Leveraged Buyouts and Credit Spreads

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Abstract

What is the impact of LBO restructuring risk on corporate credit spreads? We show that LBO risk increases credit spreads significantly by showing that a) intra-industry credit spreads increase upon an LBO announcement, b) yields on bonds without event risk covenants are, on average, 21bps higher than those on same-firm bonds with such covenants and c) structural models calibrated to historical LBO events imply an impact on 10-year credit spreads of 18-21bps. We also show that the impact is strongest in expansion periods and for bonds with maturities of 10-20 years.

Keywords: Credit Spreads, LBO risk, Structural Models, Leveraged Buyouts;

JEL: G12, G34

1 Introduction

The last decade has seen unprecedented waves of leverage buyout (LBO) activity, identified by rating agencies as "a primary force behind the global rise in credit risk and the decline in credit quality".[1] In 2013, The Federal Reserve provided new debt guidelines in response to the concern that "while leveraged lending declined during the crisis, volumes have since increased and prudent underwriting practices have deteriorated".[2] In late 2015 Standard & Poors issued a warning regarding excessive leverage in the buyout market, while the Financial Times reported that "credit risks are rising to the fore as private equity groups seek to put a near-record $540bn cash pile to work, pushing leverage back to levels not seen since the boom of 2007".[3] Recent history, thus, clearly shows that although buyouts ebb and flow with the business cycle, LBO activity is a mounting concern for debt investors and regulators.

A leveraged buyout is an acquisition of a company using a significant amount of borrowed funds. It involves substitution of equity for debt and, typically, elimination of publicly-held stock. The borrowed funds are issued against the assets of the target firm and are repaid with cash flows generated by the company or with revenue earned by selling off the newly acquired company's assets. The post-LBO firm frequently has high leverage, and as a result, LBOs typically cause a dramatic change in the risk profile of the target firm.

The relationship between LBO risk and credit spreads is theoretically ambiguous. On one hand, as we show, credit spreads increase around LBO announcements – due to the increase in financial leverage – and bond investors should take this risk into account by requiring a higher credit spread ex-ante. We call this effect the "leverage effect". On the other hand, the threat of an LBO may reduce agency costs by disciplining managers (Jensen and Meckling (1976), Jensen (1986) and Innes (1990)), an effect we call the "disciplining effect". The disciplining effect of LBOs can naturally be viewed as reducing credit spreads (Qiu and Yu (2009) and Francis, Hasan, John, and Waisman (2010)) but may also lead to an increase in credit spreads if managers pursue more profitable but riskier projects, beneficial for equity

[1] See "The leveraging of America: recent leveraged buyouts drive credit risk higher as the market churns", S&P RatingsDirect, August 6, 2007, "Moody's warns on LBO debt defaults", Financial Times, May 29, 2012 and "LBOs 31% of defaults since financial crisis", Fitch Wire, May 28, 2014.

[2] https://www.federalreserve.gov/newsevents/press/bcreg/20130321a.htm

[3] 'Growth in leveraged deals prompt credit risk warning', Financial Times, November 4, 2015.

holders but detrimental to bondholders (Roades and Rutz (1982)).

In addition to the theoretical ambiguity of the effects of LBOs on credit risk, empirically identifying a causal link between LBO risk and credit spreads is challenging. The identification challenge is exemplified in a notable paper on this topic by Crabbe (1991), in which the author attempts to estimate the impact on yields of including an event risk covenant protecting bondholders against an LBO ("Poison Put"). Specifically, Crabbe (1991) regresses a small set of corporate bond yield spreads (72 in number), at the end of 1989, on a dummy variable indicating whether the bond includes an event risk covenant protecting bondholders against an LBO ("Poison Put"). Crabbe interprets the negative dummy (-32bps) as the result of the leverage effect. In light of the limited data available 25 years ago, the documented correlation was useful in understanding LBO risk, but one concern is that firms issuing bonds with event risk covenants are different from those issuing bonds without such covenants, thus leading to an omitted variables bias. In particular firms that face higher LBO risk are potentially also lower credit quality firms. While Crabbe attempts to control for credit quality using several proxies, one may question the quality of the control variables and their correct functional form. When we apply Crabbe's cross-sectional regression to a much larger sample of 41,181 bond yield observations over 13 years, we obtain monthly estimates that are volatile, range from -46 to 92 basis points and are positive in 112 out of 159 months. It is difficult to rationalize positive estimates arising from a pure leverage effect.

Employing a different approach, Qiu and Yu (2009) and Francis, Hasan, John, and Waisman (2010) measure spread changes around laws enacted in 30 U.S. states between 1985-1991 raising the cost of takeovers and arguably decreasing the likelihood of an LBO. Admittedly, the potential effect of these laws were not limited to LBOs but also to other takeover events and therefore their results, although informative, have to be interpreted with caution in the context of LBO risk. Qiu and Yu (2009) find that credit spreads increase in the year the law is enacted while Francis, Hasan, John, and Waisman (2010) find that credit spreads decrease in the month around the first press announcement that is related to the expected passage of these laws. Besides the general challenge in defining the event date in studies of law changes, there is evidence suggesting that the laws did not have an impact on hostile takeover activity (Comment and Schwert (1995) and Cain, McKeon, and Solomon (2016)).

In light of these ambiguous and conflicting empirical results, this paper revisits the link between

LBO risk and credit spreads using an extensive dataset of LBOs, CDS spreads and corporate bond transactions from recent decades and a new estimation approach.[4] We provide comprehensive and robust evidence on an economically important ex-ante effect of leveraged buyouts leading to higher credit spreads. In addition, we show that LBO risk has had a larger impact in recent years and find its effect to be strongest at 10-20 years maturities.

We begin by studying the reaction of target firm credit spreads to LBO announcements in the US during the years 2002-2015. We study the reaction in bond markets, differentiating between bonds protected by event risk covenants and those that are not, to control for takeover protection. We focus on the latter since they are most common and document an average abnormal negative reaction of 5.1% in prices of unprotected bonds, confirming results in earlier literature documenting significant bondholder losses.[5] We also document an increase in 5-year CDS spreads of 43.8%.

We then proceed to the main contribution of this paper, namely to quantify the ex-ante relation between LBO risk and credit spreads. First, we investigate intra-industry credit spread reactions around LBO announcements, based on the finding in Harford, Stanfield, and Zhang (2016) that an LBO announcement significantly increases the likelihood that an industry peer becomes an LBO target in the following year. We find a significant intra-industry spread increase in 5-year CDS spreads of 9.1% and a bond price decrease of -1.0% in unprotected bonds around the announcement, providing evidence that LBO risk has a sizeable influence on credit spreads.

We investigate the significance of the disciplining effect by estimating the abnormal price change of protected bonds around intra-industry LBO announcements. Protected bonds are paid back and cease to exist if an LBO happens and therefore an increase in leverage after the LBO does not influence their prices ex ante. However, the disciplining impact of an LBO threat on management will influence their prices. Any reaction in a protected bond's yield can therefore be attributed to the disciplining effect. We find a small and statistically insignificant abnormal price reaction of 0.1% in protected bonds, showing that the disciplining effect is not economically significant in our sample in understanding the relation between LBO risk and credit spreads.

[4] In their regressions, Crabbe (1991) uses 72 observations from December 1989, Qiu and Yu (2009) use 4,951 observations from 1976-1995 and Francis, Hasan, John, and Waisman (2010) use 1,857 observations from 1985-1991. We use 28,916 bond observations from 2007-2015 in our main regression.

[5] See for example Baran and King (2010), Billett, Jiang, and Lie (2010), Warga and Welch (1993), Crabbe (1991), Asquith and Wizmann (1990), and Marais, Schipper, and Smith (1989).

