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S&P 500 Index revisions and credit spreads

Lindsay Baran[1] | Ying Li[2] | Chang Liu[3] | Zilong Liu[4] | Xiaoling Pu[1]

[1]Department of Finance, Kent State University, Kent, Ohio

[2]School of Business, University of Washington Bothell, Bothell, Washington

[3]Harmon College of Business and Professional Studies, University of Central Missouri, Warrensburg, Missouri

[4]Key Bank, Cleveland, Ohio

Correspondence
Lindsay Baran, Department of Finance, College of Business Administration, Kent State University, Kent, Ohio.
Email: lbaran@kent.edu

Abstract

We investigate the impact of S&P 500 Index revisions on credit spreads from 2001 to 2014. Additions have a significant negative impact on credit default swap (CDS) spreads both during the financial crisis period and for speculative grade firms, but deletions show no significant CDS spread changes. After excluding the effect of market integration between the stock and CDS markets, we find that S&P 500 Index inclusion conveys no unique information beyond that due to market integration except during the financial crisis. Furthermore, CDS trading liquidity does not improve after S&P 500 Index inclusion.

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KEYWORDS
credit default swap, credit spreads, S&P 500 Index revisions

1 | INTRODUCTION

Ever since the first documentation of price effects of Standard and Poor's (S&P) Index revisions more than two decades ago, researchers proposed multiple hypotheses to explain the stock price increases (decreases) associated with addition to (deletion from) the S&P 500 Index.[1] The stock price reaction to these announcements should either be information free, resulting from downward-sloping demand curves for index stocks or price pressure from index fund rebalancing, or it should involve information relevant in pricing the newly added or removed stocks conveyed in S&P 500 Index revisions. One strand of literature investigates information relevance in the credit market by studying the reaction in the credit market to S&P 500 Index revision announcements and documents supporting evidence of the existence of information. For example, Dhillon and Johnson (1991) find significant decreases in bond yield spreads after firms are added to the S&P 500 Index pointing to information in S&P 500 Index inclusion announcements.

In this paper, we examine the reaction in the credit default swap (CDS) market to S&P 500 Index revision announcements and explore the underlying mechanisms of the effect. Compared with the bond market, the CDS market provides a more liquid setting (Longstaff, Mithal, & Neis, 2005) for us to examine the reaction of credit spreads to equity index revisions, especially over short-term windows. Not only does our study have a much larger sample size with more liquid credit spreads data compared to that of Dhillon and Johnson (1991), but it employs the structural model of credit risk. Using the structural model of risk, we can distinguish the market integration effect between equity and credit markets from the additional information in S&P 500 Index revisions that are uniquely identified in the CDS market.

We find that, over the period of 2001–2014, addition announcements have a negative and significant impact on CDS spreads. The CDS spread declines are significant over windows of up to 30 days post announcement date (AD), with an increasing magnitude over time. The magnitude of negative abnormal CDS spread changes is larger during the financial crisis period and for speculative grade firms for most windows that we examine. However, the differences between crisis and non-crisis periods (or differences between investment grade and speculative firms) are not statistically significant. In contrast to index addition announcements, deletion announcements have a positive but statistically insignificant impact on CDS

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spreads. The asymmetric reaction of CDS spreads to addition and deletion announcements is consistent with the findings in Marsh and Wagner (2016), which shows that the price discovery in the CDS market is news-specific and only significant following positive news. The stock market reaction to index inclusion is significant and positive for the full sample and similarly larger magnitude of abnormal returns for speculative grade firms. However, the stock returns are positive but statistically insignificant for the crisis period. For the deletion sample, the stock cumulative abnormal returns (CARs) are significantly negative for only a few windows.

The significant reactions to the addition announcements could be due to the CDS market participants uniquely identifying new information from the S&P 500 Index revision announcement, or these reactions could simply stem from the price integration between the CDS and equity markets (Fung, Sierra, Yau, & Zhang, 2008; Kapadia & Pu, 2012). To separate these two effects, we employ the structural model to predict credit spreads and compute the abnormal changes in differences between the actual and predicted spreads for the event firms. We find that the significance of the abnormal differences disappears for the whole sample and low-rated firms and only appears in the crisis period. The results suggest that S&P 500 Index revisions do not convey additional information to the CDS market that is unrecognized in the stock market except during the financial crisis.

Furthermore, mirroring the existing S&P 500 Index revision literature, we test whether liquidity changes in the CDS market lead to the abnormal CDS spread declines upon additions, as liquidity is also an important pricing factor for CDS contracts (Bongaerts, De Jong, & Driessen, 2011; Loon & Zhong, 2014; Tang & Yan, 2014). We find that the CDS liquidity does not significantly change in windows of up to 45 days after the inclusion announcements. In addition, the correlations between CDS liquidity and abnormal spread changes are insignificant in all windows. Thus, liquidity improvements do not drive our main results from the CDS market.

Exploring the determinants of both CDS and stock market reactions to index inclusion in a regression framework, we find the stock CAR is an insignificant predictor of CDS spread changes in all but one event window. During the crisis period, we observe larger CDS spread declines. When we use the stock market reaction as the dependent variable, the CDS CARs have no impact after controlling for other variables and the crisis dummy has no statistical significance. Based on our full set of analyses, we find that index inclusion during the financial crisis was not information-free for CDS market participants. However, our results from the CDS market do not show widespread support across all time periods and credit ratings for any of the S&P 500 Index inclusion hypotheses.

2 | LITERATURE REVIEW AND MOTIVATION

Prior studies document a stock price reaction to inclusion in or removal from the S&P 500 Index. These studies find that permanent stock price increases after S&P 500 Index inclusion and temporary stock price declines upon S&P 500 Index removal. To explain the stock price reaction after S&P 500 Index revision announcements, researchers have proposed several explanations which can be categorized into five competing hypotheses.[2]

The first hypothesis, *downward-sloping demand curve* hypothesis, argues that there is no information conveyed in S&P 500 Index revisions and the price effect arises because non-index stocks are imperfect substitutes for index stocks (Scholes, 1972). This hypothesis is supported by some previous work (Greenwood, 2005; Kaul, Mehrotra, & Morck, 2000; Lynch & Mendenhall, 1997; Shleifer, 1986). A second explanation is that *temporary price pressure* from index fund rebalancing drives these price changes, supported by Harris and Gurel (1986), Elliott and Warr (2003), Shankar and Miller (2006), and Hrazdil (2009).

