Online Appendix for

"Funding Liquidity Shocks in a Quasi-Experiment: Evidence from the CDS Big Bang"

January 12, 2020

Abstract

This appendix reports additional analyses to support our main results in the paper and provides details of empirical results that are not tabulated in the main text.

Appendix A: Interaction Terms between BB and Control Variables

For brevity, interaction terms $\boldsymbol{\gamma_2}$ between BB and control variables are not reported in Table 2 in the paper. Therefore, we report the complete results in Table A1.

Appendix B: Alternative Upfront Cost Measure

In this section, we repeat our main analyses using an alternative upfront cost measure based on the ISDA CDS standard model. Following the industrial practice in the CDS market, we employ the ISDA CDS standard model to convert the distance between the coupon rate and the CDS spread into the upfront fee.[1] Specifically, using our North American CMA sample, we calculate the two possible sizes of upfront fees for the two coupon rates (100 bps and 500 bps) and choose the smaller one as our estimated upfront fee, $Fee_{i,t}^{ISDA}$. The upfront funding cost for the five-year contract is then measured as

$$F_{i,t}^{ISDA} = Fee_{i,t}^{ISDA} \times LOIS_t. \tag{A1}$$

We first repeat our earlier difference-in-difference analyses in Section 3.2 using our estimated upfront funding cost F^{ISDA}. The results, reported in Table A2, are very similar to those in columns (1)-(3) of Table 2. For example, in column (3), the interaction term $F^{ISDA} \times BB$ is 0.53 (*t*=5.3). This is consistent with the evidence in column (3) of Table 2 that the upfront funding cost has a differential effect on the bid-ask spread. In fact, since the estimated upfront fee, Fee^{ISDA}, is mostly proportional to our earlier upfront fee measure, *DIS*, the coefficient of the interaction term $F^{ISDA} \times BB$ in column (3) of Table A2 is mostly proportional to that in column (3) of Table 2.

The ISDA measure of upfront funding cost, F^{ISDA}, also gives similar economic magnitudes to those using the *DIS* measure in Section 3.2 in the paper. For the ISDA measure, the estimate of

[1] We use the function "JpmcdsCdsoneUpfrontCharge" to compute the upfront fee from the CDS spread, the coupon rate, and the term structure of the LIBOR rates. Details of this function and the model can be found at http://www.cdsmodel.com/cdsmodel/.

b_2 is 0.53 for the interaction term of $b_2 \times F_{i,t}^{ISDA} \times BB_t$, where $F_{i,t}^{ISDA}$ is defined as $Fee_{i,t}^{ISDA} \times LOIS_t$ (see Table A2.) We have confirmed that, even though the coefficient estimates of these two measures are different, they give similar economic magnitudes regarding the effect of funding liquidity on bid-ask spreads. For example, in the non-crisis period, the mean and median of $Fee_{i,t}^{ISDA}$ are 2.87 percent and 2.83 percent, respectively. Using these values, we estimate the increase in the bid-ask spread post-Big Bang to be $b_2 \times F_{i,t}^{ISDA} \times BB_t = 0.53 \times (2.87 \ \times 0.32) \times 1 = 0.49$ bps for the average contract or $b_2 \times F_{i,t}^{ISDA} \times BB_t = 0.53 \times (2.83 \ \times 0.32) \times 1 = 0.48$ bps for the median contract. These numbers are similar to the 0.51 bps and 0.49 bps estimated using the *DIS* measure, as mentioned in Section 3.2 in the paper.

Next, we repeat the analyses of central clearing in Sections 4.2.1 and Deutsche Bank's exit from the single-name CDS market in Section 4.2.2 using the alternative upfront cost measure based on the ISDA CDS standard model. In our Markit samples, we can observe the actual size of the upfront fee, $Fee_{i,t}^{Markit}$, for contract i at day t. The upfront funding cost is now measured as

$$F_{i,t}^{ISDA} = Fee_{i,t}^{Markit} \times LOIS_t. \tag{A2}$$

We conduct the regression in Eq. (6) in the paper with F^{ISDA} and report the results in Table A3. In column (1), the estimate of $F^{ISDA} \times Clear$ is -0.59 and is statistically significant (*t*=2.68). The economic effect is also quantitatively important. For example, the average of F^{ISDA} is 0.84 bps in our sample period. Hence, our estimate implies that, on average, due to the improvement in netting, central clearing reduces the bid-ask spread by around 0.5 bps (≈5.9 × 0.84). This estimate is the same as the estimate in Section 4.2.1. Column (2) shows a similar estimate of $F^{ISDA} \times Clear$ using the European Markit sample.

We then conduct the regression in Eq. (7) in the paper with F^{ISDA} and report the results in Table A4. As shown in column (1), where the exit event time is set as September 15, 2014, the estimate of $F^{ISDA} \times DB$ is 1.10 (*t*=4.09). In our Markit sample, the average of F is 0.84 bps; our estimate hence implies that, on average, Deutsche Bank's exit increases the bid-ask spread by about 0.9 bps (≈1.10×0.84). This is consistent with our estimate in Section 4.2.2. Column (2) reports the regression results when the exit date is set as November 17, 2014. The interaction coefficient of $F^{ISDA} \times DB$ is similar in both economic magnitude and statistical significance. Columns (3) and (4) show similar results using the European Markit sample.