To sharpen our analysis further, we investigate a sample of firms in which every firm has at least two bonds outstanding, one with and one without an event risk covenant, and include firm and time fixed effects in a panel regression of the yield spread on a dummy indicating the inclusion of an event risk covenant along with controls. Thus, we estimate the effect of an event risk covenant by comparing, at the *same time* and for the *same firm*, the difference in yields of a bond with and a bond without an event risk covenant. This provides a much cleaner identification of the LBO effect, in particular the leverage effect, since the within firm comparison (firm fixed effects) allows us to control for firms' credit quality non-parametrically. It should be noted that this identification strategy also controls for other time-varying omitted variables, such as expectation of changes in firm leverage unrelated to LBOs. Since such leverage changes would affect spreads on both types of bonds, our identification strategy differences it out. Using this approach, the average impact of not including an event risk covenant during the period 2007-2015 is 20.66 basis points.

Having identified the leverage effect as the dominant one in the relation between LBO risk and credit spreads, we propose a general way of incorporating LBO risk into structural models and derive closed-form solutions for credit spreads in two cases, the Merton (1974) model and Collin-Dufresne and Goldstein (2001)'s stationary leverage model. In both models the firm issues a zero-coupon bond and defaults if the firm value is below the face value of debt at maturity. We model the leverage effect by assuming that there is a time-varying probability – governed by an underlying intensity – of the firm undergoing an LBO, at which point there is a jump in the amount of debt issued by the target.

It is important for us to be able to distinctly interpret the implications of the model as risk of an impending LBO rather than other corporate events leading to a change in leverage.[6] To be able to do so, we calibrate the model to two measurements in the data that are unique to LBO risk: the frequency of LBOs and the ex-post impact of LBOs on bond prices. Specifically, we use the overall number of LBOs divided by the total number of firms as an annual proxy for the unobserved LBO intensity, allowing us to estimate the parameters of the LBO intensity. Furthermore, to estimate the jump size in the event of an LBO, we match model-implied bond price reactions to the historical bond price reactions.[7]

[6] Examples of other corporate events leading to a change in leverage are mergers, share repurchases or steep losses due to a lawsuit.

[7] Besides an increase in the level of debt arising from financial engineering, there may also be an increase in firm value due to operational improvements arising from a change in management or, in case of a management-led buyout, stronger incentives for existing management put into place. In this case bond price changes around an LBO reflect the joint effect

The calibrated models allow us investigate the impact of LBO risk over time and across bond maturity. The average contribution of LBO risk to 10-year credit spreads is 18-21bps, consistent with the event risk covenant regression estimates. The impact on the 10-year credit spread of a typical BBB-rated firm ranges from around 11-14bps in the early eighties to around 25-30bps in the high LBO periods 2005-2007 and 2012-2014. To examine the impact of LBO risk on the term structure of credit spreads we study a typical firm in an average year and find the contribution to be only 0-2bps at the one-year maturity, but increasing to 18-24bps at the 15-year maturity. We, therefore, conclude that while LBO risk has little impact at very short maturities, it affects the slope of the term structure of credit spreads quite significantly.

Incorporation of LBO risk can further our understanding of the cross-sectional variation in credit spreads. Standard structural credit risk models suggest that only firm specific variables such as asset volatility and leverage determine spreads. In our model, LBO risk is an additional variable explaing credit spreads, but in contrast to standard variables, LBO risk is not firm-specific. This additional variable might therefore, in part, explain the finding in Collin-Dufresne, Goldstein, and Martin (2001) that a common residual factor unrelated to firm-specific variables is an important determinant of credit spreads.

The rest of this paper proceeds as follows. Section 2 details the CDS, bond, covenant, and LBO data. Section 3 studies the reaction of the target firm's bond prices and CDS spreads around LBO announcements. Section 4 presents the empirical study of the ex-ante effect of LBO risk on credit spreads and Section 5 concludes.

2 Data

In our analysis we use credit spreads – CDS premiums and corporate bond yield spreads – in combination with details about corporate bond covenants and information on LBO announcements. We focus on the U.S. market and use four main data sources: CDS quotes from Markit, corporate bond transaction prices from TRACE, bond covenant information from Mergent FISD, and LBO announcements from Thomson One Banker. The data sources are well-known and used in a large number of studies and

effect of a leverage increase and operational improvements, and since the structural models are calibrated to these price changes, the model-implied ex ante effects will reflect the net effect of the two opposing factors.

below we provide a brief description of each data source.

Credit Default Swaps

Credit default swaps are the most common type of credit derivative and have been actively traded in financial markets since the early 2000s. According to a report by the Bank for International Settlements, the total notional amount outstanding of CDS contracts was $14.6 trillion at the end of June 2015. CDS premiums abstract from certain bond characteristics such as decaying maturity and covenants.

The CDS dataset includes daily quotes for a broad cross-section of firms over the years 2001-2015. CDS data are provided by Markit, a comprehensive data source that assembles a network of over 30 industry-leading partners who contribute information across several thousand credits on a daily basis. Based on the contributed quotes, Markit creates a daily composite for each CDS contract and rigorous cleaning of the data helps to ensure that the composite price closely reflects transaction prices. We use all CDS quotes written on U.S. corporate entities and denominated in U.S. dollars. We retain only CDS on senior unsecured debt, which constitute 92% of all contracts. We focus on contracts with Modified Restructuring (MR) or No Restructuring (XR) clauses as these are the most common in the US. The MR contract is used, with the exception of firms for which the XR contract is more frequently traded. We focus on the 5-year contract, which is the most liquid.

Bond transaction prices

Corporate bond transactions data is obtained from the Financial Industry Regulatory Authority's (FINRA) Trade Reporting and Compliance Engine (TRACE). Since July 1, 2002, all dealers have been required to report their secondary over-the-counter corporate bond transactions through TRACE. The data set starts on July 1, 2002 and ends on September 30, 2015. We apply standard filters (Dick-Nielsen (2009) and Dick-Nielsen (2014)) to clean the dataset for errors. The information on TRACE includes time of execution, price, yield, and volume. We merge this data with information on the issue and its covenants, as described in the following section, and exclude all convertible bonds, as these might be expected to react differently from non-convertibles. Furthermore, we only look at senior unsecured bonds. We calculate a daily price as the average price of all transactions on that day.

Bond covenants

We retrieve bond covenant information from The Mergent Fixed Income Securities Database (FISD).

The FISD contains detailed issue-level information on over 140,000 corporate, US Agency, US Treasury and supranational debt securities, collected from bond prospectuses and issuers' SEC filings including 10-K, 8-K, registration forms, etc. For each issue, the FISD provides a variable indicating whether detailed covenant information is collected for that issue.

One covenant is directly related to LBOs, namely a put, which gives the bondholder the option to sell the issue back to the issuer in the event of a change of control in the firm, typically at 101% of par value. The covenant is denoted "Change Control Put Provisions" in FISD and we refer to this covenant as an "event risk" covenant. Out of the 9.1% of bonds, for which information about covenants is provided in FISD, 41.6% are reported to have an event risk covenant.

LBO announcements

Data on LBO announcements are retrieved from Thomson One Banker. A deal is classified as a Leveraged Buyout if the investor group includes management or the transaction is identified as such in the financial press and 100% of the company is acquired. We filter by announced deals of type LBO, where the target is a US firm.[8] The total number of announcements between 1980 and 2015 is 12,210. Figure 1 details the number and total value of LBO announcements in the U.S. by year. The figure illustrates clear trends in buyout activity over time. We observe increased LBO activity in the late 1980s, in the 2004-2007 period preceding the financial crisis, and again in 2012-2015, both in number and magnitude of deals.[9]

3 Ex post effect of LBO announcement

In this section we study the effect of LBO announcements on the credit spreads of target firms. Before we examine the general effect in the sample, we zoom in on two specific deals, Heinz in 2013 and Safeway in 2014.