The remaining three hypotheses concur that index revisions are not information-free events, but each proposes a different form of information transmission. The *certification hypothesis* deals with whether S&P 500 Index inclusion or removal conveys unknown information about future performance to explain the price response to announcements. Jain (1987) provides empirical evidence that S&P 500 Index addition conveys information to investors, which might change their perceptions of the stocks. Dhillon and Johnson (1991) investigate stock, bond, and option prices around the announcements of inclusion in the S&P 500 Index and find bond and option prices to move with stock prices from 1978 to 1988, suggesting that there is information involved in these announcements that impacts the equity, debt, and option markets. Denis et al. (2003) and Platikanova (2008) also argue that addition to the S&P 500 Index is not information free by discovering earnings improvement around the announcement date. In addition, Cai (2007) finds the positive addition information may spread to the industry of the company.

On the other hand, Shleifer (1986) confirms the positive price effects after S&P 500 Index inclusion but argues that the inclusion does not mean that the firm has improved quality because the abnormal returns are not related with the bond

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ratings. Harris and Gurel (1986) state that the addition events to the S&P 500 Index do not carry specific information as the stock prices reverse back over the 30 days following the announcement in their sample. Beneish and Gardner (1995) support this argument by investigating the price and the trade volume of newly listed Dow Jones Industrial Average firms. Hrazdil and Scott (2009) find that improved earnings following index inclusions are due to these firms' larger discretionary accruals, not because of the information effect from the additions.

The *investor awareness hypothesis* draws on the observation that the price responses to inclusion and removal are asymmetric. Chen et al. (2004) show that the shadow cost (Merton,1987) declines upon inclusion because of increased investor awareness but does not decline on index removal as investors do not lose awareness simply because stocks are removed from the S&P 500 Index. Finally, the *liquidity hypothesis* proposes that inclusion to the index brings sustained improvements in stock liquidity and reductions in bid-ask spread, consistent with an increase in price. Amihud and Mendelson (1986) propose that firms included into the S&P 500 Index tend to attract more institutional holdings and larger trading volume. This trend leads to less information asymmetry and the stock becomes more liquid, which moves the stock price upward. Following this explanation, Beneish and Gardner (1995), Chung and Kryzanowski (1998), Hegde and McDermott (2003), Chen et al. (2004), and Becker-Blease and Paul (2006) find consistent empirical evidence from the S&P 500 Index and other U.S. market indices.

One prior study (Dhillon & Johnson, 1991) explored the impact of S&P 500 Index revisions on the bond and option markets, but there is little knowledge of the impact on the credit derivatives market. Our paper investigates the S&P 500 Index revisions inclusion effects in the CDS market.

As both equity and debt are contingent claims on a firm's assets (Merton, 1974), it is important to distinguish whether the significant reactions to the addition announcements stem from the new information of the S&P 500 Index inclusions or simply from the price integration between the CDS and equity markets. One implication from Merton (1974) is that in a frictionless world, there exists a no arbitrage price relationship between equity and CDS markets. However, empirical studies have documented the lack of relation sometimes found between equity and CDS markets. Past literature has suggested possible reasons. First, transaction costs matter, and the high bid-ask spreads in CDS markets prevent arbitrageurs from trading on less significant information (Hilscher, Pollet, & Wilson, 2015). Second, investor inattention in the CDS markets may slow down the integration process (Hilscher et al., 2015). Third, distressed firms with low credit quality are more sensitive obligors in the CDS markets (Fung et al., 2008). Fourth, regulation restrictions (e.g., short-sale ban) or limits of arbitrage lead to lack of integration between CDS and equity markets (Kapadia & Pu, 2012; Ni & Pan, 2011). Finally, the nature of the news has an impact (Marsh & Wagner, 2016), and the CDS market responds differently to various types of news.

Other researchers have explored the integration between the CDS and equity markets by looking at which market incorporates information more quickly, owning to the presence of informed traders in that market (Augustin, Subrahmanyam, Tang, & Wang, 2014). A few studies document that the CDS market leads the equity market and informed investors trade in the CDS market. For example, Acharya and Johnson (2007) find that the CDS market leads for distressed firms, and insiders take advantage of credit information to gain in the equity market. However, other studies find that the equity market leads the CDS market. For example, Marsh and Wagner (2016), Hilscher et al. (2015), Forte and Peña (2009), Norden and Weber (2009), among others, document that the equity market leads the CDS market and that the changes in CDS spreads cannot predict stock returns. In particular, Marsh and Wagner (2016) find that for positive shocks, the equity market leads the CDS market, but not necessarily for all information. Prior studies also explore the responses of both the CDS and equity markets surrounding particular events related to changes in credit quality. In particular, Norden and Weber (2004) find that both the equity and CDS markets respond similarly to credit rating changes. Based on the theory and past empirical evidence, it is necessary to differentiate the market integration effect from the S&P 500 Index inclusion effects in our empirical analysis.

3 | SAMPLE AND DESCRIPTIVE STATISTICS

3.1 | Sample construction

We analyze the abnormal changes in CDS spreads whose underlying reference firms were added into or removed from the S&P 500 Index between 2001 and 2014.[3] Panel A of Table 1 provides a breakdown of our sample collection process. The S&P 500 Index revision events are hand-collected from changes in the monthly lists of index constituents in Compustat (Baran & King, 2012) with 320 inclusions and 318 deletions. We then use the Lexis-Nexis news retrieval system to verify the announcement day as well as pertinent details of the index revisions. The sample excludes stocks in the following

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scenarios: (1) where an S&P 500 Index firm is acquired by a non-index firm which replaces it on the index (12 additions and 12 deletions), (2) where an index firm is acquired by another index firm (31 deletions), (3) where a firm is spun-off from an S&P 500 Index firm and added to the index (15 additions), (4) where a firm is spun-off from an index firm and replaces it on the index (8 additions and 8 deletions), and (5) two instances where S&P allowed for an additional class of stock from a current index firm to be included on the index.[4] This process leaves 283 additions and 267 deletions to merge with the Markit CDS database.

We collect information on CDS spreads, depth, and firm ratings from Markit, a leading provider of CDS data for price discovery and valuation. There are 995 U.S. firms in our CDS data from Markit in the period from 2001 to 2014. We use the 5-year CDS spreads as they are the most liquid among different maturities. The CDS spreads represent the premium that the insurance buyer pays to exchange for the residual value of the debt from the insurance protector in the event of default. We use the composite credit rating, which is the average rating of Fitch Ratings, Moody's Investors Service, and S&P's Rating Services, provided in Markit as our measure of credit rating. We obtain information on stock returns, number of shares outstanding, and share volume from the Center for Research in Security Prices (CRSP), and relevant firm-level financial data from the quarterly updated Compustat database.