Appendix C: Probability of CDS Central Clearing

In this section, we build regression models to explain the probability of CDS central clearing during our sample period. We follow the approach of modeling the selection for CDS clearing and estimate probit models for the selection of central clearing used in Loon and Zhong (2014). We use the same set of explanatory variables in Loon and Zhong (2014), which include liquidity measures (relative bid-ask spreads and market depth), outstanding CDS positions (net notional and the number of contracts), and credit rating and firm characteristics (leverage, current assets, and tangible assets). The regression specification is

$$\begin{aligned} D_{clear,i} = \beta_1 &\cdot Relative\ quoted\ spread_i + \beta_2 \cdot Composite\ depth_i + \beta_3 \\ &\cdot Log(NetNotional_i) + \beta_4 \cdot Log(Contracts_i) + \beta_5 \\ &\cdot Investment\ grade_i + \beta_6 \cdot Nonfincl_i \times Leverage_i + \beta_7 \\ &\cdot Nonfincl_i \times Leverage_i^2 + \beta_8 \cdot Nonfincl_i \times Current_i + \beta_9 \\ &\cdot Nonfincl_i \times Tangile_i + u_I + \epsilon_i, \end{aligned} \tag{A3}$$

where D_{clear} equals one if the reference entity is centrally cleared by ICE Clear Credit during our sample period and zero otherwise. *Relative quoted spread* is the average relative quoted CDS bid-ask spread. *Composite depth* is the average daily number of CDS market participants that contribute CDS spread information to Markit Group Ltd. for its five-year CDS composite spread calculations. *NetNotional* is the average weekly net notional value of open CDS positions (in billions of US dollars), obtained from DTCC TIW reports. *Contracts* is the average weekly number of CDS contracts outstanding, obtained from DTCC TIW reports. *Investment grade* is a dummy variable that equals one if the reference entity has an average credit rating of BBB or better and zero otherwise. *Nonfincl* is a dummy variable that equals one if the reference entity is a nonfinancial firm and zero otherwise. *Leverage* is the book value of debt divided by firm value. *Leverage2* is the squared of *Leverage*. *Current* is current assets divided by current liabilities.

Tangible is plant, property, and equipment divided by total assets. Industry dummies u_I are constructed using Markit's 10-industry classification.

As shown in Table A5, the explanatory variables can explain the selection of central clearing for the North American Markit sample (in Panel A) and the European Markit sample (in Panel B) reasonably well.

After establishing the selection model of central clearing, we construct matched samples for each of the North American Markit sample and the European Markit sample. To identify matched firms, we use propensity scores derived from the model in column (3) of Table A5. For each cleared firm, we choose one matched non-cleared firm with the closest score.

Appendix D: Alternative Identification Specification

In the main analysis, our focus is on the interaction term of $F \times BB$. However, F is a product of DIS and $LOIS$, and, thus, the interpretation of its coefficient needs more careful examinations. We further examine the effect of its components separately. Specifically, we run the following regressions using DIS (size of the upfront payment) and its interactions with the Big Bang dummy BB and $LOIS$:

$$BidAsk_{i,t} = b_1 \times DIS_{i,t} + b_2 \times DIS_{i,t} \times BB_t + b_3 \times DIS_{i,t} \times LOIS_t \times BB_t + \boldsymbol{\gamma} \times \boldsymbol{X}_{i,t} + u_i + v_t + \epsilon_{i,t}. \quad \text{(A4)}$$

We also include a quintic polynomial in CDS spreads to control for the general dependence of liquidity on the CDS spread, such as the CDS market being more liquid for certain credit spread levels due to higher trading activities for those contracts. As shown in column (1) in Table A6, the coefficient of DIS is statistically insignificant in the pre-Big-Bang sample, suggesting that DIS does not have a differential effect on the CDS bid-ask spread before the CDS Big Bang. In column (2), the coefficient of DIS is 1.77 (t=3.28) in the post-Big-Bang sample, indicating that DIS has a differential effect on the CDS bid-ask spread after the Big Bang. In column (3), the estimate of the interaction term $DIS \times BB$ is 0.89 and is statistically significant (t=3.95), confirming that the bid-ask spread becomes sensitive to DIS only after the CDS Big Bang. In column (4), we further include a triple interaction term $DIS \times BB \times LOIS$. The positive triple interaction term suggests that the CDS bid-ask spread becomes more sensitive to DIS when $LOIS$ is higher after the CDS Big Bang.

Appendix E: Overall Effect

As discussed earlier, the CDS Big Bang is expected to have at least two opposing effects on market liquidity. First, the standardization of CDS contracts is expected to enhance market liquidity. Second, the upfront funding cost arising from the fixed coupons is expected to reduce the market liquidity of firms with different levels of CDS spreads. Thus, the overall effect on market liquidity consists of two components: the effect arising from the benefits of standardization and the upfront funding effect. One can estimate the relative strength of these two components by removing the time fixed effect v_t in the following regression:

$$BidAsk_{i,t} = b_1 \times F_{i,t} + b_2 \times F_{i,t} \times BB_t + b_3 \times BB_t + \boldsymbol{\gamma} \times \boldsymbol{X}_{i,t} + u_i + \epsilon_{i,t}. \qquad \text{(A5)}$$

The upfront funding effect is captured by the coefficient of $F \times BB$, and other effects are captured by the coefficient of BB. To minimize potential confounding effects, we focus on short time windows around the CDS Big Bang. The regression results are reported in Panel A of Table A7.