[8]Based on the CapitalIQ database and World Economic Forum reports, the coverage of deals in Thomson One Banker seems to be incomplete, but there is no reason to suspect any bias in coverage. Furthermore, since LBO firms in our sample have quoted CDS premiums, the focus is, by definition, on the larger, public, highly traded firms, for which the coverage is likely to be high. We checked LBOs on Bloomberg and did not find additional LBO events where the target firm had quoted CDS premiums.

[9]The value is the equity value of target firms, but since only 16.2% of the deals in Thomson One Banker have information on the equity value, the reported value is a lower bound on the actual total value (although we do expect that the 16.2% for which there is information are among the largest LBO deals).

Berkshire Hathaway and 3G Capital announced on February 14, 2013 that they had reached an agreement with Heinz to take the company private in an LBO that valued the firm's equity at $23bn. Before the LBO, total debt was $6.2bn and the firm's leverage ratio was 24.2%. After the deal, $12.5bn of new debt was issued, senior to the existing debt. Thus, existing debt became significantly more risky and post-LBO Heinz had a leverage ratio of 49.9%. The firm was subsequently downgraded by Moody's from investment grade rating BBB to speculative grade rating BB-. As a consequence of the increase in credit risk, the top-left corner of Figure 2 shows that an unprotected bond maturing in 2032 experienced a price drop of about 15%. However, some of Heinz's bonds had event risk covenants and prices of one of these are shown in the upper-middle corner. As the graph shows the bond did not suffer losses around the LBO. Consistent with the drop in price of unprotected bonds, we see in the top-right corner that the five-year CDS premium jumped from about 50bps to 200bps.

On February 19, 2014 Safeway announced that it was "in discussions concerning a possible transaction involving the sale of the company" and on March 6, 2014 it was announced that the private equity firm Cerberus Capital Management had agreed to buy Safeway in a leveraged buyout deal worth more than $9 billion, of which $7.6 billion would be in debt. A Safeway bond maturing in 2031 with no event risk protection lost approximately 10% in value in the period around the announcement as ther bottom-left corner of Figure 2 shows. On the other hand, the bottom-middle corner shows that the price of a protected bond maturing in 2020 did not decrease at all. Also, the bottom-right corner shows a jump of approximately 100bps in the five-year CDS premium (from about 200bps to 300bps).

While the above examples are instructive, we now examine price reactions in an event study including a large sample of LBOs. The event study methodology is detailed in Appendix A. We look at LBO announcements of firms for which we have CDS spreads at some point in the sample, which leaves us with 119 firms. Since the focus is on firms with public debt and traded CDS contracts, the firms are typically large, public firms.

There are 60 LBO announcements for which we have 5-year CDS spreads around the event. The median rating is BBB- immediately before the LBO and BB- one year after the corporate event. We exclude 18 cases where the 5-year CDS spread data is stale around the event.[10] Panel A in Figure 3

[10] We define CDS prices as stale in the event window if there are more than five days where the CDS price does not change from one day to the next.

shows that the CDS spread increases, on average, in the period leading up to the LBO announcement and, in particular, on the day of the announcement, remaining stable from that point onwards. It is not surprising that there is some reaction before the announcement, as the deal may have been rumored, or, as in the case of Safeway, the firm might have announced that negotiations were ongoing. On average the CDS spread increases approximately 100 basis points from 180 basis points to 280 basis points and Panel A in Table 1 shows that the increase is statistically significant.

There are 45 firms that have 230 bonds outstanding trading actively around the announcement.[11] To investigate bond price reactions, we calculate the average abnormal price reaction of all bonds and adjust the t-statistics to account for the return correlation of bonds issued by the same firm (see Appendix A). Panel B in Table 1 shows that the average abnormal return is -4.18% in the period between 22 days before and five days after the event and this price drop is statistically significant. There are 187 unprotected bonds issued by 28 firms and Panels B in Figure 3 and C in Table 1 document a statistically significant cumulative abnormal return of -5.05% around the event.[12] For bonds protected by an event risk covenant, Panels B in Figure 3 and D in Table 1 show a small and statistically insignificant negative abnormal return of 0.40%. Thus, although, on average, event risk covenants mitigate losses to bondholders, the majority of bonds are unprotected and bondholders experience significant losses.

Using a sample of bonds over the period 1991-2006, Billett, Jiang, and Lie (2010) find that protected bonds experienced an average gain of 2.30% upon an LBO announcement, while unprotected bonds experienced an average loss of 6.76%. A likely explanation for why we find (small) average losses for protected bonds is that interest rate levels in our sample period were low and decreasing, thus a larger fraction of protected bonds were likely to be trading above the event put strike price of $101, and, therefore, experienced some losses despite the event risk protection.

4 Ex ante pricing of LBO restructuring risk

The event study in the previous section shows that bond prices go down after an LBO due to an increase in credit risk. We attribute this increase in credit risk to the increase in leverage that typically occurs

[11] We define a bond as actively traded if there are no more than five days in the event window where there is no transaction. On days with no transaction we use the previous day's price.

[12] In "unprotected bonds" we include those that have no information about event risk covenants in the Mergent FISD.

and denote this effect as the leverage effect consistent with previous literature (Crabbe (1991) and Qiu and Yu (2009)).

Since credit spreads are forward-looking and should reflect all priced risks, the leverage effect should lead to a positive relation between LBO risk and ex-ante credit spreads. However, an increase in LBO risk may also reduce agency costs because a takeover is a more imminent threat to managers and therefore they are less likely to lead "the quiet life" (Bertrand and Mullainathan (2003)). The reduction in agency costs is generally viewed in the literature to imply a negative relation between LBO risk and credit spreads (see for example Qiu and Yu (2009) and Francis, Hasan, John, and Waisman (2010)). Roades and Rutz (1982) find supporting evidence for the hypothesis that managers leading "the quiet life" trade off higher profits for less risk, leading to a potential positive relation between LBO risk and credit spreads. Therefore, the qualitative effect of the disciplining channel on credit spreads is not clear.

4.1 Industry-wide effects of LBO announcements

Harford, Stanfield, and Zhang (2016) document that an LBO announced in a given year significantly increases the likelihood that an industry peer becomes an LBO target the following year. To investigate their finding in our sample we estimate a panel regression where we regress the number of LBOs in an industry on the number of LBOs in the same industry the period before. The results are in Table 2 and we see strong predictive power, confirming their result. For example, when the time period is one year, the regression coefficient when including time and industry fixed effects is statistically highly significant at 0.86 and the R^2 is 0.85. Thus, intra-industry LBO announcements increase the likelihood that other within-industry firms will be targeted in LBOs.

We use the predictive power of LBO announcements to study the relation between LBO risk and credit spreads. Since an LBO announcement increases the likelihood that other firms in the same industry will be targets in an LBO, the spread reaction of other firms in the same industry is informative about this relation.

We collect firms' 2-digit SIC code from Compustat by matching with Markit's ticker. For each LBO event, the sample consists of spreads of non-targets in a window around LBO announcements in the industry. Event window, abnormal returns and test statistics are as detailed in Appendix A.

Figure 4 Panel A shows increasing CDS premiums on the two days around the announcement and subsequent increasing premiums in the three weeks following the announcement. Table 3 Panel A shows that the increases both around and after the announcement are statistically significant: the average cumulative abnormal return is 9.93% in a 2-month interval around the event, displaying a significant within-industry reaction to LBO announcements. Thus, credit spreads increase in response to a within-industry LBO announcement.

