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How much should creditors worry about operational risk? The credit default swap spread reaction to operational risk events

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This paper examines the credit default swap (CDS) market's reaction to operational risk events in the banking industry, and thus addresses the question of the extent to which operational risk affects the default risk of the banks. The analysis is based on a sample of ninety-nine operational losses occurring at large European financial institutions between January 2004 and September 2010. Previous literature studying the market reaction to operational risk events has so far only focused on the stock and bond markets. This paper complements and extends existing literature by being the first to provide empirical evidence on the topic from the CDS market. The results shed light on the impact of operational losses on the default risk of banks, which is important not only for creditors but also from a regulatory point of view. On average, there is a statistically significant increase in CDS spreads around the settlement date of losses in the range of five basis points, or roughly 5% in relative terms. Multivariate regressions show that the CDS market's reaction to operational risk events is influenced by the (relative) size of losses. Moreover, the increase in CDS spreads is more pronounced for banks with a good credit rating, while internal fraud events do not seem to be particularly harmful.

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1 INTRODUCTION

Losses of financial institutions due to operational risk are often highly publicized events because they result, almost by definition,[1] from some kind of (intentional or unintentional) wrongdoing, failure or problem, with a unique "story" that is readily covered by the media. Previous research on operational risk examines the market reaction to news items reporting operational losses and the associated wealth effects. More precisely, several studies focus on the effects of operational risk events on shareholder wealth using stock market data (de Fontnouvelle and Perry 2005; Cummins *et al* 2006; Gillet *et al* 2010; Sturm 2013), while Plunus *et al* (2012) investigate the effects of operational losses on the bond market.

Empirical results from the stock market are not only interesting for shareholders; they are also relevant in the context of the regulatory changes of Basel II introduced in 2006, which require banks to hold capital in order to buffer losses from operational risk.[2] Since the full scope of operational losses is notoriously difficult to quantify (eg, because of damages to reputation), results from the stock market provide another estimate of the losses resulting from operational risk (ie, other than nominal and/or reported loss amounts).[3] This paper is similar to previous work in that it assesses the impact of operational losses on the banks incurring the loss by looking at the market reaction to the announcement of operational risk events. In contrast to prior studies, however, this paper looks at credit default swaps (CDSs), thus taking the perspective of creditors (not shareholders) and addresses the following question: to what extent do large operational risk events affect the default risk and, thus, debt holders of the banks' incurring the loss? In order to provide an answer to this question, the following analysis examines CDS spreads, which can be interpreted as an insurance premium for protection against the risk of default.

This paper is motivated by the fact that rating agencies give considerable importance to operational risk when evaluating the creditworthiness of financial institutions (Moody's 2003; Ferry 2003; Fitch 2004). More detailed examples of rating changes triggered by operational risk include the downgrade of Société Générale by Fitch, Moody's and Standard & Poor's following the enormous loss caused by the trader

[1] As a consequence of its binding character, the Basel definition is now by far the most prevalent definition of operational risk. According to the Basel Committee on Banking Supervision, operational risk is "the risk of losses resulting from inadequate or failed internal processes, people and systems or from external events" (Basel Committee on Banking Supervision 2006, p. 144).

[2] The Basel Committee has recently stressed the importance given to operational risk with the publication of its Principles for the Sound Management of Operational Risk (Basel Committee on Banking Supervision 2011a) and the Supervisory Guidelines for the Advanced Measurement Approaches (Basel Committee on Banking Supervision 2011b).

[3] The loss in market value may be seen as a more comprehensive estimate of the loss compared with the nominal or pure financial loss amounts typically reported.

Jérôme Kerviel in 2008; similarly, Moody's placed the rating of UBS on review after the loss due to unauthorized trading by Kweku Adoboli. Immediate reactions to losses such as these suggest the use of ratings to study the impact of operational risk on the soundness of financial institutions, even though ratings are obviously influenced by many other factors (especially when not triggered by a single event). However, ratings are commonly issued as credit grades (eg, from AAA to C or D). Consequently, issuers are assigned to a specific rating class rather than given a rating on a continuous scale. Therefore, ratings are at best a very rough measure for the impact of operational losses on a bank's default risk in cases where the loss is large enough to trigger a rating change (or review). In contrast, CDS spreads, expressing a reference entity's default risk as an insurance premium, can adjust continuously on a daily basis, also reflecting smaller variations in a bank's creditworthiness, for example, due to changes in the exposure to operational risk. Furthermore, the empirical work by Norden and Weber (2004) suggests that rating agencies react to changes in CDS spreads (not the other way round), indicating that information about credit quality is incorporated by markets first rather than discovered and disclosed by rating agencies.

The remainder of the paper is organized as follows. Section 2 reviews prior literature and motivates the hypotheses to be tested. Section 3 describes the data set and the methodology used for the empirical investigation. Section 4 presents univariate and multivariate results for the CDS market's response to operational risk events. Section 5 concludes.

2 RELATED LITERATURE AND HYPOTHESIS DEVELOPMENT

2.1 Related literature

The paper most closely related to this work is the study by Plunus *et al* (2012). In their empirical investigation, Plunus *et al* examine the bond market reaction to the announcement of operational losses by financial institutions. More precisely, they calculate cumulated abnormal bond returns by applying traditional event study methodology to the bond market. Their paper is based on loss data stemming from the Algo FIRST database of the Fitch Group, providing a sample of 71 losses exceeding US$10 million that occurred in 41 US companies between 1994 and 2006. Plunus *et al* document a significant bond market reaction for up to three different announcement dates (press, recognition and settlement date). Analyzing CDSs rather than bonds offers several potential advantages:

(a) CDS spreads are a pure measure of credit risk not influenced by interest rate risk;

(b) CDS markets react faster than bond markets;

(c) CDS spreads are available on a daily basis with a constant maturity (eg, five years) and, thus, time-to-maturity issues do not cause problems, as they do in the case of bonds.