Even though Markit has quite thorough coverage of the CDS market, not every firm has CDS contracts traded on them. After merging with the Markit database, we find that 140 addition firms and 106 deletion firms have no CDS trading over the entire period of 2001–2014. Of the 143 (161) addition (deletion) firms with some available CDS data in the 2001–2014

TABLE 1 Sample description and summary statistics

Panel A: Sample description		
	Addition firms	**Deletion firms**
Original numbers	320	318
Number of firms removed due to:		
S&P 500 Index firm acquired by a non-index firm and replaced by it	12	12
S&P 500 Index firm acquired by another index firm	0	31
Spin-off from an S&P 500 firm added to the index and original firm remains	15	0
Spin-off from an S&P 500 firm added to the index and original firm replaced	8	8
Additional class of stock included for trading	2	0
Remaining firms	283	267
Number of firms removed due to:		
No CDS trading in entire period (2001–2014)	140	106
CDS trading ended before AD	18	19
CDS trading started after AD	44	11
Invalid or missing data around event window	13	85
Final sample	68	46

Panel B: Summary statistics for 68 addition firms and 46 deletion firms										
	Addition					**Deletion**				
	Mean	**Std.**	**10th**	**Median**	**90th**	**Mean**	**Std.**	**10th**	**Median**	**90th**
CDS spread (bps)	118.21	114.67	30.34	90.77	233.03	331.15	328.32	69.56	206.57	765.23
Market cap. (billions)	10.81	11.81	4.45	7.52	16.92	5.34	6.75	1.06	2.26	12.22
Leverage	0.24	0.16	0.06	0.22	0.46	0.35	0.20	0.14	0.31	0.63
Return on assets (%)	1.35	1.50	0.31	1.12	2.98	−0.83	3.56	−4.70	−0.11	1.83
Market-to-book ratio	5.19	17.78	1.39	2.50	5.02	3.31	4.28	0.82	2.05	7.16

Notes: This table presents the process of selecting our sample firms in Panel A from S&P 500 Index revisions between 2001 and 2014. Panel B includes summary statistics for the 68 addition firms (46 deletion firms). CDS spread is the daily composite 5-year CDS spread in basis points. Market capitalization is calculated by the daily stock price times the number of outstanding shares. Leverage is equal to the ratio of book debt value to the sum of book debt value and market capitalization. Return on assets (ROA) is defined as net income divided by total assets. Market-to-book ratio is defined as the ratio of market value to book value of equity. We compute the statistics for these variables at the end of the previous quarter for each event.

period, 75 (115) addition (deletion) firms have CDS trading which ended before, started after, or had missing observations in the event window of [AD − 2, AD + 30]. Thus, our final sample contains 68 newly added firms and 46 firms that are dropped from the S&P 500 Index. Among the addition firms, 44 firms have investment grade ratings (ratings of BBB or above) and the remaining firms have speculative ratings (ratings that are below BBB) in the Markit database. There are no credit rating changes for any short-term windows up to 30 days after the announcements except in the instance that one firm is downgraded to a lower category. Although about half of the sample firms have credit rating changes from 2001 to 2014, the changes are usually in nearby rating categories, and there are no dramatic changes over three rating notches.

3.2 | Summary statistics

Panel B of Table 1 presents the summary statistics for 68 addition firms and 46 deletion firms. We compute the summary statistics across all the observations at the end of the previous quarter before the announcements. The CDS spread is the daily composite 5-year CDS spread in basis points (bps). Market capitalization is calculated as the daily stock price times the number of outstanding shares. Leverage is equal to the ratio of book value of debt to the sum of book value of debt and market capitalization. The book value of debt is computed as the sum of long-term debt and debt in current liabilities. Return on assets (ROA) is defined as net income divided by total assets. Market-to-book ratio is defined as the ratio of market value to book value of equity.

We notice major differences between addition and deletion firms in terms of their average size: the market capitalizations are \$10.81 and \$5.34 billion. The profitability and valuation ratios are higher for the addition firms, with an average ROA of 1.35% for newly included firms, compared with −0.83% for the deletion firms. The leverage in the addition firms is much lower than that in the removed firms, which is in line with the lower CDS spread for the addition firms (118.21 bps) compared with that of the deletion firms (331.15 bps).

4 | EMPIRICAL DESIGN AND RESULTS

In the following analysis, we explore the response of the CDS spreads to the announcement of an S&P 500 Index revision. We then assess how the timing of announcements and credit quality influence such response. Furthermore, we employ the structural model to examine whether there is new information in these events relevant to the credit market beyond the market integration between the equity and credit markets.

4.1 | CDS spread changes and equity returns in sample firms

We examine the impact of index revision announcements on CDS spreads for the addition and deletion firms separately, as the asymmetric price reaction in the equity market to S&P 500 Index reconstitutions is well documented (Chen et al., 2004). We use the cross-sectional CDS spread average from all the CDS contracts available from Markit as the benchmark index to calculate market-adjusted abnormal CDS spread changes. For an event firm, the abnormal percentage change reported in Panel A of Table 2 is computed as the difference between the firm's CDS spread percentage change $((CDS_{it} - CDS_{it-1})/CDS_{it-1})$ and the market CDS spread percentage change, that is, the average percentage change of all available CDS spreads in our CDS Markit sample, computed as $((CDS_{mt} - CDS_{mt-1})/CDS_{mt-1})$ where $CDS_{mt} = \frac{\sum_{j=1}^{N} CDS_{jt}}{N}$. The percentage change measure is consistent with Acharya and Johnson (2007), Callen, Livnat, and Segal (2009), and Batta, Qiu, and Yu (2016) and comparable among firms with different credit spread levels. We compute a cumulative change over each event window [AD − 2, AD + n], where n spans from 2 to 30, by adding the daily spread changes. We report the mean and median of the cumulative abnormal changes and apply cross-sectional t-tests and Wilcoxon signed-rank tests to investigate whether the cumulative abnormal CDS spread changes are significantly different from zero. The signed-rank test is nonparametric and serves as additional robustness check which does not require the data to be normally distributed. To gauge the reaction in the stock market, we compute cumulative abnormal returns using a market-adjusted model for the same windows as the CDS spread changes.