The increase in the probability of an LBO may affect spreads through two channels. One channel is the leverage effect, through which an increase in financial leverage around the LBO leads to an increase in credit spreads. Another channel is the disciplining effect, whereby a takeover is a more imminent threat to managers and therefore they work harder, reducing agency costs. While the reaction of CDS spreads does not allow us to investigate the channels separately, we can use bond price reactions to shed light on the relative importance of the two channels.

Corporate bonds without an event risk covenant are exposed to both channels and we would therefore expect their spreads to react in the same direction as CDS premiums. This is indeed the case as Table 3 Panel C and Figure 4 Panel B show: the average abnormal price reaction of unprotected bonds is -1.02% (recall that price and yield are inversely related). In contrast, we expect corporate bonds with an event risk covenant to react differently. Protected bondholders are affected by an intra-industry LBO announcement through the disciplining of management. However, in case of the issuing firm being target of an LBO at a later date, protected bondholders are being paid back par and the bond ceases to exist. Therefore, protected bondholders are not concerned about the increased probability of an LBO-induced leverage increase at a later date. In turn, this imples that protected bonds are exposed to the disciplining channel but not the leverage channel.

Panel B in Figure 4 shows that the price reaction of protected bonds is small around intra-industry LBO announcements and the average cumulative abnormal return in the two months around announcements is only 0.10% as Table 3 Panel D shows and statistically insignificant. Thus, the disciplining effect of LBOs appears to be small and insignificant relative to the leverage effect.

There are other explanations consistent with the widening of intra-industry CDS spreads and drop in unprotected bond prices around LBO announcements. Mitchell and Mulherin (1996) find that buyout intra-industry patterns are related to industry economic shocks; an LBO in one firm might provide relevant economic information about other firms within the same industry, causing a subsequent change in their pricing. Harford, Stanfield, and Zhang (2016) find that LBOs cause or signal private information about optimal changes to the industry and lead to a range of changes for the target's peers such changes to investment outlays, strategic alliances, and anti-takeover provisions. It may also be the case that some firms "mimick" an LBO and increase leverage in the future.

While it is clear that LBOs contain a range of information, there are two reasons why we find it unlikely that the change in spreads around LBOs is due to the alternative explanations. Panel E in Table 3 shows that there is a positive and significant abnormal equity price reaction of the target's peer around the LBO. If the increase in spreads is due to a downward repricing of firms, we would see a widening of credit spreads along with *negative* equity returns. Furthermore, while protected bonds are not exposed to the leverage channel, their prices are not protected against repricing caused by the above alternatives and we would expect to see a similar price reaction for both protected and unprotected bonds. For example, bonds with an event risk covenant are protected against LBOs but not against future increases in leverage that are not associated with ownership change.

Anecdotal evidence from the press further supports the hypothesis that the increase in CDS spreads is mainly driven by increased probability of further LBOs. *Bloomberg Business* ("Dell Lifts Default Risk on Next Buyout Targets: Credit Markets") wrote in January, 2013 that "Derivatives traders are beginning to speculate that the potential leveraged buyout of computer maker Dell Inc. marks the return of credit-busting takeovers as the cost of financing the deals gets ever cheaper. The cost to protect against losses on Quest Diagnostics Inc. bonds reached a 15-month high yesterday and Nabors Industries Ltd. credit-default swaps jumped to the most since July amid speculation they may become targets for leveraged buyouts." *The Wall Street Journal* also wrote on February 3, 2013 ("New Worry for Bondholders: LBOs") that "bonds from other likely LBO targets [...] have fallen in value. Leader Capital Corp. portfolio manager Scott Carmack noticed unusual selling in bonds of telecommunications provider CenturyLink Inc. and Nabors when talk of the Dell deal leaked."

Overall, we find that LBO risk causes an increase in credit spreads and that this relation is primarily operating through a leverage channel, while the disciplining effect of LBOs appears small. In the next sections we quantify the total impact of LBO risk on credit spreads.

4.2 Corporate bonds and event risk covenants

We next analyse the yield difference between bonds with and without event risk covenants issued by the same investment grade firm. We exclude bonds with missing covenant information and (as noted in Section 2) 9.1% of the bond sample has covenant information in Mergent FISD.[13] We are not restricted to analyse bonds around LBO announcements and investigate yield spreads for firms in any industry regardless of an LBO occuring or not.

Figure 5 shows that it has become more common to issue bonds with covenant protection in recent years. Approximately 80% of the firms that issue a bond for the first time include an event risk covenant at the end of the sample 2015, increasing steadily from 0% in the early eighties.[14] The figure shows a similar trend for firms that already have both a protected and non-protected bond outstanding. Thus, in this dimension, the two types of firms are similar. Overall, the increasing use of event risk covenants implies that it has become common to have both bonds outstanding: out of 511 (297) firms that issued a bond in 2015 and after the issue had at least two (five) bonds outstanding, 26.2% (38.3%) had both kinds of bond outstanding.

A plausible explanation for the increasing use of covenant protection is investor demand. Anecdotal press reports support this explanation. For example, Reuters write on February 22, 2013 under the headline "Investors demand LBO protection in US bonds" that "there have been deals recently where large investors have decided to walk away, or threatened to do so, if there was no change of control put included in the structure." Financial Times write on March 22, 2006 under the headline "Bondholders seek protection from LBOs" that "BAA, the UK airport operator, was in the process of completing a 2bn bond issue when Ferrovial, the Spanish infrastructure group, shocked the market by announcing it was considering a takeover bid. Investors, who had been happy to buy the bonds without any specific protection, revolted and forced BAA to change the terms. Because the deal had yet to be formally completed, investors threatened to walk away from it."

Billett, Jiang, and Lie (2010) find that the probability of being an LBO target is reduced if the

[13] Billett, King, and Mauer (2007) find missing covenant information to be unrelated to time of issuance, priority, rating, maturity, size of issue or issuer, thus they find no bias in the selection of bonds examined.

[14] In the figure 'Have no bonds outstanding' corresponds to the firm having no previous bonds outstanding for which we have event risk information. If we instead condition on the firm having no bonds outstanding, whether we have event risk covenant information on the bonds or not, the time series correlation is 97% with the series in the figure.

target firm has at least one bond with an event risk covenant outstanding. If this is also the case in our more recent sample period, the effect of LBO risk on pricing is stronger for firms with no protected bonds outstanding relative to firms with at least one protected bond outstanding. Since we restrict our sample in the following analysis to firms with at least one protected bond outstanding, we can interpret our results as a lower bound.

As evidenced earlier bonds with an event risk covenant react differently to an LBO announcement than bonds without an event risk covenant. Bonds with an event risk covenant are paid back if the issuer is the target of an LBO and therefore the bonds are not exposed to the direct effect of increased leverage at the LBO. However, protected bonds are possibly affected indirectly because the threat of an LBO may reduce agency costs and this will influence bond valuation. We document in the previous section that there is no material price reaction of protected bonds to an increase in LBO probability – suggesting that agency costs play a minor role in bond valuation – and we therefore focus on the leverage channel in the following. Unsecured bonds remain in the capital structure of a target firm after an LBO and an LBO-induced increase in financial leverage will affect valuation of unprotected bonds ex ante. Therefore, we estimate the effect of the leverage channel by comparing credit spreads of bonds with and without event risk covenants.

Crabbe (1991) uses a similar approach to isolate the impact of the leverage effect on credit spreads. Specifically, Crabbe regresses the 1989 year-end yield spread of 72 bonds on a dummy indicator for event risk and controls for credit risk by adding rating dummies and maturity controls and controls for liquidity by adding size to the regression. The regression coefficient on the event risk dummy in Crabbe's regression is -32bps indicating that the average effect of LBO risk on credit spreads through the leverage channel at the end of 1989 was 32 basis points. Using the same cross-sectional regression in the first six months in 1990 Crabbe finds that the effect of LBO risk decreased to around 15bps by June 1990.