In columns (1), (3), (5), and (7), the regressions are based on the sample from 3-6 months before the CDS Big Bang to 3-6 months after. The estimate of the coefficient of BB decreases monotonically from -0.61 (3 months) to -2.13 (6 months). This is consistent with the notion that the standardization from the CDS Big Bang improves market liquidity. Moreover, as in our earlier regressions, the coefficient of $F \times BB$ is significantly positive, suggesting that the upfront funding cost decreases market liquidity.

The overall market liquidity effect from the CDS Big Bang is a tradeoff between the two opposing effects, and it can be estimated by removing the interaction term. The regressions in columns (2), (4), (6), and (8) are based on the sample from 3-6 months before to 3-6 months after the CDS Big Bang. The coefficient estimate of BB decreases monotonically from 0.36 to -0.70.

This result suggests that, as CDS traders become more familiar with the new rules, the benefit from standardization increases and the overall effect becomes liquidity enhancing.

Next, we turn to our European dataset to estimate the overall effect of the CDS Small Bang. Since the implementation date of the Small Bang is June 20, 2009, which is about two and a half months later than the CDS Big Bang, we expect the beneficial effect of standardization for the CDS Small Bang to be incorporated into CDS trading more quickly. Furthermore, the CDS Small Bang allows four fixed coupons and, thus, the funding cost effect is expected to be smaller. The results are reported in Panel B of Table A7. In columns (2), (4), (6), and (8), the coefficient of SB is all negative and statistically significant, indicating that the overall effect of the CDS Small Bang is liquidity enhancing.

Appendix F: European CDSs as a control group

To account for the potential confounding effects of unobserved shocks around the CDS Big Bang, we conduct a triple difference analysis using samples from both European and North American CDS markets. Since the CDS Big Bang applies only to North American CDS contracts, we can use European CDSs as a control group. Under the assumption that unobservable shocks have the same effects on the sensitivity of bid-ask spreads to F across the two CDS markets, our triple difference test can account for the confounding effects of those unobservable shocks and identify the effect from the CDS Big bang.

For our main triple difference analysis, we choose a sample period of January 25 to June 19, 2009. The end date is chosen because, on June 20, 2009, the CDS Small Bang took place for European CDS contracts. To avoid the confounding effect from the CDS Small Bang, we end our sample on the day before it was implemented. The starting date of this sample (January 25, 2009) is chosen so that the pre- and post-Big-Bang samples have the same length (about two months). During the second half of this period (April 8 to June 19), the CDS Big Bang has been adopted for North American CDS contracts while the CDS Small Bang has not yet been implemented for European CDS contracts. This window of opportunity allows us to examine the effects of the CDS Big Bang, using European CDS contracts as a control.

We define a dummy variable NA_i, which is equal to one if the reference entity i is a North American firm and zero otherwise. We regress the CDS bid-ask spread on the triple interaction term $F \times BB \times NA$ in the following specification:

$$\begin{aligned} BidAsk_{i,t} = b_1 \times F_{i,t} \\ &+ b_2 \times F_{i,t} \times BB_t + b_3 \times F_{i,t} \times BB_t \times NA_i + b_4 \times BB_t \times NA_i \\ &+ \boldsymbol{\gamma} \times \boldsymbol{X}_{i,t} + u_i + v_t + \epsilon_{i,t}. \end{aligned} \tag{A6}$$

The results are reported in Table A8. In column (1), the coefficient for the triple interaction term is 2.15 (t=2.95), suggesting that, after the CDS Big Bang, bid-ask spreads become more sensitive to the upfront funding costs for North American CDS contracts, after controlling for the effects in the European sample. Moreover, the economic magnitude of this coefficient is comparable to the estimate in Table 2.

We also conduct placebo tests to further test our hypothesis. Specifically, we pick two fictitious dates for the CDS Big Bang. Then, for each date, we repeat the above triple difference analysis using the sample from two months before the chosen date to two months after. In column (2), the chosen fictitious date is February 8, 2009. Hence, the entire sample period for this regression (from December 8, 2008 to April 7, 2009) is before the CDS Big Bang. Therefore, we expect the coefficient for the interaction term $F \times BB \times NA$ to be insignificant. Indeed, as shown in column (2), the estimate of this coefficient is 0.37 (t=0.69). Similarly, for the placebo test in column (3), the chosen fictitious date is August 20, 2009, so that the entire sample for this regression is after both the CDS Big Bang and the CDS Small Bang. Hence, the triple interaction coefficient is also expected to be insignificant. Consistent with this conjecture, as shown in column (3), the estimate of this triple interaction coefficient is 0.04 (t=0.03). These tests further support our interpretation that it is the upfront funding cost induced by the CDS Big Bang that has a cross-sectional effect on the CDS bid-ask spread.

Table A1
Interaction terms between BB and control variables.

