**(3.22)**	**(2.80)**	**(6.81)**
b_1	0.1129	**-0.1314**	-0.1154	**-0.1654**
	(0.24)	**(-1.13)**	(-0.41)	**(-2.95)**
b_2	-0.6207	**-0.3406**	**-0.4703**	-0.0514
	(-1.31)	**(-2.94)**	**(-1.69)**	(-0.92)
b_3	-0.2092	0.0625	-0.1197	-0.0503
	(-0.45)	(0.54)	(-0.43)	(-0.90)
b_4	0.3648	0.0031	0.2263	-0.1104
	(0.78)	(0.03)	(0.82)	(-1.99)
Adj. R^2 [%]	3.7392	1.9741	18.8395	26.6780
N	47,565	138,013	47,076	137,980

Panel E: Table 7,

$$\Delta prem_t = a + b \cdot \left(1_{\text{submitter=seller}} - 1_{\text{submitter=buyer}}\right) + c \cdot \left(1_{\text{submitter=seller}} - 1_{\text{submitter=buyer}}\right) \cdot 1_{\text{counterparty=dealer}} + \varepsilon_t$$

b	**2.1108**	**0.8633**	**2.4187**	**0.6151**
	(2.85)	**(3.75)**	**(5.54)**	**(5.30)**
c	-1.1364	**-0.7882**	**-1.7376**	**-0.2556**
	(-1.45)	**(-2.79)**	**(-3.75)**	**(-1.80)**
Adj. R^2 [%]	2.7036	0.8244	0.3136	0.3021
N	53,000	149,141	52,423	149,108

Panel F: Table 8, $\Delta prem_t = a + b \cdot OF_t + c \cdot OF_t \cdot 1_{\text{counterparty=dealer}} + \varepsilon_t$

b	**5.0166**	**0.7746**	**4.7629**	**0.6079**
	(2.84)	**(3.16)**	**(4.48)**	**(4.92)**
c	**-3.7951**	**-0.6566**	**-3.9753**	**-0.3757**
	(-2.04)	**(-2.23)**	**(-3.55)**	**(-2.53)**
Adj. R^2 [%]	2.5391	0.5709	0.2664	0.2025
N	53,000	149,141	52,423	149,108

Panel G: Table 9,

$$\Delta prem_t = a + b \cdot \left(1_{\text{submitter=seller}} - 1_{\text{submitter=buyer}}\right) + c \cdot \left(1_{\text{submitter=seller}} - 1_{\text{submitter=buyer}}\right) \cdot \Delta T_t + \varepsilon_t$$

b	**0.7130**	**0.5119**	**0.7908**	**0.4537**
	(2.61)	**(3.56)**	**(4.91)**	**(6.28)**
c	**0.0357**	**-0.0068**	0.0077	-0.0003
	(3.29)	**(-3.25)**	(1.20)	(-0.31)
Adj. R^2 [%]	2.7197	0.1011	0.2896	0.2812
N	53,000	149,141	52,423	149,108

Panel H: Table 10, $\Delta prem_t = a + b \cdot OF_t + c \cdot OF_t \cdot \Delta T_t + \varepsilon_t$

b	**1.1848**	**0.4263**	**1.4191**	**0.3379**
	(1.85)	**(2.91)**	**(3.70)**	**(4.58)**
c	0.0198	**-0.0041**	-0.0127	0.0004
	(1.25)	**(-1.95)**	(-1.28)	(0.34)
Adj. R^2 [%]	2.5343	0.4917	0.2454	0.1602
N	53,000	149,141	52,423	149,108

Panel I: Table 11,

$$\Delta prem_t = a + b \cdot \left(1_{\text{submitter=seller}} - 1_{\text{submitter=buyer}}\right) + c \cdot \left(1_{\text{submitter=seller}} - 1_{\text{submitter=buyer}}\right) \cdot \Delta \text{market}_{t-1} + \varepsilon_t$$

b	**0.9278**	**0.4128**	**0.7870**	**0.4446**
	(3.91)	**(3.31)**	**(5.55)**	**(6.71)**
c	0.0088	-0.0042	0.0053	-0.0006
	(1.51)	(-1.51)	(1.50)	(-0.44)
Adj. R^2 [%]	2.5619	0.8230	0.2051	0.2993
N	51,350	146,879	51,350	146,879