Including covenants in a bond issue is an endogenous decision by the issuing firm. Consistent with Smith and Warner (1979)'s Agency Theory of Covenants, Bradley and Roberts (2015) find that riskier firms are more likely to issue loans with covenants and Billett, King, and Mauer (2007) find that covenant protection in public bonds is increasing in growth opportunities and leverage. This poses a challenge when using event risk covenants to assess the pricing impact of LBO risk through the leverage channel.

To examine the approach in Crabbe more closely, we estimate the cross-sectional regression in Crabbe on a monthly basis for the period 2002-2015, resulting in 159 cross-sectional regressions. In each month, we use the last transaction in the month to calculate a bond's yield and discard the bond if there are no transactions in the month. Table 4 reports the distribution of the 159 regression coefficients. The average number of observations in the monthly regressions is 259, compared to Crabbe's 72 observations, and we estimate the regression in 159 months while Crabbe restricts his analysis to 7 months. Thus, our analysis is on a much larger scale than that in Crabbe. The average regression coefficient on the event risk dummy is 8.59, suggesting that the effect of adding an event risk dummy is an *increase* in the credit spread of 8.59 basis points, and the coefficient is positive in 112 out of 159 months, i.e. in more than 70% of the months. A positive relation between an event risk covenant and credit spreads is hard to interpret, intensifying the concerns about covenants being an endogenous decision by firms.

To assess the pricing impact of LBO risk using event risk covenants, we propose a different approach that directly controls for the simultaneity between pricing and the inclusion of an event risk covenant. In our analysis, we restrict our sample to firms that have at least two bonds outstanding, where at least one was issued with an event risk covenant, and at least one was issued without. The estimated impact of LBO risk is the difference in yields between the bond with the covenant and the bond without. Thus, we estimate, *at the same time*, the impact of an event risk covenant by comparing the yield on a bond with an event risk covenant and a bond without an event risk covenant, where the bonds have been issued by *the same firm.* Factors known to affect credit spreads such as leverage and volatility is controlled for by looking at different bonds issued by the same firm. We do the analysis in a panel regression with firm (interacted with time) fixed effects.

As in Crabbe (1991) we restrict our sample to senior unsecured bonds issued by industrial firms, with a remaining maturity of at least seven years, with an investment grade rating (BBB- or higher), with a fixed coupon and exclude puttable, convertible, asset-backed, and non-USD denominated bonds. Also, since the vast majority of bonds with event risk covenants are callable, we exclude non-callable bonds to avoid the confounding effect of callabillity. Thus, the bonds are comparable in many dimensions that are known to impact pricing.

In each month in the sample period 2002-2015 we include all bond observations from firms which have at least one bond outstanding with an event risk covenant and at least one bond outstanding without an event risk covenant (we use the last transaction in the month to calculate a bond's yield and discard the bond if there are no transactions in the month).

Table 5 shows summary statistics for our sample of bonds. We see that the average maturity of protected bonds is 17.09, lower than that of unprotected bonds, 18.39. Feldhütter and Schaefer (2017) find the average investment grade spread for U.S. bonds for the period 1987-2012 to be very similar for short-, medium-, and long-maturity bonds, making it less likely that a potential maturity mismatch would have a material effect, but nevertheless we will control for bond maturity in several ways. Table 5 also shows that protected bond issues are generally larger (average log amount outstanding is 13.15 for protected bonds vs 12.08 for unprotected bonds) and their liquidity is higher as measured through the commonly used Amihud and Roll illiquidity measures where higher value implies lower liquidity (see Bao, Pan, and Wang (2011), Dick-Nielsen, Feldhütter, and Lando (2012), Friewald, Jankowitsch, and Subrahmanyam (2012), and others).[15] Bond illiquidity is known to affect corporate bond prices and may influence our results, so we will be careful to control for illiquidity. However, Dick-Nielsen, Feldhütter, and Lando (2012) and Feldhütter and Schaefer (2017) find that the impact of bond illiquidity on corporate bond prices is small for investment grade bonds and since we restrict our analysis to investment grade bonds, it is less likely that bond illiquidity has a material impact. Finally, we see that protected bonds on average have included 17.6% of available covenants in Mergent FISD (excluding the event risk covenant) while unprotected bonds have included 11.0% and we therefore include other covenants as a control as well.

We analyse event risk covenants in a panel regression with time × firm fixed effects. Specifically, we estimate the regression

$$s_{jit} = \beta 1_{j,ERC} + \gamma \times \text{controls} + \alpha_{it} 1_{it} + \epsilon_{jt}, \qquad t = 1, ..., T, j = 1, ..., N_j^t$$

where s_{jit} is the credit spread in month t of bond j issued by firm i, $1_{j,ERC}$ is an indicator that is one if the bond is protected, α_{it} are coefficients corresponding to the firm × month fixed effects, N_j^t is the number of bonds at time t, T is the number of months, and controls include other covenants, log

[15] We calculate the Amihud and Roll measures for a given bond on a monthly basis using all transactions within a month and follow the methodology in Dick-Nielsen, Feldhütter, and Lando (2012).

amount outstanding, maturity, maturity^2, Amihud, and Roll. The fixed effects account for the time-varying credit risk of firms, and therefore (abstracting from the influence of controls) the regression coefficient β corresponds to the average effect in spread of including an event risk covenant.

Table 6 Specification 1 shows that without any controls, the effect of including an event risk covenant is estimated to lower the yield spread by 25.04 basis points. Once we control for other covenants, bond size, and bond maturity in specification 2 the estimated effect is 20.66 basis points, economically and statistically highly significant. Specification 3 shows that other covenants and bond size have an insignificant impact, while specification 2 and 4 shows that controlling for maturity is important and results are similar whether the maturity control is linear or non-linear. Specification 5-7 controls for bond liquidity and we see that bond liquidity is not driving the yield difference between protected and unprotected bonds. Overall, we find the average impact of protecting a bond from a change in control to be 20.7 basis points and, thus, the average impact of LBO risk (where a change in control occurs) on long-term credit spreads is estimated to be 20.7 basis points.

The bechmark specification 2 in Table 6 shows a negative coefficient of -10.37 on other covenants. A negative coefficient is in line with the argument that more covenants restrict firm decisions to the benefit of bondholders. It may be surprising that the estimated coefficient is economically modest and statistically insignificant (going from no other covenants to the complete menu of other covenants only reduces the yield spread by 10.37 basis points). This does not necessarily imply that other covenants are not important for cost of debt. Instead, the benefits of most of these other covenants accrue to all bond issues once they are included in one bond issue as discussed in Helwege, Huang, and Wang (2016). Therefore, the effect of other covenants are absorbed by the firm fixed effects in contrast to the event risk covenant that is bond-specific.

To examine the time series variation of the impact of LBO risk, we estimate the impact of an event risk covenant on a monthly basis by estimating the above regression as a cross-sectional regression. That is, we estimate for each month the regression

$$s_{ji} = \beta 1_{j,ERC} + \gamma \times \text{controls} + \alpha_i 1_i + \epsilon_j, \qquad j = 1, ..., N_j$$

where s_{ji} is the credit spread of bond j issued by firm i, $1_{j,ERC}$ is an indicator that is one if the bond is protected, α_i are coefficients corresponding to the firm fixed effects, N_j is the number of bonds, and controls include other covenants, log amount outstanding, maturity, and maturity^2 (i.e. repeated monthly regressions corresponding to Table 6 Specification 2).