For the addition sample, we find significant reductions in abnormal CDS spreads upon index inclusion. The CDS spreads react strongly to the inclusion event in the short windows around the announcement date. For example, in the window [AD − 2, AD + 3], we observe significant cumulative abnormal change of −1.23%. The stock cumulative abnormal

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TABLE 2 CDS cumulative abnormal spread changes for event firms

Windows	Statistics	Addition firms	Deletion firms
Panel A: CDS abnormal spread changes			
[AD − 2, AD + 2]	Mean	−1.16%**	1.13%
	t-value	(−2.09)	(0.65)
	Median	−1.29%***	−0.01%
	Sign rank *p*-value	.0045	.6946
[AD − 2, AD + 3]	Mean	−1.23%**	0.98%
	t-value	(−2.06)	(0.53)
	Median	−1.48%***	−0.20%
	Sign rank *p*-value	.0034	.8424
[AD − 2, AD + 10]	Mean	−3.14%***	−0.66%
	t-value	(−3.12)	(−0.27)
	Median	−2.03%***	−0.52%
	Sign rank *p*-value	.0039	.5076
[AD − 2, AD + 30]	Mean	−5.38%***	−0.25%
	t-value	(−2.82)	(−0.07)
	Median	−5.48%***	−2.10%
	Sign rank *p*-value	.0014	.7187
N		68	46
Panel B: Stock cumulative abnormal returns			
[AD − 2, AD + 2]	Mean	2.63%***	−5.98%
	t-value	(5.27)	(−1.57)
	Median	2.88%***	−2.03%*
	Sign rank *p*-value	<.0001	.0755
[AD − 2, AD + 3]	Mean	2.25%***	−4.95%*
	t-value	(3.97)	(−1.78)
	Median	2.26%***	−1.95%*
	Sign rank *p*-value	<.0001	.0744
[AD − 2, AD + 10]	Mean	2.52%***	−3.02%
	t-value	(3.56)	(−1.37)
	Median	1.91%***	−1.34%
	Sign rank *p*-value	.0004	.2868
[AD − 2, AD + 30]	Mean	1.64%	−2.55%
	t-value	(1.36)	(−0.76)
	Median	3.05%**	−0.01%
	Sign rank *p*-value	.0272	.4669
N		68	46

Notes: Panel A of the table presents mean of market-adjusted cumulative abnormal changes of the CDS spreads in various windows around the announcement day (AD) with *t*-values in the first two rows. The median and the Wilcoxon sign rank test are reported in the last two rows. Our measure of CDS market response to the index revisions is the cumulative abnormal spread change where we measure the average spread change for all firms in the CDS dataset and subtract it from the sample firm spread change. We then sum the abnormal spread change for each window. Panel B of the table reports the mean and median of market-adjusted cumulative abnormal stock returns and the associated *t*-values. We compute the stock CARs from the market-adjusted models, which uses abnormal returns defined in excess of CRSP value-weighted market returns (assumes market beta of 1). *, **, and *** represent the statistical significance at the 10%, 5%, and 1% levels, respectively.

returns[5] presented in Panel B for newly added firms are significantly positive except for the mean value in the [−2, +30] window, but appear smaller in magnitude than much previous literature using earlier sample periods. This is consistent with Schnitzler (2017) who finds that the long-lasting benefits of S&P 500 Index inclusion decline in the more recent period.

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We do not find significant reactions in the CDS market upon announcement of the firms' deletion from the S&P 500 Index in all event windows. This finding is contrary to those in the equity market, which document a stock price decline immediately after the removal announcement but then a reversal after 60 days (e.g., Chen et al., 2004). We find in Panel B of Table 2 that the stock CARs for deletions are only significantly negative in the two shortest windows around the announcement date. As the CDS market captures the downside risk, CDS market participants may possess similar information on the reference entity firm that is deleted from the S&P 500 Index. Thus, unlike its price effect in the equity market, removal from the S&P 500 Index has little impact on the CDS market. Because of the insignificant effect of deletion news on CDS spreads and confounding deletion reasons, we focus on addition announcements in our subsequent analysis.

4.2 | Comparison of addition firms and matching sample

We next construct a matching sample by industry and pre-inclusion CDS spread and compare the difference in abnormal CDS spread change between event firms and matching peers. We identify potential matching firms for each inclusion announcement if they have valid CDS data and the firm was not added to or removed from the S&P 500 Index from 3 years before to 3 years after the inclusion announcement date. From this pool of possible matching firms, we identify all firms in the same four-digit SIC codes of the event firm and resort to three-digit SIC codes if there is no match based on four-digit SIC codes. Then, we identify the industry-matched control firm with the closest pre-inclusion CDS spread to the event firm to find firms with similar credit risk. As not every traded firm has CDS data and some industries have no valid firms in the universe of possible matching firms around the event date, we find matching firms for 64 event firms. We compare the firm characteristics (size, leverage, ROA, and market-to-book ratio) of the matching firms and the event firms at the end of the previous quarter before the announcement dates, and our matching sample mimics the characteristics of the event firms quite well.[6] The abnormal CDS spread changes of the event firms, the matched peers, and we present the differences between the two groups in Table 3 Panel A. We find that only event firms have a significantly negative abnormal CDS spread change while their close matches do not respond to the addition announcements in all event windows. Similarly, in Panel B, we test the stock market response of both the inclusion and matching firms and find inclusion firms have significant stock CARs in the first three windows, whereas matching firms have no significant reactions.

4.3 | CDS spread changes in subsamples

We next explore whether timing and credit quality influence the response of the CDS market to S&P 500 Index addition announcements. CDS spreads mainly reflect firms' default risk, which is affected by both firm characteristics and market conditions (Tang and Yan, 2010). Correspondingly, CDS spreads are higher during crisis than non-crisis period and for weaker firms as mentioned by Augustin et al. (2014). Furthermore, Finnerty, Miller, and Chen (2013) find that CDS market responses are different for investment and speculative grade firms to credit ratings changes and that the impact is different for varying economic conditions. Therefore, we expect differential responses in the CDS market to addition into the S&P 500 Index under varying market conditions and for firms with different characteristics, especially credit ratings. Because S&P 500 Index inclusion is regarded as favorable news which could be amplified during distressed times and for weak firms,[7] we expect to observe a more pronounced effect of S&P 500 Index additions on the CDS market during the crisis period and for low-rated firms. Table 4 Panel A reports the abnormal CDS changes in the crisis and non-crisis periods with the financial crisis period being defined as the period between October 2007 and December 2009. We find that the mean and median cumulative abnormal CDS spread changes are significant in all the event windows for additions during the financial crisis, but additions during the non-crisis period have smaller CDS spreads declines that show mixed statistical significance between the mean and median values. We conduct the *t*-tests to compare the cumulative abnormal CDS spread changes between the two subsamples and the difference is only statistically significant in one event window AD[−2, +30]. For the stock returns in Panel B, however, the significant equity returns occur during the non-crisis periods. The stock CARs, while sometimes larger in magnitude than the non-crisis period, are largely insignificant in the crisis period. Similarly, there is no significant difference across two subsamples. We also create subsamples based on credit rating to compare investment grade and speculative grade firms. Similarly, for speculative grade firms, we observe larger CDS spread declines with more statistical significance for both the mean and median values when compared with investment grade firms. The exception is during the shortest window of [AD − 2, AD + 2] where the mean values for both rating subgroups are insignificant. The magnitudes of stock returns for the speculative grade firms are, in general, larger than those of investment grade firms. However, the differences across two subsamples based on crisis and credit rating are not statistically significant.