Previous event study results from the stock market have documented and discussed the reputational effects of operational risk (de Fontnouvelle and Perry 2005; Cummins *et al* 2006; Gillet *et al* 2010; Sturm 2013). Looking at the CDS market, it is difficult, if not impossible, to disentangle the impact of the financial loss and potential reputational effects, because financial losses cannot be directly attributed to the equity position. From the perspective of creditors and regulatory authorities, however, the overall impact of operational losses might perhaps be of greater interest than the separate effects of the financial and reputational losses.

As of 2012, there are only a handful of event studies analyzing the impact of a certain set or type of events on CDS spreads. The reason why the history of CDS event studies (and empirical work on CDSs in general) is still rather short compared with event studies focusing on the stock or bond market is that CDSs were not introduced on a larger scale in the US before 1997 (Subrahmanyam 2012, p. 16). At the beginning, CDSs were only available for major companies and it was not until 2004 that information on CDSs became available on major databases (see Mayordormo *et al* (2010, p. 15) for a comparison of the major data providers). Compared with the equity market, the availability and quality of information on CDS prices is more problematic because the CDS market is an over-the-counter (OTC) market (with almost exclusively institutional investors) and there are no organized exchanges or clearing houses[4] providing reliable information. Thus, the information on CDSs is typically gathered from market participants by data providers. However, a certain level of disagreement on prices among different sources is posing a challenge to empirical research (see Mayordormo *et al* 2010, p. 9). However, with the increasing coverage and reliability of CDS data available, CDS event studies are a promising field, as they allow for an analysis of the effect on debt holders without suffering the drawbacks of bond event studies (such as limited coverage, illiquidity and methodological issues). For an initial discussion of the emerging field of CDS event studies and the applied methodology, see Jacobs (2010). The remainder of this literature review summarizes a few of the most relevant papers analyzing CDSs in an event study setting and provides information on the data used in these studies.

The first authors in the field using CDS in an event study approach were Norden and Weber (2004), publishing simultaneously with Hull *et al* (2004). Both studies

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[4] Central clearing houses were only introduced in the US and Europe in 2009 in an attempt to counter the problems related to CDSs in the financial crisis (for more information on ICE, providing clearing for North American and European CDSs, see www.theice.com).

focus on the informational efficiency of the credit default swap market by analyzing the market's reactions to rating announcements. Norden and Weber (2004) use daily spread observations of senior CDSs with five-year maturity provided by a large European bank for their analysis. The final sample contains CDS spread observations over the period from January 2000 to December 2002 for a total of 90 firms (58 from Europe). They look at positive and negative rating events (231 rating changes and 166 reviews) by Standard & Poor's, Moody's and/or Fitch. Hull *et al* (2004) use five-year CDS quotes from GFI, a specialized broker for credit derivatives, covering the time period from October 1998 to May 2002, but limit their analysis to corporations rated by Moody's. Overall, their sample of positive and negative rating events comprises 105 rating changes, 138 reviews and 82 outlooks. In both studies, Norden and Weber (2004) and Hull *et al* (2004) compute absolute changes in CDS spreads adjusted by the spread changes of indices constructed from their respective samples. The main result of both Norden and Weber and Hull *et al* is that the CDS market anticipates rating announcements by the major rating agencies. In the context of the present paper, this finding is important because it suggests looking at the CDS market directly (rather than the announcements of rating agencies) in order to examine the impact of operational losses on the default risk of banks suffering the loss.

Following the line of research established by Norden and Weber (2004) and Hull *et al* (2004), Galil and Soffer (2011) and Burghof *et al* (2012) are aiming at more detailed aspects of the CDS market's reaction to rating announcements. With a larger data set, Galil and Soffer (2011) confirm the previous finding that the CDS market's response to bad news is stronger than to good news.[5] Taking into account the clustering of events, the authors show that the common practice of using "uncontaminated" samples underestimates the market's response. The recent working paper by Burghof *et al* (2012) looks not only at the reference entity rated by a credit rating agency but also at the companies within the same industry, thus addressing the question of spillover effects. Burghof *et al* find that rating announcement can result in spillover effects for firms within in the same industry. However, results vary for different industries and depend on the agency issuing the rating.

Among the CDS event studies not analyzing rating announcements is the work of Wei and Yermack (2011). Their study examines the reaction of stock and bond prices as well as changes in CDS spreads to the disclosure of CEOs' inside debt positions initiated by a US Securities and Exchange Commission disclosure reform in 2007. They use data on CDSs from Markit CDS pricing on 235 North American firms in their sample for the analysis of CDS spreads. In particular, they use five-year, senior unsecured CDSs, arguing that this CDS type is the most common and most liquid.

[5] Norden and Weber (2004) and Hull *et al* (2004) have already provided some evidence for this observation. However, their samples for positive ratings events are relatively small.

The results of Wei and Yermack (2011) indicate that equity prices tend to fall and debt values tend to rise when the CEO holds large amounts of inside debt. As losses to stockholders are larger than the gains to bondholders, the net effect appears to be negative.

Addressing yet another research topic, Koziol and Theis (2011) analyze the debt value effects of mergers and acquisitions and use five-year senior CDS data from Thomson DataStream for their analysis. CDS spread data availability restricts the global sample from 627 mergers and 3252 acquisitions of nonfinancial companies to 20 mergers and 293 acquisitions between July 2003 and June 2007. Koziol and Theis find that mergers lead to falling CDS spreads, whereas acquisitions are associated with rising CDS spreads of the acquiring firm.

2.2 Hypothesis development

The previous studies on the stock market reaction to operational risk events cited above have shown that operational losses have a negative impact on stock prices. From a naive point of view, we could argue that operational risk events should not have an impact on a bank's debt holders because financial losses are entirely borne by shareholders as the residual claimants of the bank, leaving CDS and bond markets unaffected.[6] However, while this line of argument might seem plausible for small losses it is unlikely to be true in general for several reasons. First, sufficiently large (operational) losses will obviously impair a bank's ability to repay its debt, thus affecting its credit risk, and may even cause bankruptcy, as in the famous case of Barings Bank. Second, previous empirical work has shown that CDS spreads and equity returns are inversely correlated, confirming intuitive considerations. Thus, decreasing CDS spreads are generally associated with positive equity returns and vice versa (Acharya and Johnson 2007).[7] Furthermore, there is empirical evidence that CDS spreads react more strongly to negative news than to positive (see Zhang and Zhang 2011; Acharya and Johnson 2007). Third, large operational loss events may induce or reveal a permanent shift in the risk profile of banks, which will be reflected in higher CDS spreads after the event indicating increased (credit) risk of the reference entity. For example, the research note accompanying Moody's decision to review the credit rating of UBS in September 2011 states that the review "will center on ongoing

[6] Plunus *et al* (2012) argue along those lines for bonds with the following statement: "As shareholders' equity represents a residual claim on the economic value of the firm, it naturally experiences the first, mechanical loss due to an operational event, whatever its magnitude and degree of certainty. Thus, although the return effect is likely to be much less pronounced on debt contracts, it is also presumably purely reputational".