This table reports the effects of upfront funding costs on CDS bid-ask spreads. The regressions are based on the North American CMA sample (January 1, 2004 to September 30, 2010). We include interaction terms between control variables and the Big Bang dummy in the baseline regression. The regression specification is

$$BidAsk_{i,t} = b_1 \times F_{i,t} + b_2 \times F_{i,t} \times BB_t + \boldsymbol{\gamma}_1 \times \boldsymbol{X}_{i,t} + \boldsymbol{\gamma}_2 \times \boldsymbol{X}_{i,t} \times BB_t + u_i + v_t + \epsilon_{i,t},$$

where $BidAsk_{i,t}$ is the bid-ask spread for trading CDS contract i on day t, $F_{i,t}$ is the upfront funding cost for trading CDS contract i with five-year maturity on day t as defined in Eq. (2) in the paper, BB_t is a dummy variable that is one if the date t is later than April 8, 2009, and zero otherwise, $\boldsymbol{X}_{i,t}$ is the set of control variables described in Section 2.2, u_i is the firm fixed effect, and v_t is the day fixed effect. Numbers in parentheses are *t*-statistics based on standard errors that are clustered by firm and time. *, **, and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

	(1) Pre-BB	(2) Post-BB	(3) Overall
F	0.16***	0.66***	0.65***
	(5.72)	(6.83)	(5.96)
F × BB			2.39***
			(5.62)
S	0.03***	0.03***	0.03***
	(28.98)	(20.50)	(29.29)
Log(stock volume)	0.05	0.00	-0.01
	(0.81)	(0.01)	(-0.23)
Stock bid-ask spread	0.00	-0.00	0.00
	(0.71)	(-0.23)	(0.62)
Stock volatility	18.65***	26.71***	20.82***
	(3.94)	(4.96)	(4.37)
Log(bond volume)	-0.02	-0.02*	-0.02
	(-1.33)	(-1.90)	(-1.23)
Log(bond Amihud)	0.01	-0.04***	0.01
	(0.86)	(-2.85)	(0.86)
Leverage	-2.97**	0.69	-2.25**
	(-2.54)	(0.20)	(-2.33)
S × BB			0.00*
			(1.91)
Log(stock volume) × BB			0.07
			(0.89)
Stock bid-ask spread × BB			0.01
			(0.67)
Stock volatility × BB			-3.43
			(-0.49)
Log(bond volume) × BB			-0.06**
			(-2.08)
Log(bond Amihud) × BB			-0.05*
			(-1.76)
Leverage × BB			0.20
			(0.40)
Observations	252,444	102,220	354,664
R-squared	0.83	0.88	0.84
Number of firms	450	387	459

Table A2
Alternative funding cost measure for main analysis.

This table reports the effects of upfront funding costs on CDS bid-ask spreads using an alternative funding cost measure. The regression is based on the North American CMA sample (January 1, 2004 to September 30, 2010). The regression specification is

$$BidAsk_{i,t} = b_1 \times F_{i,t}^{ISDA} + b_2 \times F_{i,t}^{ISDA} \times BB_t + b_3 \times BB_t + \boldsymbol{\gamma_1} \times \boldsymbol{X}_{i,t} + \boldsymbol{\gamma_2} \times \boldsymbol{X}_{i,t} \times BB_t + u_i + v_t + \epsilon_{i,t},$$

where $BidAsk_{i,t}$ is the bid-ask spread for trading CDS contract i on day t, $F_{i,t}^{ISDA}$ is the upfront funding cost for trading CDS contract i on day t calculated using the ISDA CDS standard model as defined in Eq. (A1), BB_t is a dummy variable that is one if the date t is later than April 8, 2009, and zero otherwise, $\boldsymbol{X}_{i,t}$ is the set of control variables described in Section 2.2, u_i is the firm fixed effect, and v_t is the day fixed effect. Interaction terms ($\boldsymbol{\gamma}_2$) between BB_t and control variables are not reported in the table. Numbers in parentheses are *t*-statistics based on standard errors that are clustered by firm and time. *, **, and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

	(1) Pre-BB	(2) Post-BB	(3) Overall
F^{ISDA}	0.16***	0.66***	0.16***
	(5.72)	(6.83)	(6.12)
$F^{ISDA} \times BB$			0.53***
			(5.30)
S	0.03***	0.03***	0.03***
	(28.98)	(20.50)	(29.80)
Log(stock volume)	0.05	0.00	-0.02
	(0.81)	(0.01)	(-0.25)
Stock bid-ask spread	0.00	-0.00	0.00
	(0.71)	(-0.23)	(0.62)
Stock volatility	18.65***	26.71***	20.80***
	(3.94)	(4.96)	(4.37)
Log(bond volume)	-0.02	-0.02*	-0.02
	(-1.33)	(-1.90)	(-1.24)
Log(bond Amihud)	0.01	-0.04***	0.01
	(0.86)	(-2.85)	(0.82)
Leverage	-2.97**	0.69	-2.27**
	(-2.54)	(0.20)	(-2.36)
Observations	252,444	102,220	354,664
R-squared	0.83	0.88	0.84
Number of firms	450	387	459

Table A3

Alternative funding cost measure for central clearing.