Panel A in Figure 6 shows the time series of estimated contribution of LBO risk to credit spreads based on monthly cross-sectional regressions, i.e., the figure shows the negative value of the regression coefficient on the event risk dummy. We begin the analysis in 2007 because all months before this period have less than 20 firms in the sample and estimates become noisy. For comparison, Panel B shows the estimated contribution using the method in Crabbe (1991). According to our estimates the importance of LBO risk was low after the financial crisis in 2008 but has increased in the past years, consistent with heightened LBO activity in recent years. In contrast, Crabbe's methodology frequently gives rise to negative estimates.

Overall, we find that LBO risk has an economic important ex ante impact on spreads, on average 20.7bps. In the next section we study the variation of this impact over the period 1980-2014 and across bond maturity.

4.3 Evidence from structural models with LBO risk

In the previous sections we document that LBO risk contributes significantly to an increase in credit spreads. We also document that the relation between LBO risk and credit spreads is mainly because of an increase in financial leverage when a firm is acquired in an LBO. We use these results to present a framework for studying LBO risk in structural models of credit risk.

Specifically, we extend standard structural models by incorporating the leverage effect: there is a time-varying probability of the firm undergoing an LBO and if an LBO occurs the firm's leverage is increased. We implement the framework in the classic Merton (1974) model and Collin-Dufresne and Goldstein (2001)'s model with stationary leverage, calibrate the models and use the models to present further evidence on the pricing of LBO risk over time and across bond maturities.

4.3.1 The Merton model with LBO risk

Assume that firm value follows a Geometric Brownian Motion

$$\frac{dV_t}{V_t} = (r - \delta)dt + \sigma dW_t^V \tag{1}$$

under the risk neutral measure, and r is the riskfree rate while δ is the total payout to debt and equity holders.[16] Assume that the firm has issued one zero-coupon bond with maturity T and a face value of K. The firm can only default at bond maturity and it does so if firm value is below the face value of debt. Following Chen, Collin-Dufresne, and Goldstein (2009) and Feldhütter and Schaefer (2017) we assume that in the event of default, bondholders receive a fraction α of the face value of debt. If we define leverage as $L_t = \frac{K}{V_t}$ and the price of the zero coupon bond at time 0 as $v^M(L_0, \delta, \sigma, \alpha, r)$ it is well-known that

$$v^M(L_0, \delta, \sigma, \alpha, r) = e^{-rT}\Big[\alpha + (1-\alpha)N\big(\frac{-\log(L_0) + (r - \delta - \frac{1}{2}\sigma^2)T}{\sqrt{\sigma^2 T}}\big)\Big]. \tag{2}$$

We extend the model by assuming that the firm can potentially undergo an LBO at time τ. if an LBO occurs, the firm issues more debt with the same maturity and seniority as existing debt. The total amount of debt after the LBO is $e^J K$ where J is normally distributed with mean η and standard deviation ς.[17] We assume that the LBO event follows a Cox process with intensity λ_t (see Lando (1998)). This implies that in a short time interval between t and $t+\Delta$, the probability of an LBO occuring is approximately $\lambda_t \Delta$. We assume that λ_t follows a CIR process,

$$d\lambda_t = \kappa(\theta - \lambda_t)dt + \xi\sqrt{\lambda_t}dW_t^\lambda, \tag{3}$$

and that W^λ and W^V are independent. Appendix B shows that the probability of an LBO event not occurring during the life of the bond is

$$P(\lambda_0, \kappa, \theta, \xi) = E[e^{-\int_0^T \lambda_s ds}] = A(T)e^{-B(T)\lambda_0} \tag{4}$$

where

$$\begin{aligned} A(T) &= \Big(\frac{2he^{(h+\kappa)T/2}}{2h + (h+\kappa)(e^{hT} - 1)}\Big)^{\frac{2\kappa\theta}{\xi^2}} & (5) \\ B(T) &= \frac{2(e^{hT} - 1)}{2h + (h+\kappa)(e^{hT} - 1)} & (6) \\ h &= \sqrt{\kappa^2 + 2\xi^2}. & (7) \end{aligned}$$

[16] See Feldhütter and Schaefer (2017) for a more extensive discussion of the assumptions of the model.

[17] It can happen that the firm retires debt if $J < 0$. If this happens we assume that the firm buys back debt at post-LBO market value.

The price of the zero coupon bond in the presence of LBO risk is derived in Appendix B as

$$v_T^{LBO}(L_0, \delta, \sigma, \alpha, r, \lambda_0, \kappa, \theta, \xi, \eta, \varsigma)$$
$$= P(\lambda_0, \kappa, \theta, \xi) v^M(L_0, \delta, \sigma, \alpha, r) + \left[1 - P(\lambda_0, \kappa, \theta, \xi)\right] v^M(L_0, \delta + \frac{\eta}{T} - \frac{1}{2}\frac{\varsigma^2}{T}, \sigma^2 + \frac{\varsigma^2}{T}, \alpha, r) \qquad (8)$$

The pricing formula shows that the bond price is a weighted average of the bond price in the standard Merton model and the bond price in the standard Merton model with an adjusted drift and volatility, where the weight is the probability of an LBO occurring during the life of the bond. The adjusted volatility is higher, and for empirically plausible parameters the drift is adjusted downwards.

We estimate the LBO risk parameters of the structural models assuming that there is no risk premium associated with LBO events. Parameters associated with LBO intensity are estimated using the time series variation in the market-wide frequency of LBOs. The parameters determining the increase in leverage when an LBO happens are estimated by matching model-implied bond price reactions to an LBO to historical bond price reactions around LBOs.

We estimate the time variation in contribution to spreads of LBO risk for a "typical" firm issuing corporate bonds. The most common ratings in the corporate bond market are A and BBB. The average leverage ratios of A and BBB-rated firms are estimated in Feldhütter and Schaefer (2017) [FS17] to be 0.28 and 0.38, respectively. The median pre-event rating of firms subject to an LBO is BBB and the average leverage in the year before the LBO is 0.33 in our sample. We therefore choose 0.33 as leverage. The asset volatilities of A and BBB-rated firms are 0.23 and 0.25, respectively (FS17), so we choose the average of 0.24 as asset volatility. The drift of the assets under the risk neutral measure is $r - \delta$, where r is the riskfree rate and δ is the payout rate to debt and equity holders (as a percentage of firm value). We set r equal to the average 5-year Treasury yield for the period 1980-2014 of 6.10% and the payout ratio to 4.85% (the average payout rate of A and BBB firms according to FS17).[18] Finally, we set the recovery rate $\alpha = 37.8\%$, Moody's (2013)'s average recovery rate for senior unsecured bonds for 1982-2012.

We calculate a market-wide annual LBO probability by computing the ratio of the number of public firms that were targets of an LBO (according to Thomson Financial LBO announcements) to the total number of firms (as reported in Compustat). Both the denominator and numerator reflect public firms,

[18] Feldhütter and Lando (2008) show that the swap rate is a better proxy for the riskfree rate than the Treasury yield, but swap rates are not available before 1987.

so the probability reflects that of listed companies. We let the time series of LBO probabilities proxy for the path of λ, observed on a yearly basis. The average annual LBO probability in the period 1980-2014 is 1.83%. We estimate the parameters κ, θ, and ξ in equation (3) by Maximum Likelihood using the method in Kladıvko (2007); they are estimated to be $\kappa = 0.1946$, $\theta = 0.0215$ and $\xi = 0.0511$. A mean reversion of $\kappa = 0.1946$ implies that the half-life of a shock to the LBO intensity is $\frac{\log(2)}{0.1946} = 3.56$ years consistent with LBO intensity varying with the business cycle. θ is close to the unconditional mean of 0.0183.