[7] The intuitive line of argument is that good (bad) news for the company is good (bad) news for equity holders and debt holders. However, there are interesting exceptions, such as wealth-transfer and risk-shifting events.

weaknesses in the Group's risk management and controls that have become evident again by the events leading to UBS announcing a loss due to unauthorized trading" (Moody's 2011). Moreover, it clearly points out that it is not the financial loss itself that is causing worry, as "Moody's believes that a loss of that magnitude would be manageable for the Group given its sound liquidity and capital position. However, the losses call into question the Group's ability to successfully complete the rebuilding of its investment banking operations". While Moody's acknowledges that UBS has improved its risk management, it expresses "concerns with regards to the ability of the management to develop a robust risk culture and effective control framework" and considers this "a key downside risk for the Group".

The considerations above provide reason to assume that operational losses may have an impact on CDS spreads. As there is no empirical evidence on this issue so far, the primary question to be addressed in this paper is whether CDS spreads react to the announcement of operational risk events. To be more precise, the main hypothesis is that CDS spreads increase around the announcement dates of operational risk events.

Hypothesis 1: operational loss events have a positive impact on CDS spreads of the bank incurring the loss (ie, spreads increase)

An increase in CDS spreads might be not so much due to the financial loss itself but could also stem from reputational effects in the CDS market and/or new information revealed by the operational loss about the riskiness of the business model.

The second hypothesis focuses on the event characteristics of the loss events in the sample. Intuitively, we would expect that the market accounts for the (relative) size of the loss, ie, the market reaction is stronger for large losses. Furthermore, following considerations in the previous literature, we may argue that fraud events or events related to clients, products and business practices have a stronger impact on CDS spreads because they are particularly harmful to reputation. Since results from papers analyzing the stock market are not unambiguous, it seems appropriate to keep the second hypothesis very general.

Hypothesis 2: the CDS market reaction differs depending on event characteristics (ie, relative loss size, loss amount and event type).

When considering the company characteristics, a bank's leverage may be an important factor for how sensitive CDS spreads react to the announcement of a loss (see Sturm (2013) for stock market results). Similarly, a bank's credit rating may influence the CDS market's reaction to operational losses. However, two lines of argument seem plausible: on the one hand, a good credit rating could lead to a weaker market reaction providing a buffer to the operational loss; on the other hand, operational risk events could be particularly harmful to banks with a good credit rating because a good rating implies a lower level of (operational) risk. The results expected for the CDS market may be different from stock market results because expectations about future cashflows (reflected in stock prices) are different from a bank's default risk (reflected in CDS spreads). The third hypothesis tests whether the company characteristics of the bank incurring the loss influence the CDS market's reaction to the loss announcement.

Hypothesis 3: the CDS market reaction differs depending on company characteristics (ie, leverage, credit rating and firm size).

3 DATA DESCRIPTION AND METHODOLOGY

3.1 Data description and summary statistics

The information on operational losses used for the empirical analysis stems from the ÖffSchOR database operated by the Association of Public Sector Banks (Bundesverband öffentlicher Banken, VÖB). The provider systematically scans public news sources for information on operational losses and categorizes the loss events according to the regulatory guidelines. Overall, more than 1500 loss events have been reported in ÖffSchOR as of September 2012. While ÖffSchOR records all operational losses exceeding €100 000, the threshold is set to €1 million for the analysis in this paper.[8]

The sample of operational risk events used for the empirical analysis in this study is further restricted by the availability of CDS data. First, CDS quotes are not available before 2004 across different data providers (see Mayordormo *et al* 2010, p. 13). This study uses CDS quotes from CMA Datavision, which is available via Thomson Reuters until September 2010 and information on the iTraxx Europe from Bloomberg. Consequently, the time frame considered for the investigation of CDS spreads is limited to a period of 81 months (January 2004–September 2010). Second, only major banks are regularly traded on the CDS market providing the basis for the corresponding information to be available in the database. As in the case of the other CDS event studies presented above, five-year senior CDSs are used for the analysis for reasons of availability and liquidity. The restructuring type of the CDS is MMR (modified-modified restructuring), which is the most common restructuring type in Europe.[9] The final sample consists of 99 loss events from 33 different European financial institutions. Balance sheet information for all banks in the sample is from Bureau van Dijk's Bankscope database[10] and credit rating information is from Standard &

[8] For comparison, the threshold in Plunus *et al* (2012) is US$10 million.

[9] For more information on CDS contracts and restructuring type conventions, see, for example, Markit (2009).

[10] In a few cases balance sheet information was complemented with data from annual reports.

TABLE 1 Summary series for the sample of ninety-nine loss events.

	Mean	Median	SD	Min	Max
Operational losses	205.06	45.00	577.63	1.10	4 900.00
Total assets*	1 016 378	987 064	558 714	43 911	2 465 660
Total equity*	33 093	29 936	17 287	3 846	90 130
Total liabilities*	983 285	961 169	547 530	40 065	2 375 530
Total liabilities to total assets (%)*	96.31	96.56	1.47	91.24	98.55
RLS1	0.8217	0.1196	2.0403	0.0026	15.6675
RLS2	0.0295	0.0049	0.0657	0.0000	0.4572
Credit rating	4.6	4 = AA−	1.4	2 = AA+	8 = BBB+

Operational losses, total assets, total equity and total liabilities are all shown in millions of euro. RLS1 is the relative loss size as a percentage of the total equity. RLS2 is the relative loss size as a percentage of the total assets. The credit rating is shown from AAA = 1 to BBB = 9. *Total assets, total liabilities and total liabilities to total assets of the financial institution affected by the loss are reported as of December 31 preceding the date of the initial news article.