This table reports the effects of central clearing on CDS bid-ask spreads using an alternative funding cost measure. The regression has the following specification:

$$BidAsk_{i,t} = b_1 \times F_{i,t}^{ISDA} + b_2 \times F_{i,t}^{ISDA} \times Clear_{i,t} + b_3 \times Clear_{i,t} + \boldsymbol{\gamma} \times \boldsymbol{X}_{i,t} + u_i + v_t + \epsilon_{i,t},$$

where $BidAsk_{i,t}$ is the bid-ask spread for trading CDS contract i on day t, $F_{i,t}^{ISDA}$ is the upfront funding cost as defined in Eq. (A2), $Clear_{i,t}$ is a dummy variable, which is equal to one if a CDS contract i is centrally cleared at day t, and zero otherwise, $\boldsymbol{X}_{i,t}$ is the set of control variables described in Section 2.2, u_i is the firm fixed effect, and v_t is the day fixed effect. To control for the selection of central clearing, we use probit models to fit the probability of central clearing and construct matched samples using propensity scores derived from the probit model. Details of the probit models are provided in Online Appendix C. The regression in column (1) is based on the propensity score-matched North American Markit sample (April 1, 2010 to September 14, 2014) and the regression in columns (2) is based on the propensity score-matched European Markit sample (April 1, 2010 to September 14, 2014). Numbers in parentheses are t-statistics based on standard errors that are clustered by firm and time. *, **, and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

	(1) North American propensity score-matched sample	(2) European propensity score-matched sample
F^{ISDA}	0.79***	1.16***
	(4.15)	(5.16)
$F^{ISDA} \times Clear$	-0.59***	-0.61**
	(-2.68)	(-2.30)
Clear	-0.21	0.77
	(-0.83)	(1.42)
Control	Included	Included
Observations	203,527	197,233
R-squared	0.89	0.90
Number of firms	166	155

Table A4

Alternative funding cost measure for Deutsche Bank's exit.

This table reports the effects of Deutsche Bank's exit from the single-name CDS market on CDS bid-ask spreads using an alternative funding cost measure. The regression specification is

$$BidAsk_{i,t} = b_1 \times F_{i,t}^{ISDA} + b_2 \times F_{i,t}^{ISDA} \times DB_t + b_3 \times F_{i,t}^{ISDA} \times Clear_{i,t} + b_4 \times Clear_{i,t} + \boldsymbol{\gamma} \times \boldsymbol{X}_{i,t} + u_i + v_t + \epsilon_{i,t},$$

where $BidAsk_{i,t}$ is the bid-ask spread for trading CDS contract i on day t, $F_{i,t}^{ISDA}$ is the upfront funding cost defined in Eq. (A2), DB_t is a dummy variable that is one if the date t is after Deutsche Bank exits the single-name CDS market, and zero otherwise, $\boldsymbol{X}_{i,t}$ is the set of control variables described in Section 2.2, u_i is the firm fixed effect, and v_t is the day fixed effect. Regressions in columns (1) and (2) are based on the propensity score-matched North American Markit sample (April 1, 2010 to October 19, 2016), and regressions in columns (3) and (4) are based on the propensity score-matched European Markit sample (April 1, 2010 to October 19, 2016). The exit dates are set as September 15, 2014 and November 17, 2014 in columns (1)/(3) and (2)/(4), respectively. Numbers in parentheses are *t*-statistics based on standard errors that are clustered by firm and time. *, **, and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

	North American		European	
	(1)	(2)	(3)	(4)
	09/15/2014	11/17/2014	9/15/2014	11/17/2014
F^{ISDA}	0.60***	0.62***	1.03***	1.03***
	(3.11)	(3.11)	(4.82)	(4.83)
$F^{ISDA} \times DB$	1.10***	1.08***	1.60***	1.55***
	(4.09)	(4.07)	(2.87)	(2.78)
$F^{ISDA} \times Clear$	-0.60***	-0.58***	-0.44*	-0.43*
	(-3.17)	(-3.12)	(-1.77)	(-1.77)
Clear	0.09	0.11	0.84*	0.86*
	(0.23)	(0.27)	(1.69)	(1.71)
Control	Included	Included	Included	Included
Observations	284,346	284,346	270,850	270,850
R-squared	0.87	0.87	0.90	0.90
Number of firms	166	166	155	155

Table A5
Probability of central clearing.

This table reports estimations of probit models of central clearing. The regression specification is

$$D_{clear,i} = \beta_1 \cdot Relative\ quoted\ spread_i + \beta_2 \cdot Composite\ depth_i + \beta_3 \cdot Log(NetNotional_i) + \beta_4 \cdot Log(Contracts_i) + \beta_5 \cdot Investment\ grade_i + \beta_6 \cdot Nonfincl_i \times Leverage_i + \beta_7 \cdot Nonfincl_i \times Leverage_i^2 + \beta_8 \cdot Nonfincl_i \times Current_i + \beta_9 \cdot Nonfincl_i \times Tangile_i + u_I + \epsilon_i.$$

The dependent variable is D_{clear}, which equals one if the reference entity is centrally cleared by ICE Clear Credit during our sample period and zero otherwise. *Relative quoted spread* is the average relative quoted CDS bid-ask spread. *Composite depth* is the average daily number of CDS market participants that contribute CDS spread information to Markit Group Ltd. for its five-year CDS composite spread calculations. *NetNotional* is the average weekly net notional value of open CDS positions (in billions of US dollars), obtained from DTCC TIW reports. *Contracts* is the average weekly number of CDS contracts outstanding, obtained from DTCC TIW reports. *Investment grade* is a dummy variable that equals one if the reference entity has an average credit rating of BBB or better and zero otherwise. *Nonfincl* is a dummy variable that equals one if the reference entity is a nonfinancial firm and zero otherwise. *Leverage* is the book value of debt divided by firm value. *Leverage2* is the squared of *Leverage*. *Current* is current assets divided by current liabilities. *Tangible* is plant, property, and equipment divided by total assets. Industry dummies u_I are constructed using Markit's 10-industry classification. Accounting variables for European firms are obtained from Compustat Global. All explanatory variables are averaged over our sample period (April 1, 2010 to October 19, 2016). Panel A is based on the North American Markit sample. Panel B is based on the European Markit sample.