As noted in the previous model section, if there is an LBO, total debt jumps from K to Ke^J where $J \sim N(\eta, \varsigma)$. ς is hard to identify and we therefore set this parameter to $\varsigma = 0.2$ (other values give rise to similar results). The average jump in log-leverage, η, is crucial and we back out the parameter by fitting model-implied price reactions to historical price reactions around an LBO. We do this for different bond maturities to assess the model at different bond maturities.

The average historical price reactions are given in Table 7 Panel A and we denote the historical price reaction at bond maturity t_i for $pre^{hist}(t_i)$ (we assume that t_i is the mid-point in a given maturity range, such that for example the range 8-10 years corresponds to $t_i = 9$). For a given bond maturity t_i, the corresponding model-implied price reaction in the Merton model is calculated as

$$pre(\eta, t_i) := \frac{v^M_{t_i}(e^\eta L_0, \delta, \sigma, \alpha, r) - v^{LBO}_{t_i}(L_0, \delta, \sigma, \alpha, r, \lambda_0, \kappa, \theta, \xi, \eta, \varsigma)}{v^{LBO}_{t_i}(L_0, \delta, \sigma, \alpha, r, \lambda_0, \kappa, \theta, \xi, \eta, \varsigma)} \tag{9}$$

where $v^M_{t_i}$ is given in equation (2) and $v^{LBO}_{t_i}$ is given in equation (8).[19] The intuition is that before an LBO the price is given as $v^{LBO}_{t_i}$ while after an LBO log-leverage on average increases by η and since an LBO can only happen once, the price after the LBO is given by the standard Merton model. The remaining parameters in (9) are set as above and η is estimated by minimizing the squared errors between model-implied and historical price reactions,

$$\min_\eta \sum_{i=1}^{8} \left(pre(\eta, t_i) - pre^{hist}(t_i)\right)^2. \tag{10}$$

The mean jump size is estimated to be $\eta = 0.4216$.

[19] Although the expected jump in log-leverage is η, jumps are normally distributed around the mean. An alternative estimation approach to estimating $pr(\eta, t_i)$ is to simulate the jumps J and calculate the average price reaction. Since there is a close to linear relation between the bond price and the leverage jump size, the difference between the two approaches is small and we therefore use the simpler approach.

Table 7 Panel A shows how well the Merton model captures the reaction for different maturities, although we have to be careful not to overinterpret the fit because the standard errors on the historical price reactions are considerable. There is a hump-shaped relation between bond maturity and price reaction in the data: the price reaction is stronger for longer maturities until 10-20 years whereafter the reaction starts to become smaller. The price reaction in the model is stronger than in the data for maturities less than five years and weaker at maturities longer than 10 years, while at the 10-year maturity the reaction in the data and model are similar. Interestingly, the model captures the hump-shape in the price reactions with a steeply increasing reaction at short maturities, peaking at 8-20 years, and a decreasing percentage price reaction at longer maturities.

With the estimated LBO risk parameters and the time variation in the LBO intensity λ, proxied by the yearly LBO probability, we calculate on a yearly basis the credit spread in the structural model for a typical firm with and without LBO risk. That is, the difference between the yield based on the bond price in equation (8) and the yield based on the bond price in equation (2). The difference in yields is the contribution of LBO risk. Figure 7 shows the contribution of LBO risk to the 10-year credit spread. We see that the contribution is around 20bps over time and peaks at 25-30bps before the recessions in 1990, 2001, and 2008.

When analysing LBO risk by investigating bonds with and without event risk covenants, we found that the average contribution to spreads in 2007-2015 was 20.7bps. To compare this result with the results implied by the structural model, we note that the average bond maturity in the event risk covenant regression in Table 6 is 17.7 years and at this maturity the average spread implied by the structural model in the years 2007-2014 is 18.2 basis points. Thus, the two different approaches give rise to similar estimates of the average contribution of LBO risk.

Panel B in Table 7 shows that the contribution of LBO risk to credit spreads is hump-shaped as a function of maturity. We see that the contribution of LBO risk increases from 1.8bps at the one-year maturity to 17.6bps at the 10-year maturity and then declines to 14.8bps at the 30-year maturity. Intuitively, LBO risk is not important for short-maturity bonds, because although leverage jumps in an LBO, the firm is unlikely to be on the verge of default immediately after the LBO.

4.3.2 Stationary leverage ratios

Collin-Dufresne and Goldstein (2001) incorporate a stationary leverage ratio in a standard structural model. As Flannery, Nikolova, and Oztekin (2012) find further empirical support for this model, we consider stationary leverage ratios in the context of LBO risk. The effect of LBO risk is distinct from a stationary leverage ratio. In particular, changes in debt due to a stationary leverage ratio are predictable and slow-moving, while changes in debt due to LBO risk are unpredictable and large. To show that LBO risk is significant in debt pricing under a range of model assumptions, we incorporate LBO risk in Collin-Dufresne and Goldstein (2001)'s stationary leverage model and estimate the impact of LBO risk in the case of a stationary leverage ratio.

Assume that firm value follows a Geometric Brownian Motion

$$\frac{dV_t}{V_t} = (r - \delta)dt + \sigma dW_t^V \tag{11}$$

under the risk neutral measure and r is the riskfree rate while δ is the total payout to debt and equity holders. Define $y_t = \log(Y_t)$ and assume as in Collin-Dufresne and Goldstein (2001) that the firm targets a long-run leverage ratio and that the dynamics of the log of the amount of debt, k_t, are given by

$$dk_t = \phi(\nu - (k_t - y_t))dt. \tag{12}$$

If we define log-leverage as $l_t = k_t - y_t$, the intuition is that if l_t is less than ν, the firm increases the amount of debt and vice versa, i.e. log-leverage is stationary around a mean leverage of ν. This specification captures the idea that the firm tends to issue more debt when leverage is low and tends to retire debt when leverage is high. We assume that all debt has equal priority and matures at time T, i.e. if the firm issues more debt, it issues more debt with the same maturity and seniority as existing debt. The firm can only default at bond maturity T and it does so if firm value is below the face value of all debt K_T. If the firm defaults, bondholders receive a fraction α of the face value of debt.

As in Section 4.3, we assume that the firm can potentially undergo an LBO that occurs at time τ, in which case the firm issues more debt (with the same maturity and seniority as existing debt). To capture that leverage jumps after the LBO and that the target leverage is higher after an LBO, we assume that the total amount of debt immediately after the LBO is $K_\tau e^J$ where J is normally distributed with mean η and standard deviation ς, while the target log-leverage after the LBO changes from ν to $\nu + J$. As in Section 4.3 we assume that the LBO event follows a Cox process with intensity λ_t where λ_t follows a CIR process,

$$d\lambda_t = \kappa(\theta - \lambda_t)dt + \xi\sqrt{\lambda_t}dW_t^{\lambda} \tag{13}$$

and that there is no risk premium associated with LBO risk.

Appendix B shows that the bond price is given as

$$P(\lambda_0, \kappa, \theta, \xi)N\Big(\frac{\bar{l} + (l_0 - \bar{l})e^{-\phi T}}{\sqrt{\frac{\sigma^2}{2\phi}(1 - e^{-2\phi T})}}\Big) + \big[1 - P(\lambda_0, \kappa, \theta, \xi)\big]N\Big(\frac{\bar{l} + (l_0 - \bar{l})e^{-\phi T} + \eta}{\sqrt{\frac{\sigma^2}{2\phi}(1 - e^{-2\phi T}) + \varsigma^2}}\Big) \tag{14}$$

where

$$\bar{l} = \frac{-r + \delta + \frac{1}{2}\sigma^2}{\phi} + \nu \tag{15}$$

and $P(\lambda_0, \kappa, \theta, \xi)$ is given in equations (4)-(7).