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TABLE 3 CDS cumulative abnormal spread changes in the matching sample

Windows	Statistics	Event (1)	Matching (2)	Difference (1) − (2)
Panel A: CDS abnormal spread changes				
[AD − 2, AD + 2]	Mean	−1.16%*	5.38%	−6.54%*
	t-value	(−1.96)	(1.58)	(−1.88)
	Median	−1.41%***	0.45%	−1.24%**
	Sign rank *p*-value	.0088	.2732	.0264
[AD − 2, AD + 3]	Mean	−1.23%*	5.46%	−6.69%*
	t-value	(−1.95)	(1.60)	(−1.93)
	Median	−1.67%***	0.66%	−0.77%**
	Sign rank *p*-value	.0062	.2137	.0129
[AD − 2, AD + 10]	Mean	−3.26%***	6.65%	−9.91%*
	t-value	(−3.06)	(1.23)	(−1.83)
	Median	−2.10%***	0.54%	−1.59%*
	Sign rank *p*-value	.0047	.9315	.0773
[AD − 2, AD + 30]	Mean	−5.72%***	1.74%	−7.46%
	t-value	(−2.87)	(0.24)	(−1.00)
	Median	−5.70%***	−6.94%***	0.08%
	Sign rank *p*-value	.0013	.0043	.8170
N		64	64	64
Panel B: Stock cumulative abnormal returns				
[AD − 2, AD + 2]	Mean	2.70%***	−0.17%	2.98%***
	t-value	(5.29)	(−0.38)	(4.90)
	Median	2.99%***	0.15%	3.04%***
	Sign rank *p*-value	<.0001	.9138	<.0001
[AD − 2, AD + 3]	Mean	2.33%***	−0.19%	2.65%***
	t-value	(3.98)	(−0.35)	(3.82)
	Median	2.59%***	−0.07%	2.38%***
	Sign rank *p*-value	<.0001	.8233	<.0001
[AD − 2, AD + 10]	Mean	2.34%***	0.15%	2.22%*
	t-value	(3.20)	(0.18)	(1.96)
	Median	1.78%***	1.00%	1.58%**
	Sign rank *p*-value	.0013	.9838	.0222
[AD − 2, AD + 30]	Mean	1.59%	0.47%	1.12%
	t-value	(1.26)	(0.44)	(0.79)
	Median	3.43%**	0.05%	1.31%
	Sign rank *p*-value	0.0347	0.5023	0.2029
N		64	64	64

Notes: Panel A of this table presents cumulative abnormal CDS spread changes in the windows around the announcement day (AD) for both the newly added firms to the S&P 500 Index and a matching sample. For each sample firm, we choose a matching firm with the same 4-digit SIC code that had the closest CDS spread in the quarter before index inclusion. For those firms without any 4-digit SIC code matches, we allow for matches at the 3-digit SIC code level. We find matching for 64 firms. This table presents the cumulative abnormal CDS spread percentage changes for the event and matching sample. For each window around the AD, we present the mean, *t*-statistic, median, and the *p*-values from the Wilcoxon sign rank test, respectively. In the difference column, *, **, and *** represent the statistical significance between the group mean and median values at the 10%, 5%, and 1% levels, respectively. Panel B presents the results for the stock CARs in a similar format.

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TABLE 4 CDS cumulative abnormal spread changes in subsamples

Windows	Statistics	Crisis (1)	Non-crisis (2)	Difference (1) − (2)	Investment grade (3)	Speculative grade (4)	Difference (3) − (4)
Panel A: CDS abnormal spread changes							
[AD − 2, AD + 2]	Mean	−3.02%**	−0.72%	−2.30%	−1.23%	−1.04%	−0.19%
	t-value	(−2.78)	(−1.15)	(1.65)	(−1.61)	(−1.42)	(0.16)
	Median	−2.33%***	−1.06%*		−1.56%**	−1.29%	
	Sign rank *p*-value	.0061	.0599		.0256	.1180	
[AD − 2, AD + 3]	Mean	−2.96%*	−0.82%	−2.15%	−1.05%	−1.55%**	0.50%
	t-value	(−1.92)	(−1.28)	(1.43)	(−1.25)	(−2.19)	(0.39)
	Median	−3.25%**	−1.04%**		−0.92%*	−2.15%***	
	Sign rank *p*-value	.0327	.0406		.0663	.0087	
[AD − 2, AD + 10]	Mean	−5.62%**	−2.55%**	−3.07%	−2.55%**	−4.21%*	1.65%
	t-value	(−2.56)	(−2.27)	(1.20)	(−2.50)	(−1.94)	(0.78)
	Median	−2.83%**	−1.40%**		−1.83%**	−2.03%*	
	Sign rank *p*-value	.0215	.0389		.0232	.0757	
[AD − 2, AD + 30]	Mean	−15.42%***	−3.01%	−12.41%***	−4.83%*	−6.39%**	1.59%
	t-value	(−3.62)	(−1.49)	(2.68)	(−1.81)	(−2.71)	(0.39)
	Median	−11.11%***	−2.97%**		−4.27%**	−6.07%**	
	Sign rank *p*-value	.0034	.0470		.0362	.0142	
N		13	55		44	24	
Panel B: Stock cumulative abnormal returns							
[AD − 2, AD + 2]	Mean	3.32%*	2.46%***	0.86%	2.26%***	3.31%***	−1.05%
	t-value	(1.95)	(5.19)	(0.68)	(3.82)	(3.65)	(−1.01)
	Median	3.50%	2.76%***		2.84%***	2.88%**	
	Sign rank *p*-value	.1272	<.0001		.0005	.0011	
[AD − 2, AD + 3]	Mean	2.44%	2.20%***	0.24%	1.92%**	2.84%***	−0.92%
	t-value	(1.17)	(4.29)	(0.16)	(2.62)	(3.21)	(−0.77)
	Median	4.55%	2.24%***		2.20%***	3.00%***	
	Sign rank *p*-value	.2734	<.0001		.0046	.0036	
[AD − 2, AD + 10]	Mean	1.34%	2.80%***	−1.47%	2.36%**	2.81%***	−0.45%
	t-value	(0.67)	(3.76)	(−0.81)	(2.46)	(2.83)	(−0.30)
	Median	2.06%	1.88%***		1.64%**	2.45%***	
	Sign rank *p*-value	.2734	.0008		.0134	.0096	
[AD − 2, AD + 30]	Mean	−1.76%	2.45%**	−4.21%	2.47%	0.12%	2.35%
	t-value	(−0.42)	(2.19)	(−1.38)	(1.51)	(0.08)	(0.93)
	Median	2.74%	3.14%***		4.33%**	1.47%	
	Sign rank *p*-value	1.0000	.0091		.0139	.8464	
N		13	55		44	24	