Panel J: Table 12, $\Delta prem_t = a + b \cdot OF_t + c \cdot OF_t \cdot \Delta \text{market}_{t-1} + \varepsilon_t$

b	**1.3687**	**0.3579**	**1.2323**	**0.3400**
	(2.55)	**(2.81)**	**(3.84)**	**(5.03)**
c	0.0029	-0.0035	**0.0387**	-0.0024
	(0.24)	(-1.17)	**(5.26)**	(-1.50)
Adj. R^2 [%]	2.5427	0.5412	0.2193	0.1845
N	51,350	146,879	51,350	146,879

Table 16. Events analysis

The table displays coefficient estimates (and t-statistics in parentheses) for Equations (1) to (10) where we only focus on an observation interval of four weeks around major events of the European sovereign debt crisis. The list of events is given in the appendix. The panel headers give the reference to the table to which the robustness check applies and the corresponding regression equation. For ease of comparison, we again repeat the original results for the premium change in the first column and for the markup change in the third column. In the second and fourth column, we re-estimate the original regression for the the four weeks around the major crisis events. All variables are defined as in the original regression equations. We use Newey-West standard errors, adjusted for the different lengths between two trade dates. Bold format indicates significance at the 10% level or less.

	Dependent variable premium change		*Dependent variable markup change*	
	Original result	Events interval	Original result	Events interval
	Panel A: Table 3, $\Delta prem_t = a + b \cdot \left(1_{\text{submitter=seller}} - 1_{\text{submitter=buyer}}\right) + \varepsilon_t$			
b	**1.1007**	**1.7912**	**0.8737**	**0.7096**
	(4.46)	**(3.59)**	**(6.00)**	**(3.31)**
Adj. R^2 [%]	2.6998	0.1037	0.2887	0.3548
N	53,000	11,423	52,423	11,422
	Panel B: Table 4, $\Delta prem_t = a + b \cdot OF_t + \varepsilon_t$			
b	**1.5922**	0.0917	**1.1638**	**0.0496**
	(2.89)	(1.57)	**(3.56)**	**(2.01)**
Adj. R^2 [%]	2.6785	0.2201	0.2442	0.4156
N	53,000	11,423	52,423	11,422
	Panel C: Table 5 $\Delta prem_t = a + \sum_{k=0}^{4} b_k \cdot \left(1_{\text{submitter=seller}} - 1_{\text{submitter=buyer}}\right)_{t-k} + \sum_{l=1}^{5} c_k \cdot \Delta prem_{t-l} + \varepsilon_t$			
b_0	**0.6993**	**1.7832**	**0.5392**	**0.8302**
	(3.48)	**(3.29)**	**(4.56)**	**(4.32)**
b_1	-0.0504	-0.6705	-0.1878	**-0.3823**
	(-0.25)	(-1.23)	(-1.59)	**(-1.98)**
b_2	-0.0968	0.8735	**-0.2026**	0.0651
	(-0.48)	(1.60)	**(-1.71)**	(0.34)
b_3	0.1810	-0.0060	0.0791	-0.1920
	(0.90)	(-0.01)	(0.67)	(-0.99)
b_4	-0.0703	-0.6669	0.0315	0.0867
	(-0.35)	(-1.23)	(0.27)	(0.45)
Adj. R^2 [%]	3.7522	4.3876	18.8625	26.2916
N	47,565	10,022	47,076	10,022

Panel D: Table 6, $\Delta prem_t = a + \sum_{k=0}^{4} b_k \cdot OF_{t-k} + \sum_{l=1}^{5} c_k \cdot \Delta prem_{t-l} + \varepsilon_t$

b_0	**0.9276**	0.0819	**0.7806**	**0.0457**
	(1.97)	(1.32)	**(2.80)**	**(2.07)**
b_1	0.1129	-0.0213	-0.1154	-0.0222
	(0.24)	(-0.34)	(-0.41)	(-1.01)
b_2	-0.6207	0.0652	**-0.4703**	0.0014
	(-1.31)	(1.06)	**(-1.69)**	(0.07)
b_3	-0.2092	-0.0417	-0.1197	-0.0282
	(-0.45)	(-0.68)	(-0.43)	(-1.30)
b_4	0.3648	0.0122	0.2263	0.0236
	(0.78)	(0.20)	(0.82)	(1.10)
Adj. R^2 [%]	3.7392	4.2688	18.8395	26.1874
N	47,565	10,023	47,076	10,022