Panel A: North American firms

	(1) Prediction model 1	(2) Prediction model 2	(3) Prediction model 3
Relative quoted spread	-4.97***	-4.69***	-4.96***
	(-2.74)	(-2.78)	(-2.76)
Composite depth	0.23**	0.23**	0.23**
	(2.54)	(2.37)	(2.35)
Log(NetNotional)	0.72***		0.72***
	(5.18)		(3.12)
Log(Contracts)		0.69***	0.01
		(4.51)	(0.02)
Investment grade	0.63***	0.79***	0.63***
	(3.85)	(4.84)	(3.66)
Nonfin × Leverage	6.92**	6.38**	6.91**
	(2.38)	(2.28)	(2.38)
Nonfin × Leverage2	-4.74***	-4.51***	-4.74***
	(-2.63)	(-2.63)	(-2.63)
Nonfin × Current	-0.26*	-0.31**	-0.26*
	(-1.70)	(-2.01)	(-1.70)
Nonfin × Tangible	0.06	-0.01	0.06
	(0.31)	(-0.03)	(0.30)
Constant	-18.38***	-8.59***	-18.33***
	(-5.98)	(-5.09)	(-4.89)
Observations	420	420	420
Industry dummy	YES	YES	YES
R-squared	0.28	0.27	0.28

Panel B: European firms

	(1) Prediction model 1	(2) Prediction model 2	(3) Prediction model 3
Relative quoted spread	-5.40**	-7.44***	-5.38**
	(-2.19)	(-2.85)	(-2.18)
Composite depth	0.55***	0.58***	0.55***
	(5.06)	(4.72)	(4.78)
Log(NetNotional)	0.98***		1.00***
	(4.42)		(2.88)
Log(Contracts)		0.63**	-0.03
		(2.32)	(-0.09)
Investment grade	0.90***	1.19***	0.90***
	(3.62)	(5.38)	(3.52)
Nonfin × Leverage	6.80	6.75	6.81
	(1.54)	(1.41)	(1.55)
Nonfin × Leverage2	-4.21	-4.29	-4.22
	(-1.45)	(-1.30)	(-1.45)
Nonfin × Current	-0.27	-0.34	-0.27
	(-0.97)	(-1.21)	(-0.96)
Nonfin × Tangible	-0.82	-0.65	-0.82
	(-1.01)	(-0.84)	(-1.01)
Constant	-25.56***	-10.63***	-25.88***
	(-5.36)	(-3.99)	(-4.46)
Observations	351	351	351
Industry dummy	YES	YES	YES
R-squared	0.56	0.54	0.56

Table A6
Alternative identification specification.

This table reports the effects of upfront payment on CDS bid-ask spreads using an alternative identification specification. The regressions are based on the North American CMA sample (January 1, 2004 to September 30, 2010). We use the size of the upfront payment to identify the funding effect. The regression specification is

$$BidAsk_{i,t} = b_1 \times DIS_{i,t} + b_2 \times DIS_{i,t} \times BB_t + b_3 \times DIS_{i,t} \times LOIS_t \times BB_t + \boldsymbol{\gamma} \times \boldsymbol{X}_{i,t} + u_i + v_t + \epsilon_{i,t},$$

where $BidAsk_{i,t}$ is the bid-ask spread for trading CDS contract i on day t, $DIS_{i,t}$ is the minimum distance between the CDS spread and the two possible coupon rates for CDS contract i on day t, as defined in Eq. (1) in the paper, BB_t is a dummy variable that is one if the date t is later than April 8, 2009, and zero otherwise, $\boldsymbol{X}_{i,t}$ is the set of control variables described in Section 2.2 and includes a quintic polynomial in the CDS spreads, u_i is the firm fixed effect, and v_t is the day fixed effect. The coefficients of the quintic polynomial in CDS spreads are not reported in the table. Numbers in parentheses are *t*-statistics based on standard errors that are clustered by firm and time. *, **, and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