Notes: Panel A of this table reports the addition firms' market-adjusted cumulative abnormal changes of CDS spreads during crisis and non-crisis periods. Index inclusions from October 2007 to December 2009 are in the crisis group. Among the 68 addition firms, we have 13 events during the crisis period and 55 during the non-crisis period. This table also reports the addition firms' market-adjusted cumulative abnormal changes of CDS spreads for investment grade and speculative grade firms. Among the 68 addition firms, there are 44 investment grade and 24 speculative grade addition firms. For each window around the AD, we present the mean, *t*-statistic, median, and the *p*-values from the Wilcoxon sign rank test, respectively. Panel B presents the results for stock CARs in subsamples. *, **, and *** represent the statistical significance of the mean and median values at the 10%, 5%, and 1% levels, respectively.

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The significant CDS abnormal spread changes during the crisis period and for speculative grade firms are similar to the abnormal price movements in the bond and option markets documented by Dhillon and Johnson (1991). The *certification hypothesis* in previous studies purports that S&P conveys positive information about newly added firms in their selection process, which may include improved operating performance, superior monitoring, or access to capital markets. These improvements may lead to lower default risk captured by the CDS market. Thus, our evidence to date may support the *certification hypothesis* in the crisis period and for lower rated firms that S&P 500 Index inclusion conveys more favorable information for these subgroups.

4.4 | Evidence from the structural model

As the structural model of credit risk implies a price discovery process between the equity and credit markets, the presence of capital structure arbitrageurs may lead to the significance of abnormal CDS spread changes observed in previous sections. Thus, we develop a new test to disentangle the *certification hypothesis* and the price transmission effect between the two markets. We first follow the method in Hull, Nelken, and White (2005) to estimate the credit spreads in the Merton (1974) framework for all the firms in the Markit CDS data. Let E_t be firm equity value, B_t be market price of debt, A_t be firm value at time t and B be debt face value. Then, we have $E_t + B_t = A_t$. Because the equity can be regarded as a call option on the underlying firm asset value and the strike price is the debt face value at time T, we have: $E_T = \max[A_T - B, 0]$. We then solve the equity value in the Black and Scholes (1973) model as:

$$E_t = A_t N(d_1) - B \times e^{-r(T-t)} N(d_2) \tag{1}$$

where $d_1 = \frac{\ln\left(\frac{A_t \times e^{r(T-t)}}{B}\right)}{\sigma_A} + \frac{1}{2}\sigma_A\sqrt{(T-t)}$ and $d_2 = d_1 - \sigma_A\sqrt{(T-t)}$. If we define the leverage L as $\frac{B \times e^{-r(T-t)}}{A_t}$, where $B \times e^{-r(T-t)}$ is the present value of the debt face value at time t, we have:

$$E_t = A_t[N(d_1) - LN(d_2)] \tag{2}$$

and

$$B_t = A_t[N(-d_1) + LN(d_2)]. \tag{3}$$

The implied yield to maturity (y) can be defined as

$$B_t = B \times e^{-y(T-t)} = B \times e^{-r(T-t)} \times e^{(r-y)(T-t)}. \tag{4}$$

Substituting Equation (4) into (3) and using $L = \frac{B \times e^{-r(T-t)}}{A_t}$, we can derive the yield to maturity as

$$y = r - \ln[N(d_2) + \frac{N(-d_1)}{L}]/(T-t) \tag{5}$$

and the credit spread (c) would be

$$c = y - r = -\ln[N(d_2) + \frac{N(-d_1)}{L}]/(T-t). \tag{6}$$

We use firm debt value (debt in current liabilities + 0.5 × long term debt) as B, compute asset volatility σ_A from the KMV-Merton model following Bharath and Shumway (2008).[8] Using Equation (6), we get the predicted credit spreads and compute the difference between the actual and predicted CDS spreads for each firm-month. We use linear interpolation to obtain the daily predicted CDS spreads. Then, we compute the cumulative abnormal percentage changes in the differences between actual and predicted CDS spreads for the event firms compared with all available firms in the CDS Markit sample. As the Merton (1974) model values the equity and debt in the same framework, the differences between actual and predicted spreads contain the portion that may not be explained by the price discovery process from the equity market. Thus, our measure can capture the additional information identified in the CDS market beyond that from price integration between the two markets.

Table 5 shows that the full sample of addition firms does not show significant changes in the abnormal differences between actual and predicted credit spreads, which indicates that the results we found in Table 2 are mainly due to the integration between the stock and CDS markets. The CDS market is unchanged by any unique information from the inclusion not picked up in the stock market in the full sample. Similarly, in both subsamples by debt rating as well as for the events during the non-crisis period, we find insignificant cumulative abnormal percentage changes in the actual and predicted spread differences. However, for the events during the crisis period, we find significant declines in CDS spreads for many of our event windows even after adjusting for market integration. Taken together, this evidence suggests that S&P 500 Index addition only conveys unique information not picked up in the equity response during the financial crisis. For all other subgroups, the CDS market response is mainly driven by market integration. During the financial crisis, all firms

TABLE 5 CDS cumulative abnormal spread changes in the structural model

Windows	Statistics	Whole	Crisis	Non-crisis	Investment grade	Speculative grade
[AD − 2, AD + 2]	Mean	−1.16%	−3.17%*	−0.69%	−1.83%	0.06%
	t-value	(−0.77)	(−2.18)	(−0.38)	(−1.11)	(0.02)
	Median	−1.01%	−1.41%*	−0.69%	−1.01%	−1.09%
	Sign rank *p*-value	.3081	.0942	.5964	.2525	.8464
[AD − 2, AD + 3]	Mean	−1.08%	−3.16%	−0.59%	−1.68%	0.01%
	t-value	(−0.61)	(−1.55)	(−0.28)	(−0.85)	(0.00)
	Median	−1.68%	−2.25%**	−0.27%	−1.74%	−0.40%
	Sign rank *p*-value	.3259	.0398	.6255	.2776	.8464
[AD − 2, AD + 10]	Mean	−0.89%	−3.96%	−0.17%	−0.68%	−1.29%
	t-value	(−0.27)	(−1.14)	(−0.04)	(−0.19)	(−0.21)
	Median	−5.06%	−5.17%	−4.95%	−4.19%	−8.30%
	Sign rank *p*-value	.3929	.2439	.6373	.6214	.5411
[AD − 2, AD + 30]	Mean	2.60%	−17.15%	7.27%	3.55%	0.88%
	t-value	(0.43)	(−1.56)	(1.05)	(0.46)	(0.09)
	Median	−9.15%	−12.15%*	−0.91%	−3.97%	−15.83%
	Sign rank *p*-value	.8372	.0803	.6314	.9087	.8681
N		68	13	55	44	24