Poor's RatingsXpress.[11] Credit ratings are transformed into a cardinal scale as in Jorion *et al* (2005) in order to obtain a numerical variable which can be included on the right-hand side of multivariate regression models. Table 1 reports summary statistics for the final sample of loss events.

Table 1 shows that the average loss in the sample is roughly €205 million, whereas the median is only €45 million, indicating a right-skewed loss distribution. The minimum loss of €1.1 million is slightly above the defined threshold of €1 million and the maximum of €4.9 billion is the loss caused by Jérôme Kerviel at Société Générale. Summary information on the balance sheet structure of banks incurring the losses, their leverage, the relative size of losses (as a percentage of equity and a percentage of total assets) and credit rating information is also provided in Table 1.

The distribution of losses over business lines and event types is displayed in Table 2 on the next page (by number of loss events) and Table 3 on page 13 (by volume of loss amounts). Losses of the event type category "Clients, products and business practices" account for almost half of the loss events in the sample, and this category is followed by the categories "Internal fraud" (27%) and "External fraud" (20%). Comparing these numbers from Table 2 with the corresponding information in Table 3 reveals that loss amounts caused by internal fraud are relatively large, making up 44.8% of total losses, while loss events from the "Clients, products and business practices" category caused only 26.2% of the total loss volume. Overall, the numbers reported in Table 2 and Table 3 are not very different from the distribution of losses over business

[11] There is no Standard & Poor's rating information available for three banks at the time of the event. In these cases, Moody's credit rating was used.

TABLE 2 Number of operational losses across business lines and event type categories.

Business lines	Internal fraud	External fraud	Employment practices and workplace safety	Clients, products and business practices	Damage to physical assets	Business disruption and system failures	Execution, delivery and process management	Total across event types
Corporate finance	5.1	2.0	0.0	9.1	0.0	0.0	0.0	16.2
Trading and sales	7.1	3.0	1.0	12.1	0.0	0.0	1.0	24.2
Retail banking	4.0	2.0	0.0	12.1	0.0	0.0	0.0	18.2
Commercial banking	0.0	3.0	0.0	2.0	0.0	0.0	1.0	6.1
Payment and settlement	0.0	0.0	0.0	3.0	0.0	0.0	0.0	3.0
Agency services	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Asset management	2.0	6.1	0.0	3.0	0.0	0.0	0.0	11.1
Retail brokerage	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
No business line information	9.1	3.0	3.0	5.1	0.0	1.0	0.0	21.2
Total number of events	27	19	4	46	0	1	2	99
Total across business lines	27.3	19.2	4.0	46.5	0.0	1.0	2.0	100.0

All values except for total number of events are in percentages.

TABLE 3 Operational losses by volume (in million euro) across business lines and event type categories.

Business lines	**Internal fraud**	**External fraud**	**Employment practices and workplace safety**	**Clients, products and business practices**	**Damage to physical assets**	**Business disruption and system failures**	**Execution, delivery and process management**	**Total across event types**
Corporate finance	2.5	1.1	0.0	4.0	0.0	0.0	0.0	7.5
Trading and sales	35.9	4.2	0.0	5.7	0.0	0.0	0.5	46.2
Retail banking	0.0	0.1	0.0	9.3	0.0	0.0	0.0	9.4
Commercial banking	0.0	3.9	0.0	0.1	0.0	0.0	0.1	4.2
Payment and settlement	0.0	0.0	0.0	3.0	0.0	0.0	0.0	3.0
Agency services	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Asset management	0.0	13.1	0.0	1.1	0.0	0.0	0.0	14.2
Retail brokerage	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
No business line information	6.4	0.1	4.8	3.1	0.0	1.0	0.0	15.5
Total loss amount (€ million)	9 097	4 568	984	5 322	0	205	125	20 301
Total across business lines	44.8	22.5	4.8	26.2	0.0	1.0	0.6	100.0

lines and event types reported in the study of Sturm (2013), which uses the same data from ÖffSchOR but focus on a different sample (publicly listed banks only) and a different time period (January 2000–December 2009).

For every operational loss, the following two event dates are identified by searching for the corresponding news item in LexisNexis.

(1) The date of the first news article mentioning the loss: while for some losses all details are disclosed on one single day, in other cases there may be only very little information released to the public (ie, the announcement of an investigation).

(2) The date of settlement for the loss: at this point in time, all details of the operational loss are known. In many cases the settlement is the decision of a court or the announcement of a fine by a regulatory authority.

If the date of the first press item and the settlement date are identical, the loss event is only retained in the first group. Consequently, the sample reduces to fifty-nine operational losses for the analysis of CDS spread changes around the settlement date.

3.2 Methodology

Adapting standard event study methodology (originally developed using stock market data) to the application on the CDS market, we estimate cumulative CDS spread changes (CSCs) and cumulative abnormal CDS spread changes (CASCs), broadly following the approach by Norden and Weber (2004). In the event study setup, CDS spread changes of the reference entity suffering the loss are adjusted by spread changes of a CDS index. As the sample consists of large European banks, the iTraxx Europe[12] is chosen as the market index. CDS spread changes are calculated for each reference entity (CDS_i) and the index (iTraxx) on a daily basis around the event day t. Subtracting the index change from the spread change of the reference entity suffering the loss yields the abnormal spread change:

$$\text{ASC}_{it} = (\text{CDS}_{it} - \text{CDS}_{it-1}) - (\text{iTraxx}_t - \text{iTraxx}_{t-1}). \tag{3.1}$$

Abnormal spread changes (ASCs) are easy to interpret because the resulting unit is an (abnormal) increase or decrease of CDS spreads in basis points. Even though these absolute changes in CDS spreads are widely used, a drawback of this measure is that the level of CDS spreads is not taken into account.[13] An alternative approach

[12] The first series of the iTraxx Europe (Series 1) was introduced in June 2004. More precisely, data is available on Bloomberg starting June 17, 2004. For the first months of 2004 the market index is calculated as an equally weighted index using 119 reference entities from the 125 entities of the first series where data is available as of January 1, 2004.