	(1) Pre-BB	(2) Post-BB	(3) Pre and Post-BB	(4) Pre and Post-BB
DIS	-0.24	1.77***	0.21	0.20
	(-0.77)	(3.28)	(0.71)	(0.69)
DIS × *BB*			0.89***	0.36
			(3.95)	(1.22)
DIS × *LOIS* × *BB*				1.94***
				(3.74)
S	0.02	0.05	0.06**	0.06**
	(0.80)	(0.66)	(2.05)	(2.02)
Log(stock volume)	0.02	-0.05	-0.03	-0.03
	(0.39)	(-0.65)	(-0.52)	(-0.50)
Stock bid-ask spread	0.00	0.00	0.00	0.00
	(0.54)	(0.03)	(0.70)	(0.71)
Stock volatility	15.04***	29.41***	17.14***	16.50***
	(3.62)	(5.28)	(4.65)	(4.49)
Log(bond volume)	-0.01	-0.03**	-0.03***	-0.03***
	(-0.78)	(-2.34)	(-2.62)	(-2.65)
Log(bond Amihud)	0.00	-0.05***	-0.01	-0.01
	(0.40)	(-3.34)	(-0.96)	(-0.95)
Leverage	-3.03***	0.03	-1.89**	-1.80*
	(-2.70)	(0.01)	(-2.06)	(-1.95)
Observations	252,447	102,211	354,667	354,667
R-squared	0.83	0.88	0.84	0.84
Number of firms	450	387	459	459

Table A7

Overall effects of the CDS Big Bang and the CDS Small Bang.

Panel A reports the overall effects of the CDS Big Bang on CDS bid-ask spreads based on the North American CMA sample (January 1, 2004 to September 30, 2010). The regression specification is

$$BidAsk_{i,t} = b_1 \times F_{i,t} + b_2 \times F_{i,t} \times BB_t + b_3 \times BB_t + \boldsymbol{\gamma} \times \boldsymbol{X}_{i,t} + u_i + \epsilon_{i,t},$$

where $BidAsk_{i,t}$ is the bid-ask spread for trading CDS contract i on day t, $F_{i,t}$ is the upfront funding cost for trading CDS contract i with five-year maturity on day t as defined in Eq. (2) in the paper, BB_t is a dummy variable that is one if the date t is later than April 8, 2009, and zero otherwise, and $\boldsymbol{X}_{i,t}$ is the set of control variables described in Section 2.2. In addition, we include *LOIS* and *VIX*, which are the daily close values of the CBOE volatility index expressed in percentages, obtained from Datastream, as additional control variables for the Big Bang. Similarly, we include *LOIS Euro* and *VSTOXX*, which are the daily close values of the EURO STOXX 50 volatility index expressed in percentages, obtained from Datastream, as additional control variables for the Small Bang. u_i is the firm fixed effect. The sample period for columns (1) and (2) is from 3 months before to 3 months after the CDS Big Bang. The sample periods for the other columns are similarly defined (from 4, 5, or 6 months before to 4, 5, or 6 months after the CDS Big Bang). Panel B reports the overall effects of the CDS Small Bang on bid-ask spreads based on the European CMA sample (January 1, 2004 to September 30, 2010). The regression specification for the CDS Small Bang is similarly defined with BB_t being replaced by SB_t, where SB_t is a dummy variable that is one if the date t is later than June 20, 2009. All other variables are defined in Table 1. Numbers in parentheses are *t*-statistics based on standard errors that are clustered by firm and time. *, **, and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A: Overall effects of the CDS Big Bang on the bid-ask spread

	(1) 3M	(2) 3M	(3) 4M	(4) 4M	(5) 5M	(6) 5M	(7) 6M	(8) 6M
BB	-0.61**	0.36	-1.20***	-0.00	-1.76***	-0.46*	-2.13***	-0.70***
	(-2.36)	(1.50)	(-4.12)	(-0.01)	(-6.46)	(-1.93)	(-8.09)	(-2.83)
F × BB	0.02***	0.02***	0.02***	0.02***	0.03***	0.03***	0.03***	0.03***
	(13.38)	(13.62)	(15.65)	(16.18)	(18.87)	(19.52)	(22.99)	(24.59)
F	0.17		0.20		0.15		0.17*	
	(0.84)		(1.22)		(1.15)		(1.86)	
S	1.35***		1.85***		2.46***		2.93***	
	(4.11)		(5.39)		(7.18)		(8.60)	
Log(stock volume)	0.05	0.42	2.33	2.91	1.64	2.54	1.78	3.15
	(0.01)	(0.09)	(0.84)	(1.03)	(0.61)	(0.91)	(0.70)	(1.17)
Stock bid-ask spread	0.84	2.06	-4.23	-1.72	-5.61	-4.28	0.68	3.23
	(0.18)	(0.42)	(-1.04)	(-0.40)	(-1.56)	(-1.10)	(0.19)	(0.83)
Stock volatility	0.36***	0.40***	0.21*	0.31**	0.32***	0.50***	0.25**	0.41***
	(2.75)	(2.94)	(1.74)	(2.29)	(2.61)	(3.64)	(2.18)	(3.00)
Log(bond volume)	0.01	0.02	0.00	0.01	-0.00	0.01	-0.01	0.00
	(0.67)	(0.74)	(0.22)	(0.38)	(-0.10)	(0.46)	(-0.71)	(0.00)
Log(bond Amihud)	0.01	0.01	0.02	0.02	0.00	0.01	0.00	0.02
	(0.64)	(0.69)	(0.99)	(1.19)	(0.26)	(0.75)	(0.33)	(1.27)
Leverage	0.00	-0.00	0.00	0.00	0.00	0.00	0.00	0.00
	(0.00)	(-0.25)	(1.34)	(0.88)	(1.55)	(1.21)	(0.39)	(0.06)
LOIS	1.76***	2.85***	2.23***	3.02***	2.01***	3.03***	0.37*	0.65***
	(3.54)	(5.53)	(4.62)	(5.66)	(5.03)	(6.94)	(1.81)	(3.03)
VIX	0.01	0.02	-0.03	-0.02	-0.06***	-0.07***	-0.03**	-0.02
	(0.77)	(0.98)	(-1.42)	(-0.86)	(-3.17)	(-3.70)	(-1.99)	(-1.34)
Observations	29,070	29,070	38,749	38,749	47,537	47,537	57,718	57,718
R-squared	0.90	0.90	0.89	0.89	0.88	0.88	0.87	0.87
Number of firms	344	344	350	350	358	358	369	369