Notes: The table presents mean of market-adjusted cumulative abnormal changes of the differences between actual CDS and predicted spreads in various windows around the announcement day (AD) with *t*-values in the first two rows. The median and the Wilcoxon sign rank test are also reported. We estimate the credit spreads following Hull et al. (2005) and compute the difference between actual and predicted credit spreads. We then compute the abnormal changes in the differences where we measure the average changes in differences for all firms in the CDS dataset and subtract it from the sample firm's changes in differences. We then sum the abnormal changes in differences between actual and predicted spreads for each window. *, **, and *** represent the statistical significance at the 10%, 5%, and 1% levels, respectively.

TABLE 6 CDS market depth changes around S&P 500 Index inclusions

Period		Difference (After) − (Before)			Correlation			
		Whole sample	Crisis	Non-crisis		Whole sample	Crisis	Non-crisis
45 days	Mean	0.0779	0.3278	0.0166	Correlation	0.2060	0.3341	0.2106
	Median	0.1588	0.1735	0.1488	*p*-value	.0971	.2645	.1302
15 days	Mean	−0.4494**	−0.8469*	−0.3554	Correlation	0.0570	0.0649	0.0265
	Median	−0.0509	−0.7469	0.0508	*p*-value	.6446	.8331	.8477
10 days	Mean	0.0657	0.2157	0.0303	Correlation	0.0123	−0.0089	0.0306
	Median	0.0617	0.1905	0.0346	*p*-value	.9207	.9769	.8246
5 days	Mean	−0.0085	−0.3534	0.0730	Correlation	0.0216	0.4738	−0.1296
	Median	−0.0078	0.0997	−0.0335	*p*-value	.8609	.1019	.3457

Notes: This table presents the changes in CDS liquidity around inclusions between 2001 and 2014. This table includes CDS liquidity measured by the average daily market depth in a period of 45, 15, 10, or 5 days before and after index inclusion. For each period, we present the mean and median values of the difference in liquidity. For the mean and median liquidity differences, we test for statistical significance of the difference for the whole sample as well as for events in the financial crisis period separately from those in the non-crisis period. In addition, in each event window, we compute the correlation between the mean liquidity difference and the cumulative abnormal CDS spread changes in the window of [AD − 2, AD + 15] and include the *p*-value of the correlation beneath. *, **, and *** represent the statistical significance of the correlation and liquidity differences at 10%, 5%, and 1% levels, respectively.

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experienced increased default risk, and thus the certification from S&P during this period may indicate that the newly added firms are less sensitive to this market-wide increase in default risk because one criterion for S&P 500 Index inclusion is financial viability.[9] However, the number of the addition events in the crisis is limited, so we need to interpret our results cautiously.

4.5 | Tests for liquidity hypothesis

One of the existing hypotheses that supports new information in S&P 500 Index reconstitution announcements is the *liquidity* hypothesis. This hypothesis states that improvements in stock liquidity following index additions lead to sustained price increases in the equity market. Thus, one possible reason for the reduction of abnormal CDS spread changes is liquidity improvement of the event firm's CDS contracts, as the addition to a major stock index may reduce information asymmetry and lead to the decrease of credit risk (Bongaerts et al., 2011; Tang & Yan, 2014). Many studies also document lower bid-ask spreads in equity prices that are due to index additions, such as Beneish and Gardner (1995) and Hegde and McDermott (2003).

To explore this possibility, we investigate the liquidity changes in the CDS market around S&P 500 Index addition announcements in Table 6. We use market depth to measure CDS liquidity. Market depth measures the number of the contributors for the price quote on each day, and it is widely used in CDS studies (Kapadia & Pu, 2012; Loon & Zhong,

TABLE 7 Multivariate regression results

	(1) [AD − 2, AD + 2]	(2) [AD − 2, AD + 3]	(3) [AD − 2, AD + 10]	(4) [AD − 2, AD + 30]
Intercept	−0.0026	−0.0299	−0.0069	−0.0045
	(−0.05)	(−0.33)	(−0.05)	(−0.02)
Stock CAR	−0.4679	−0.6101	−1.1206	−0.9655
	(−0.87)	(−0.74)	(−0.90)	(−0.41)
Stock CAR × Credit rating dummy	−0.7539	−0.7957	−0.4352	−0.1242
	(−1.13)	(−0.77)	(−0.28)	(−0.04)
Stock CAR × Crisis dummy	1.2994	1.6414	1.3111	−3.6628
	(1.30)	(1.07)	(0.56)	(−0.84)
Credit rating dummy	0.0182	0.0014	−0.0202	−0.1083
	(0.48)	(0.02)	(−0.23)	(−0.66)
Crisis dummy	−0.0294	−0.0187	0.0008	0.3062
	(−0.57)	(−0.23)	(0.01)	(1.35)
M/B ratio	−0.0020**	−0.0028**	−0.0034*	−0.0054
	(−2.35)	(−2.16)	(−1.73)	(−1.46)
Size	0.0248*	0.0376*	0.0464	0.0097
	(1.85)	(1.82)	(1.49)	(0.17)
ROA	−0.5743	−0.3441	−0.6542	−2.6908
	(−0.51)	(−0.20)	(−0.25)	(−0.54)
Leverage	−0.0287	−0.0255	−0.0606	−0.1947
	(−0.29)	(−0.17)	(−0.26)	(−0.45)
Depth	0.0065	0.0169	0.0090	0.0550
	(0.27)	(0.46)	(0.16)	(0.52)
N	67	67	67	67
Adj. R^2	11.0%	5.40%	−1.70%	−3.90%

Notes: In this table, the dependent variable is the cumulative abnormal CDS spread changes in the differences between actual and predicted spreads from Merton (1974) model in various windows. Stock CARs are estimated in the event window [AD − 2, AD + 2]. Size is the log of the market capitalization. Leverage is equal to the ratio of book debt value to the sum of book debt value and market capitalization. Return on assets (ROA) is defined as net income divided by total assets. Market-to-book ratio is defined as the ratio of market value to book value of equity. Depth is the logarithm of market depth at event day.