[13] To give an example, there is no difference between a 5bps increase from 5bps to 10bps and a 5bps increase from 100bps to 105bps when calculating absolute changes in CDS spreads.

accounting for the level of CDS spread changes is to calculate relative changes in CDS spreads (see, for example, Micu *et al* 2006; Jacobs 2010; Burghof *et al* 2012):

$$\mathrm{A(R)SC}_{it} = \left(\frac{\mathrm{CDS}_{it} - \mathrm{CDS}_{it-1}}{\mathrm{CDS}_{it-1}}\right) - \left(\frac{\mathrm{iTraxx}_t - \mathrm{iTraxx}_{t-1}}{\mathrm{iTraxx}_{t-1}}\right). \tag{3.2}$$

Average abnormal (relative) spread changes (ARSCs) are obtained by computing the cross-sectional average across the loss events in the sample:

$$\mathrm{A(R)SC}_t = \frac{1}{N}\sum_{i=1}^{N}\mathrm{A(R)SC}_{it}. \tag{3.3}$$

CASCs and cumulative abnormal relative spread changes (CARSCs) are obtained by adding the ARSCs over several days from t_1 to t_2 around the event date:

$$\mathrm{CA(R)SC}_{t_1,t_2} = \sum_{t=t_1}^{t_2}\mathrm{A(R)SC}_t. \tag{3.4}$$

To test for statistical significance, cross-sectional test statistics are commonly applied in CDS event studies (see Jacobs 2010). Following the literature, we calculate cross-sectional t tests and nonparametric Wilcoxon signed-rank tests to analyze whether CDS spread changes are statistically different from zero (see Norden and Weber 2004; Burghof *et al* 2012). In addition, the percentage of positive CDS spread changes is reported (see, for example, Norden and Weber 2004; Jorion and Zhang 2007). Given that time series data on CDS spreads for most European reference entities is not available via Thomson Reuters before January 2004, a cross-sectional approach offers the advantage of not requiring a long estimation period prior to the event.

4 EMPIRICAL RESULTS

4.1 Univariate analysis

This section presents the event study results analyzing the CDS market's reaction to the announcement of operational losses. In order to show the change in CDS spreads as observed on the market (ie, not adjusted for the simultaneous changes of the iTraxx) and the CDS market's reaction adjusted for index changes, cumulative (relative) CDS spread changes and cumulative abnormal (relative) CDS spread changes are reported in the following tables. The overall picture of results for CDS spread changes around the first press date is not very clear. Generally, CDS spreads increase around the first press date, however, the observed CDS spread changes are rather volatile and significance levels depend on the specific event window considered. Therefore, results for the first press date are not reported.

For the settlement date, results of the empirical analysis are much stronger and more consistent. Table 4 on the facing page reports cumulative (abnormal) CDS spread changes for different event windows around the settlement date (in basis points). Results show a statistically significant increase in CASCs over different event windows around the event date. While the range of CDS spread changes is relatively large and not in all cases significant when unadjusted for changes of the iTraxx Europe (up to 12bps), the increase in CDS spreads narrows to the range of 3–7bps for the different event windows when index changes are accounted for. Looking across different event windows, the number of positive CDS spread changes is in line with the results for mean cumulative (abnormal) spread changes and corresponding t values, thus confirming overall findings. Generally, cross-sectional t tests and Wilcoxon signed-rank tests produce almost identical results in terms of statistical significance.

Figure 1 on page 18 illustrates the increase observed in CASCs around the settlement date from Table 4 (represented by the dotted line in the chart). Considering the sharp increase in CDS spreads at day 0, the event date seems to be well identified. The solid line in Figure 1 visualizes the relative spread changes (CARSCs) around the settlement from Table 5 on page 19.

Table 5 on page 19 presents cumulative (abnormal) relative spread changes around the settlement date, hence, the numbers are to be interpreted as relative changes in CDS spreads (reported as a percentage similar to returns). The results confirm the overall picture of a significant CDS market reaction to operational risk events. CARSCs increase by as much as 8.77% over a (-10,$+10$) event window. While it seems plausible that the settlement of the operational loss is to some extent anticipated (eg, due to preliminary press coverage prior to the settlement), it is surprising that it takes up to five days following the event before all information is fully incorporated into CDS prices (see Table 5 and the solid line in Figure 1 on page 18), even more so considering that there are only institutional investors in the market. Note, however, that this is only the case when CDS changes are measured in relative terms (see the solid line in Figure 1), while the market's reaction is more abrupt when looking at absolute spread changes (see the dotted line in Figure 1). Not surprisingly, relative CDS spread changes which take the level of CDS spreads into account, are less volatile than absolute CDS spread changes (compare the solid and the dotted line in Figure 1).

4.2 Multivariate analysis

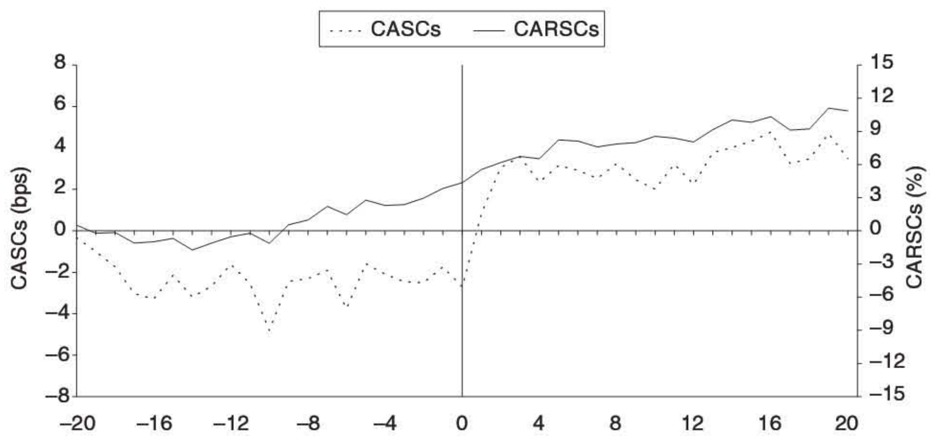
The univariate analysis in Section 4.1 revealed that spread changes observed around the first press date of operational losses are rather volatile. The overall positive trend of spread changes is in line with the hypothesis of increasing spreads, but, due to the high variation in significance levels, results were not reported in detail and should be interpreted with caution. As a consequence of the volatility in the observed changes

TABLE 4 CASCs for all loss events around the settlement date.