Panel B: Overall effects of the CDS Small Bang on the bid-ask spread

	(1) 3M	(2) 3M	(3) 4M	(4) 4M	(5) 5M	(6) 5M	(7) 6M	(8) 6M
SB	-2.25***	-2.35***	-2.30***	-2.50***	-2.16***	-2.40***	-1.97***	-2.21***
	(-9.82)	(-9.67)	(-9.99)	(-9.67)	(-9.34)	(-9.29)	(-7.97)	(-8.23)
F × SB	2.28***		2.30***		2.21***		2.23***	
	(3.77)		(3.77)		(3.67)		(3.59)	
F	0.28		1.46**		1.55***		1.77***	
	(0.39)		(2.56)		(3.43)		(4.33)	
S	0.03***	0.03***	0.03***	0.03***	0.03***	0.04***	0.04***	0.04***
	(8.75)	(9.78)	(10.45)	(11.80)	(14.07)	(15.45)	(16.39)	(18.47)
Log(Stock volume)	0.02	0.02	0.05	0.03	0.10	0.09	0.12	0.11
	(0.21)	(0.15)	(0.56)	(0.36)	(1.22)	(1.02)	(1.54)	(1.36)
Stock bid-ask spread	-5.02	-5.92	-5.63	-6.36	-2.72	-2.56	-1.17	-0.52
	(-0.94)	(-1.06)	(-1.24)	(-1.33)	(-0.62)	(-0.54)	(-0.26)	(-0.10)
Stock volatility	9.72	10.02	10.01	11.45	4.53	6.28	1.52	4.02
	(1.52)	(1.58)	(1.39)	(1.58)	(0.67)	(0.90)	(0.22)	(0.56)
LOIS Euro	4.27***	3.53***	4.48***	4.86***	5.99***	6.60***	8.03***	8.62***
	(3.69)	(2.89)	(5.05)	(5.01)	(8.68)	(9.03)	(10.39)	(11.19)
VSTOXX	-0.04	-0.03	-0.06**	-0.08**	-0.08***	-0.11***	-0.12***	-0.14***
	(-1.46)	(-1.08)	(-2.27)	(-2.49)	(-3.75)	(-4.32)	(-4.62)	(-5.36)
Observations	23,098	23,098	30,706	30,706	38,945	38,945	45,153	45,153
R-squared	0.89	0.89	0.88	0.88	0.88	0.88	0.88	0.87
Number of firms	288	288	295	295	301	301	305	305

Table A8

The effects of upfront funding costs of CDS Big Bang using European CDSs as a control group.

This table reports the effects of upfront funding costs on CDS bid-ask spreads using a combined sample of CDSs on North American and European firms. The North American sample is from our North American CMA sample and the European Sample is from our European CMA sample. The regression specification is

$$BidAsk_{i,t} = b_1 \times F_{i,t} + b_2 \times F_{i,t} \times BB_t + b_3 \times F_{i,t} \times BB_t \times NA_i + b_4 \times BB_t \times NA_i + \boldsymbol{\gamma} \times \boldsymbol{X}_{i,t} + u_i + v_t + \epsilon_{i,t},$$

where $BidAsk_{i,t}$ is the bid-ask spread for trading CDS contract i on day t, $F_{i,t}$ is the upfront funding cost for trading CDS contract i with five-year maturity on day t defined in Eq. (2), BB_t is a dummy variable that is one if the date t is later than the event date, and zero otherwise, and NA_i is a dummy variable that is equal to one if firm i is a North American firm, and zero otherwise, $\boldsymbol{X}_{i,t}$ is the set of control variables described in Section 2.2, u_i is the firm fixed effect, and v_t is the day fixed effect. Column (1) is based on the actual date for the CDS Big Bang, while columns (2) and (3) are based on two fictitious dates for the event, 2/8/2009 and 8/20/2009, respectively. Numbers in parentheses are *t*-statistics based on standard errors that are clustered by firm and time. *, **, and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

	(1)	(2)	(3)
	Baseline test	Placebo test 1	Placebo test 2
Event date	04/08/2009	02/08/2009	08/20/2009
Sample period	1/25/2009–6/19/2009	12/8/2008–4/7/2009	6/20/2009–10/20/2009
F	0.73***	0.81***	2.74***
	(2.77)	(3.35)	(4.37)
F × *BB*	0.07	-0.44	-0.30
	(0.12)	(-0.96)	(-0.24)
F × *BB* × *NA*	2.15***	0.37	0.04
	(2.95)	(0.69)	(0.03)
BB × *NA*	0.08	2.31***	1.22***
	(0.25)	(6.07)	(4.14)
Control	Included	Included	Included
Observations	48,278	35,772	44,893
R-squared	0.89	0.88	0.91
Number of firms	731	672	753