Panel E: Table 7,

$$\Delta prem_t = a + b \cdot \left(1_{\text{submitter=seller}} - 1_{\text{submitter=buyer}}\right) + c \cdot \left(1_{\text{submitter=seller}} - 1_{\text{submitter=buyer}}\right) \cdot 1_{\text{counterparty=dealer}} + \varepsilon_t$$

b	**2.1108**	**2.7106**	**2.4187**	**1.3702**
	(2.85)	**(2.96)**	**(5.54)**	**(3.55)**
c	-1.1364	-1.3714	**-1.7376**	-0.9567
	(-1.45)	(-1.24)	**(-3.75)**	(-0.06)
Adj. R^2 [%]	2.7036	0.1312	0.3136	0.3262
N	53,000	11,423	52,423	11,422

Panel F: Table 8, $\Delta prem_t = a + b \cdot OF_t + c \cdot OF_t \cdot 1_{\text{counterparty=dealer}} + \varepsilon_t$

b	**5.0166**	**0.2356**	**4.7629**	**0.0968**
	(2.84)	**(1.94)**	**(4.48)**	**(1.89)**
c	**-3.7951**	-0.2112	**-3.9753**	-0.0614
	(-2.04)	(-1.53)	**(-3.55)**	(-1.05)
Adj. R^2 [%]	2.5391	0.2129	0.2664	0.4147
N	53,000	11,423	52,423	11,422

Panel G: Table 9,

$$\Delta prem_t = a + b \cdot \left(1_{\text{submitter=seller}} - 1_{\text{submitter=buyer}}\right) + c \cdot \left(1_{\text{submitter=seller}} - 1_{\text{submitter=buyer}}\right) \cdot \Delta T_t + \varepsilon_t$$

b	**0.7130**	**1.9696**	**0.7908**	**0.7613**
	(2.61)	**(3.67)**	**(4.91)**	**(3.36)**
c	**0.0357**	-0.0085	0.0077	-0.0021
	(3.29)	(-1.20)	(1.20)	(-0.7148)
Adj. R^2 [%]	2.7197	0.1321	0.2896	0.3591
N	53,000	11,423	52,423	11,422

Panel H: Table 10, $\Delta prem_t = a + b \cdot OF_t + c \cdot OF_t \cdot \Delta T_t + \varepsilon_t$

b	**1.1848**	**0.1279**	**1.4191**	**0.0620**
	(1.85)	**(2.05)**	**(3.70)**	**(2.36)**
c	0.0198	**-0.0011**	-0.0127	-0.0004
	(1.25)	**(-1.67)**	(-1.28)	(-1.36)
Adj. R^2 [%]	2.5343	0.2044	0.2454	0.4081
N	53,000	11,423	52,423	11,422

Panel I: Table 11

$$\Delta prem_t = a + b \cdot \left(1_{\text{submitter=seller}} - 1_{\text{submitter=buyer}}\right) + c \cdot \left(1_{\text{submitter=seller}} - 1_{\text{submitter=buyer}}\right) \cdot \Delta\text{market}_{t-1} + \varepsilon_t$$

b	**0.9278**	**1.8214**	**0.7870**	**0.7003**
	(3.91)	**(3.52)**	**(5.55)**	**(3.24)**
c	0.0088	**-0.0270**	0.0053	-0.0045
	(1.51)	**(-2.58)**	(1.50)	(-1.02)
Adj. R^2 [%]	2.5619	0.0874	0.2051	0.3650
N	51,350	11,142	51,350	11,142

Panel J: Table 12, $\Delta prem_t = a + b \cdot OF_t + c \cdot OF_t \cdot \Delta\text{market}_{t-1} + \varepsilon_t$

b	**1.3687**	0.0928	**1.2323**	**0.0499**
	(2.55)	(1.56)	**(3.84)**	**(2.01)**
c	0.0029	**-0.0038**	**0.0387**	-0.0011
	(0.24)	**(-1.88)**	**(5.26)**	(-1.33)
Adj. R^2 [%]	2.5427	0.2018	0.2193	0.4140
N	51,350	11,142	51,350	11,142

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