N	Window	Mean CSC (bps)	t-value	% (>0)	Mean CASC (bps)	t-value	% (>0)
59	(0,0)	−0.42	−0.34	49.06	−0.95	−0.85	42.37
59	(−1,+1)	2.79	2.25**	51.79	3.36	3.35^{***+++}	57.63
59	(−2,+2)	3.74	2.27**	47.37	5.51	3.50^{***+++}	61.02
59	(−3,+3)	2.92	2.33**	49.12	5.65	3.77^{***+++}	67.80
59	(−5,+5)	2.81	1.27	52.54	6.91	4.46^{***+++}	72.88
59	(−10,+10)	12.25	4.35^{***+++}	68.52	4.56	2.59^{**++}	66.10
59	(0,+1)	0.73	0.78	58.49	2.61	3.00^{***+++}	67.80
59	(−1,+2)	2.32	1.55	57.89	5.56	3.48^{***+++}	61.02
59	(−1,+3)	2.11	1.32	53.45	6.07	3.76^{***+++}	67.80
59	(−1,+4)	2.23	1.48	50.88	4.85	3.76^{***+++}	67.80
59	(−1,+5)	2.77	1.63	54.24	5.67	4.37^{***+++}	74.58
59	(−1,+10)	5.13	1.88^{*++}	58.93	4.51	2.59^{**++}	61.02

This table displays CSCs and CASCs for different event windows around the settlement date. ***, ** and * (respectively, $^{+++}$, $^{++}$ and $^{+}$) indicate significance at the 1%, 5% and 10% levels (respectively, according to the cross-sectional t test) (Wilcoxon signed-rank test). (Cumulative) spread changes of zero are not taken into account when calculating the percentage of positive spread changes.

FIGURE 1 CARSCs for all loss events around the settlement date.



in spreads (and the corresponding significance levels), it may not be a surprise that multivariate regression models with cumulative spread changes on the left-hand side and a set of company and event characteristics on the right-hand side are not robust to changes in the event window and the choice of variables included in the model. In addition, most model specifications have little explanatory power and do not produce meaningful results. Therefore, multivariate results for the first press date are also not reported.

For the settlement date, univariate results look much more favorable in terms of a robust estimate of the CDS market's reaction to the news on the loss (see Section 4.1). Conditional on observing a statistically significant reaction to the loss announcement (ie, not rejecting Hypothesis 1), this section tests for a potential effect of event characteristics (Hypothesis 2) and company characteristics (Hypothesis 3) on the market's reaction. More precisely, estimated (relative) abnormal spread changes from Section 4.1 are regressed on a set of explanatory variables for the event and company characteristics (for summary statistics and data description, see Section 3). The results from these models with CARSCs around the settlement date as the dependent variable are presented in Table 6 on page 20. Regression diagnostics (ie, normal Q–Q plots and residual versus fitted plots) do not provide reasons for concern and maximum values of Cook's distance are well below 0.5 in all regression models. To counter potentially remaining problems of nonnormality, heteroscedasticity or observations with leverage, all regressions are estimated with Eicker–Huber–White standard errors. All models have good explanatory power in terms of R^2 and the VIF values (below 4) for all independent variables suggest that multicollinearity is not causing problems.

TABLE 5 Cumulative (abnormal) relative spread changes for all loss events around the settlement date.

		Mean CRSC					Mean CARSC
N	Window	(%)	t-value	% (>0)	(US$)	t-value	% (>0)
59	(0,0)	1.38	1.10	50.94	0.54	0.60	50.85
59	(−1,+1)	2.59	1.79*	53.57	2.58	2.56**++	62.71
59	(−2,+2)	3.52	1.69*	50.88	3.81	2.82***++	66.10
59	(−3,+3)	4.05	2.10**	50.88	4.40	3.57***+++	66.10
59	(−5,+5)	6.63	2.29**+	52.54	6.77	4.31***+++	66.10
59	(−10,+10)	17.84	4.63***+++	74.58	8.77	4.90***+++	71.19
59	(0,+1)	0.89	0.90	58.49	1.71	1.91*++	66.10
59	(−1,+2)	1.68	1.02	56.14	3.21	2.38**++	64.41
59	(−1,+3)	1.73	0.99	50.88	3.77	2.66**+++	66.10
59	(−1,+4)	3.05	1.67*	54.39	3.56	2.60**+++	69.49
59	(−1,+5)	4.71	2.21**++	59.32	5.26	2.53***+++	76.27
59	(−1,+10)	8.88	2.82***+++	64.41	5.58	3.05***+++	64.41

This table displays CSRCs and CARSCs for different event windows around the settlement date. ***, ** and * (respectively, +++, ++ and +) indicate significance at the 1%, 5% and 10% levels (respectively, according to the cross-sectional t test) (Wilcoxon signed-rank test). (Cumulative) spread changes of zero are not taken into account when calculating the percentage of positive spread changes.

TABLE 6 Multivariate results for the settlement dates with CASCs and CARSCs as the dependent variable. [Table continues on next page.]