2014). A larger depth suggests higher level of CDS market liquidity. Table 6 presents the addition effect on CDS market liquidity and the correlation between depth in each window with the CDS cumulative abnormal spread changes in [AD − 2, AD + 15] to see if changes in liquidity are related to the declines in CDS spreads. We compare the liquidity changes in windows of 45, 15, 10, and 5 days before and after the S&P 500 Index revision announcement. Across all the windows around the announcement date, the average market depth is stable, with about five to six contributors for each price quote. We do not observe substantial improvement of the credit market liquidity before or after the addition, and the *t*-statistics are insignificant in most windows. Only the difference between 15 days before and after the announcement date is negatively significant, which suggests deteriorating liquidity. The correlations between CDS cumulative abnormal spread changes and depth are also insignificant. In summary, our results suggest that CDS liquidity improvement is not the main driver for the declines in CDS spreads for inclusion firms.

4.6 | Evidence from multivariate regressions

As we find that only index inclusions during the financial crisis period convey unique information to the CDS market, we also explore the relationship between the equity and CDS market responses in multivariate regressions of the determinants of the CDS spread changes. In Table 7, the dependent variables are the cumulative abnormal changes in the differences between the actual and predicted spreads from the structural model. We include stock CARs, firm size, leverage, ROA, market-to-book ratio, CDS market depth, investment grade dummy, crisis dummy, and the interaction of the stock CARs with the dummies. The crisis dummy is not significant in all four event windows. The stock CAR interaction with the crisis dummy is not statistically significant. The results suggest that S&P 500 Index inclusion does not convey unique information to the CDS market after excluding the market integration effect between the equity and CDS markets. The stock CAR is not significantly related to the CDS spread.[10] Among the firm characteristics, only firm size and book-to-market ratio are significant predictors over several windows. We further investigate whether equity or credit liquidity improvements may affect the CDS market response and find no relation between liquidity improvement and CDS spread declines in the multivariate regressions.[11] We also use the stock CARs in various windows as the dependent variable and find very little relationship between any of the control variables and the stock market response.[12]

5 | CONCLUSION

Our study provides a comprehensive analysis of the CDS market reaction to S&P 500 Index reconstitutions announcements and explores the mechanisms for the observed effects. We also use the structural model of credit risk to distinguish the market integration effect between equity and credit markets and the S&P 500 Index information effect. During the period from 2001 to 2014, we find that the CDS market reacts significantly to the addition announcements in short-term windows, especially during the financial crisis and for speculative grade firms. For the addition events, the stock market response is positive in the overall sample and more pronounced for the speculative grade firms compared with investment grade. Deletion from the index has little impact on the CDS market, and we only find significantly negative reactions in the stock market for the short windows. Upon controlling for the effect of market integration, however, we only find significant declines for S&P 500 Index inclusions during the financial crisis. There is only limited evidence from the CDS market that supports the *certification hypothesis* during the financial crisis. Our findings, thus, suggest that the S&P 500 Index addition events largely convey no unique information to the CDS market beyond the effect of market integration. In addition, liquidity changes in the CDS market are insignificant and cannot explain the abnormal CDS spread declines.

In summary, our paper is the first study that examines S&P 500 Index revisions in connection with CDS spreads. Even though our results are inconclusive with respect to the specific mechanism of the S&P 500 Index revision effect, we provide some answers to an interesting question. First, we show that announcements of S&P 500 Index addition and deletion have differential effects on the CDS market and only the former is influential. Second, we show that equity and CDS markets react differently to the same S&P 500 Index revision announcement in and out of crisis periods. This tells managers what to expect from the equity and credit market, respectively, when the firm gets a major index revision. This also tells managers that the equity market and credit market could react quite differently in and out of crisis periods.

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ENDNOTES

[1] See Scholes (1972), Shleifer (1986), Beneish and Gardner (1995), Lynch and Mendenhall (1997), Denis, McConnell, Ovtchinnikov, and Yu (2003), Chen, Noronha, and Singal (2004), and Hegde and McDermott (2003) Becker-Blease and Paul (2006), Cai (2007), among others.

[2] A more detailed description of the literature about these hypotheses can be found in Kappou, Brooks, and Ward (2008) and Baran and King (2012).

[3] We began in 2001 because of the availability of CDS data in Markit and did not find any events with valid CDS data around announcement dates in 2015.

[4] The first time this occurred was April 2014 when S&P allowed the second class of Google stock to be part of the index. Thus, there were 501 stocks representing 500 companies.

[5] We compute the stock CARs from the market-adjusted models, which uses abnormal returns defined in excess of CRSP value-weighted market returns (assumes market beta of 1).

[6] The summary statistics of the matching sample are available on request.

[7] Previous studies find that CDS market responses are larger for distressed economic conditions and for lower rated firms. Finnerty et al. (2013) find CDS market reaction to credit rating upgrades (but not downgrades) are more pronounced during economic recessions. They find a larger impact for lower credit ratings in their regression analysis of CDS response to rating upgrades. More generally, there are asymmetric responses to positive and negative price information in goods markets (Bacon, 1991) and financial markets (Green, Li, and Schurhoff, 2010). Recently, Marsh and Wagner (2016) find that price discovery in equity markets only leads CDS markets following positive news and tend not to do so following other news.

[8] The definitions of model parameters are listed in the Appendix.

[9] https://us.spindices.com/documents/methodologies/methodology-sp-us-indices.pdf

[10] We confirm this finding by looking at the correlation between the stock CARs and CDS spread changes. The correlations between actual CDS spread changes and stock CARs are insignificant in the windows [AD − 2, AD + 2] and [AD − 2, AD + 3], and they are only significant in longer windows. After removing the market integration effect, none of the correlations between CDS abnormal changes and stock CARs are statistically significant in the windows around AD. Results are available on request.

[11] The regression results with equity illiquidity measure (Amihud, 2002 measure) are available on request.

[12] Results are available on request.

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APPENDIX A

PARAMETERS USED IN THE MODEL ESTIMATION IN SECTION 4.4

This appendix lists the definition of parameters used in the model estimation in Section 4.4.

Variables	Definition
B	Face value of debt in millions of dollars measured as quarterly debt in current liabilities (item 45) + 0.5 × long-term debt (item 51)
	We assign the same value for each month in the same quarter
E	Market value of equity in millions of dollars measured as the product of share price at the end of the month and the number of shares outstanding
r	Risk-free rate measured as the monthly three-month Treasury-bill rate
	The following variables are generated as the result of solving the KMV-Merton model using the iterative procedure described in Bharath and Shumway (2008) for each firm-month
A	Market value of firm assets in millions of dollars
σ_A	Asset volatility in percentage per annum
L	Leverage measured as the ratio between discounted debt face value to firm asset value
c	Credit spread computed from Equation (5)
$T - t$	The maturity is defined as 5 years, since the actual CDS spreads in the sample have 5-year maturity

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