(a) Mean CASC					
	(1) **(−1,+1)**	**(2)** **(−2,+2)**	**(3)** **(−3,+3)**	**(4)** **(−1,+2)**	**(5)** **(−1,+3)**
RLS1	1.1592**	2.8396***	3.1719***	2.4538***	2.8772***
	(2.37)	(3.75)	(4.49)	(3.07)	(3.62)
Internal fraud	−6.6099	−5.6741	−4.2353	−7.1316	−7.1041
(yes = 1/no = 0)	(−1.47)	(−0.87)	(−0.72)	(−1.10)	(−1.00)
External fraud	1.5450	6.7157	3.8489	4.7537	1.2477
(yes = 1/no = 0)	(0.31)	(0.84)	(0.50)	(0.58)	(0.14)
CPBP	−1.2487	1.7852	0.6582	−1.5889	−3.8451
(yes = 1/no = 0)	(−0.27)	(0.27)	(0.11)	(−0.24)	(−0.54)
Total assets	0.0000	0.0000	0.0000	0.0000	0.0000
(€ million)	(−0.43)	(−0.20)	(0.43)	(0.49)	(1.28)
Total liabilities to	1.4912	−40.1705	26.8187	−83.3798	−107.3380*
total assets (%)	(0.03)	(−0.76)	(0.36)	(−1.41)	(−1.81)
Credit rating	−0.7110	−1.8389**	−1.6236*	−1.9845**	−2.0759**
	(−1.28)	(−2.27)	(−1.87)	(−2.20)	(−2.19)
Constant	6.9725	49.9865	−16.0209	93.5139	117.3952*
	(0.15)	(0.95)	(−0.22)	(1.59)	(1.96)
R^2	0.2234	0.2892	0.2679	0.2477	0.2231
Prob > F	0.0075	0.0014	0.0016	0.0176	0.0169
N	59	59	59	59	59

In both cases, ie, no matter whether CASCs (part (a) of Table 6) or CARSCs (part (b) of Table 6 on the facing page) are considered, the coefficients of the variable relative loss size are positive and statistically significant for all event windows under consideration (with one exception, column 6), providing evidence that the CDS market takes the size of the loss (as a percentage of equity) into account when reacting to the loss event. The coefficient is also significantly positive when the size of the loss is measured as a percentage of total assets or by the nominal loss amount, but models have less explanatory power. Moreover, when looking at the models with CASCs as the dependent variable (Table 6, part (a)), the coefficient for the variable credit rating is significantly different from zero with a negative sign for all but the shortest event window.[14]

[14] We could expect the independent variables credit rating and liabilities to total assets to be strongly correlated, but the correlation between the two variables is even slightly negative (−0.13) and not statistically significant.

TABLE 6 Continued.

(b) Mean CARSC

	(6) (−1,+1)	(7) (−2,+2)	(8) (−3,+3)	(9) (−1,+2)	(10) (−1,+3)
RLS1	0.3105 (0.44)	1.8501* (1.90)	2.1096** (2.28)	1.3692* (1.69)	1.7526* (1.84)
Internal fraud (yes = 1/no = 0)	−0.1247** (−2.40)	−0.1436** (−2.10)	−0.1199* (−1.83)	−0.1240** (−2.16)	−0.1368* (−1.91)
External fraud (yes = 1/no = 0)	−0.0552 (−1.06)	−0.0477 (−0.68)	−0.0435 (−0.64)	−0.0449 (−0.73)	−0.0459 (−0.64)
CPBP (yes = 1/no = 0)	−0.0870 (−1.66)	−0.0593 (−0.85)	−0.0673 (−1.02)	−0.0790 (−1.42)	−0.1024 (−1.49)
Total assets (€ million)	0.0000 (−0.36)	0.0000 (−0.57)	0.0000 (0.01)	0.0000 (0.33)	0.0000 (0.83)
Total liabilities to total assets (%)	−0.1074 (−0.26)	−0.3293 (−0.67)	0.3822 (0.79)	−0.3412 (−0.59)	−0.1356 (−0.22)
Credit rating	0.0029 (0.45)	−0.0126 (−1.53)	−0.0098 (−1.10)	−0.0061 (−0.59)	−0.0035 (−0.36)
Constant	0.2017 (0.49)	0.4848 (1.00)	−0.2257 (−0.47)	0.4466 (0.77)	0.2431 (0.39)
R^2	0.2270	0.2895	0.2939	0.1723	0.2186
Prob > F	0.0380	0.0041	0.0455	0.0690	0.0731
N	59	59	59	59	59

This table shows results based on OLS regressions of CASCs and CARSCs on loss event and firm characteristics. The independent variables are defined as follows: RLS1 (relative loss size) is the nominal loss amount divided by the book value of equity (in %), internal fraud (17 observations), external fraud (13 observations) and CPBP (24 observations) are indicator variables for the event type of the loss, total assets is the book value of total assets, total liabilities to total assets is the ratio of total liabilities to total assets (in %) and credit rating is the S&P credit rating on a scale from 1 (AAA) to 9 (BBB). t values are given in parentheses. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively. All regressions are estimated using Eicker–Huber–White heteroscedasticity-robust standard errors.

In other words, there is some evidence that, when measured in absolute spread changes, banks with good credit rating react more strongly to operational risk events, possibly due to the market's perception of a credit rating underestimating the bank's risk. In contrast, internal fraud events are not followed by as strong a CDS market reaction as we might expect because of reputational damage.[15] When looking at the results with abnormal relative spread changes as the dependent variable (part (b) of Table 6 on the facing page), the opposite seems to be the case. The

[15] Intuitively, it seems plausible to expect damages to reputation in cases of (internal) fraud, but the argument has also been made that cases of intended and systematic fraud cannot be entirely prevented by the management and should not be particularly harmful to reputation.

TABLE 7 Multivariate results for the settlement date with CASCs and CARSCs as the dependent variable (robustness). [Table continues on next page.]

(a) Mean CASC					
	(1) **(−1,+1)**	**(2)** **(−2,+2)**	**(3)** **(−3,+3)**	**(4)** **(−1,+2)**	**(5)** **(−1,+3)**
RLS1	1.1090**	2.7215***	3.0404***	2.3225***	2.7331***
	(2.26)	(3.64)	(4.29)	(3.07)	(3.57)
Internal fraud	−6.2823	−4.9041	−3.3786	−6.2765	−6.1649
(yes = 1/no = 0)	(−1.40)	(−0.75)	(−0.57)	(−0.97)	(−0.86)
External fraud	1.9761	7.7290	4.9762	5.8790	2.4835
(yes = 1/no = 0)	(0.40)	(0.97)	(0.63)	(0.73)	(0.28)
CPBP	−1.2370	1.8127	0.6888	−1.5584	−3.8115
(yes = 1/no = 0)	(−0.26)	(0.27)	(0.11)	(−0.23)	(−0.53)
Total assets	0.0000	0.0000	0.0000	0.0000	0.0000
(€ million)	(−0.54)	(−0.42)	(0.10)	(0.24)	(0.96)
Total liabilities to	7.4714	−26.1161	42.4551	−67.7717	−90.1960
total assets (%)	(0.16)	(−0.47)	(0.53)	(−1.13)	(−1.48)
Credit rating	−0.6908	−1.7913**	−1.5706**	−1.9316**	−2.0178**
	(−1.28)	(−2.46)	(−2.04)	(−2.26)	(−2.34)
Time	0.0019	0.0046**	0.0051*	0.0051**	0.0056**
	(1.43)	(2.07)	(1.99)	(2.36)	(2.41)
Constant	−4.8316	22.2446	−46.8854	62.7052	83.5588
	(−0.10)	(0.40)	(−0.58)	(1.06)	(1.36)
R^2	0.2389	0.3239	0.3152	0.2893	0.2722
Prob > F	0.0174	0.002	0.0038	0.0191	0.0156
N	59	59	59	59	59

coefficient of the internal fraud variable is significantly negative for all event windows considered.

As a robustness check, all regression models from Table 6 on page 20 are also estimated with a time variable in order to control for a potential time effect in the results (see Table 7). This variable time is counting the days since January 1, 2000 until the event date, thus including the calendar date in the analysis. Results show that the coefficients for this time variable are positive and statistically significant in all regression models (except for the models in columns 1 and 8 in Table 7), indicating a stronger reaction of the CDS market to operational losses over the course in time, which is potentially due to the changing dynamics of the CDS market during the financial crisis. Regarding all other variables, results are very similar (in terms of sign and significance level of the coefficients) compared with the results without the time variable (compare Table 6 and Table 7), confirming the robustness of results.

TABLE 7 Continued.

(b) Mean CARSC					
	(6) **(−1,+1)**	**(7)** **(−2,+2)**	**(8)** **(−3,+3)**	**(9)** **(−1,+2)**	**(10)** **(−1,+3)**
RLS1	0.2453 (0.34)	1.7596* (1.75)	2.0230** (2.08)	1.2257 (1.47)	1.5997 (1.60)
Internal fraud (yes = 1/no = 0)	−0.1205** (−2.21)	−0.1377* (−1.91)	−0.1143 (−1.65)	−0.1146* (−1.89)	−0.1268 (−1.67)
External fraud (yes = 1/no = 0)	−0.0496 (−0.91)	−0.0400 (−0.54)	−0.0360 (−0.50)	−0.0326 (−0.51)	−0.0328 (−0.43)
CPBP (yes = 1/no = 0)	−0.0869 (−1.58)	−0.0591 (−0.80)	−0.0671 (−0.96)	−0.0787 (−1.30)	−0.1020 (−1.37)
Total assets (€ million)	0.0000 (−0.53)	0.0000 (−0.75)	0.0000 (−0.19)	0.0000 (0.10)	0.0000 (0.58)
Total liabilities to total assets (%)	−0.0299 (−0.08)	−0.2216 (−0.48)	0.4852 (0.98)	−0.1707 (−0.32)	0.0462 (0.08)
Credit rating	0.0032 (0.48)	−0.0123 (−1.62)	−0.0094 (−1.23)	−0.0055 (−0.52)	−0.0029 (−0.30)
Time	0.0000* (1.68)	0.0000** (2.08)	0.0000 (1.62)	0.0001** (2.33)	0.0001** (2.52)
Constant	0.0486 (0.12)	0.2723 (0.58)	−0.4289 (−0.84)	0.1099 (0.20)	−0.1159 (−0.19)
R^2	0.2528	0.3172	0.3238	0.2418	0.2903
Prob > F	0.0314	0.0055	0.0583	0.0497	0.0543
N	59	59	59	59	59

This table shows results based on OLS regressions of CASCs and CARSCs on loss event and firm characteristics. The independent variables are defined as follows: RLS1 is the nominal loss amount divided by the book value of equity (in %), internal fraud (17 observations), external fraud (13 observations) and CPBP (24 observations) are indicator variables for the event type of the loss, total assets is the book value of total assets, total liabilities to total assets is the ratio of total liabilities to total assets (in %), credit rating is the S&P credit rating on a scale from 1 (AAA) to 9 (BBB) and time is a variable counting the days since January 1st, 2000. t values are given in parentheses. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively. All regressions are estimated using Eicker–Huber–White heteroscedasticity-robust standard errors.

5 CONCLUSION

This paper is the first to investigate the CDS market reaction to the announcement of operational risk events by looking at a sample of ninety-nine operational losses occurring at large European banks across different business lines and event types. While results for the first press date of losses are not particularly meaningful, we find that on average there is a statistically significant increase in CDS spreads around the settlement date in the range of five basis points, or roughly 5% when spread changes are measured in relative terms. Multivariate regression results show that the CDS market's reaction to operational risk events is clearly influenced by the (relative) size of losses. In the sense that the market reaction is directly influenced by the financial loss itself, this suggests that the effect is not "purely reputational" as proposed by Plunus *et al* (2012) for the bond market. Surprisingly, internal fraud events seem to be less harmful from the CDS market's perspective, whereas other event characteristics do not influence the CDS market's reaction to the announcement of losses. Moreover, multivariate regressions results provide evidence that the increase in CDS spreads is more pronounced for banks with a good credit rating, supporting the line of argument that financial institutions with a good credit rating suffer more from operational losses (rather than being "protected") because, in the light of the solid rating, investors are even more disappointed by the loss.

While this paper provides the first evidence on the market impact of operational losses by examining CDS spreads, future research may go a step further and calculate changes in implied default probabilities from observed CDS spreads around the announcement of operational loss events.

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