To disentangle the effect of LBO risk from that of a stationary leverage ratio, we calculate the spread in the model with and without LBO risk and compute the difference. We use Collin-Dufresne and Goldstein (2001)'s parameters of $\phi = 0.18$ and $\nu = -0.6$. We use the same estimated LBO intensity parameters as for the Merton model. The leverage jump size η is estimated in the same way as for the Merton model by minimizing the RMSEs between actual and model-implied price reactions to an LBO, where the model-implied price reaction is calculated as the percentage difference between the price in the standard model without LBO risk and a target log-leverage of $\nu + J$ and the model with LBO risk and a target log-leverage of ν. The mean jump size is estimated to $\eta = 0.3021$.

Table 7 shows the results. Panel A show that, as was the case in the Merton model, the stationary leverage model captures the historical hump-shaped relation between price reaction around LBOs and maturity. Panel B shows that the effect of LBO risk is similar to that in the Merton model. For example, the effect of LBO risk is 13-14bps at the 5-year maturity and 18-21bps at the 10-year maturity in both models. It is only for long maturities (20-40 years) that a 8bps difference in spread predictions starts to emerge.

Figure 7 shows the time series variation in spread contribution of LBO risk at a maturity of 10 years in the stationary leverage model as well as the Merton model. The spread contribution in the stationary leverage model is slightly higher than in the Merton model, but the time series variation implied by both models is very similar.

In the structural models we assume that the effect of an LBO is to increase the financial leverage of the firm while firm value is unchanged. If there are operational improvements associated with the LBO, firm value will increase as well and this effect will in isolation lead to a decrease in spread around the LBO. In this case bond price changes around an LBO capture the joint effect of a leverage increase and operational improvements, and since the structural models are calibrated to price changes around an LBO the model-implied ex ante effects will reflect the net effect of the two opposing factors.[20]

5 Summary

Although LBO activity is cyclical, LBO volume has generally increased in the past three decades as private equity activity has grown, rendering LBO risk a growing concern for investors in credit markets. This paper studies the impact of LBO risk on credit spreads over time, in the cross section, and across bond maturities.

We show that intra-industry credit spreads increase around LBO announcements, consistent with the notion that investors revise upward the probability of future LBOs leading to higher spreads. To rule out the most obvious alternative explanation of this result – that the increase in spreads is due to lower valuations of firms in the industry – we show that equity returns are significantly positive around the announcement.

We sharpen our analysis further and examine two channels that may contribute to this relation. One channel is due to an increase in leverage around an LBO. We isolate the contribution of this channel by comparing, at the *same time*, the yield of bonds without event risk covenants protecting against LBOs and bonds with event risk covenants, issued by the *same firm*. We find an average sizeable difference of 21 basis points. This identification strategy allows us to control for firms' credit quality non-parametrically and therefore provides strong support for the leverage effect being economically important. Another

[20]In a previous version of the paper we extended the Merton model to allow for log-normal distributed jumps in firm value around an LBO. In the extension log amount of debt jumps by J_K where $J_K \sim N(\eta_K, \varsigma_K)$ and log firm value jumps by J_V where $J_V \sim N(\eta_V, \varsigma_V)$. We showed that bond prices in the extended model can be written as bond prices in the model with only log debt jumps $J \sim N(\eta, \varsigma)$, where $\eta = \eta_K - \eta_V$ and $\varsigma = \sqrt{\varsigma_K^2 + \varsigma_V^2}$. This implies that when investigating the joint effect on credit spreads it is isomorphic to modelling the joint effect as arising solely through debt jumps as we do in the analysis.

potential channel is due to the disciplining effect of LBOs, i.e. managers cannot lead "the quiet life" when a takeover threat is looming. To investigate the importance of this channel, we exploit that all corporate bonds are exposed to the disciplining effect, but bonds with event risk covenants are not exposed to the leverage effect. Specifically, we isolate the disciplining effect by examining yield changes of bonds with event risk covenants around intra-industry LBO announcements. In a month around the announcement the average yield change of those bonds is small and we thus do not find support for the disciplining effect being economically important.

Based on our evidence that the leverage effect is the main driver of the link between LBO risk and credit spreads, we incorporate this effect in structural models of credit risk. We do so by letting the firm be exposed to a time varying probability of an LBO occurring, in which case the firm's outstanding debt jumps. Importantly, we calibrate the models to two measurements in the data that isolate LBO risk from risks coming from other corporate events: the frequency of LBOs and the ex-post impact of LBOs on bond prices. The calibrated structural models allow us to study the contribution to credit spreads across bond maturities and over a long time period, 1980-2014.

We find that the contribution of LBO risk to 10-year credit spreads varies substantially from 11-14 basis points in the early eighties to 25-30 basis points in high LBO periods such as before the financial crisis 2005-2007, underpinning the increased significance of LBO risk in credit pricing. We also find that the effect of LBO risk is hump-shaped with respect to maturity and the effect is strongest for bonds with a remaining maturity of 10-20 years, consistent with historical evidence.

Our results further the understanding of the variation in credit spreads. According to standard structural models, only firm-specific variables, such as leverage and asset volatility, affect spreads. Yet Collin-Dufresne, Goldstein, and Martin (2001) find that a significant fraction of credit spread changes is explained by a common factor unrelated to firm-specific variables and bond market liquidity. LBO risk can help explain these findings, as an increasingly significant, unaccounted-for risk. Corporate issuers have been increasingly exposed to potentially hostile takeovers, which result in a dramatic change in risk profile, particularly for investment-grade firms. While buyout activity is subject to recurring boom and bust cycles, a significant part of the growth in private equity activity is, according to Kaplan and Stromberg (2009), believed to be permanent.

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A Event study methodology

In this appendix we describe the event study methodology we use in the paper.

A.1 CDS

Daily Returns To measure the effect of the LBO announcements on CDS spreads, we follow Micu, Remolona, and Wooldridge (2006), Loon and Zhong (2014) and others and study normalized changes in spreads. In particular, for issuer i at time t the normalized change in spread is

$$R_{i,t} = log(\frac{s_{i,t}}{s_{i,t-1}}) \tag{16}$$

where $s_{i,t}$ is the CDS premium for issuer i on day t.

Abnormal Returns Abnormal return is computed over a market-wide CDS index. The index is calculated daily as the average 5-year CDS premium across all firms in the sample. We use the market-adjusted model with an estimation window of 100 days, i.e. approximately 70 business days, and include only events where there are spread changes on at least half of the days in the estimation window.

Abnormal returns in the market-adjusted model are computed as:

$$AR_{i,t} = R_{i,t} - (\alpha_i + \beta_i R_{M,t}) \tag{17}$$

where $AR_{i,t}$ is the abnormal return for issuer i on day t, $R_{i,t}$ is the return for issuer i on day t (calculated according to equation (16)), $R_{M,t}$ is the return on the index on day t (computed similarly to issuer return), and α_i and β_i are estimated in a regression of issuer i returns against the index over the estimation window.

In computing the significance of the abnormal return, we address two issues which may affect the variance. First is the error in the estimation of α_i and β_i and, second, LBO announcements could potentially lead to a change in the variance of CDS spreads due to a change in the firm's risk. We use Boehmer, Musumeci, and Poulsen (1991)'s test statistics, which correct for both issues (see Micu, Remolona, and Wooldridge (2006) for details).

A.2 Equity

Stock prices are from CRSP and abnormal returns and t-statistics are computed in the same way as for CDS spreads described above, except that the equity returns are calculated as

$$R_{i,t} \quad = \quad log(\frac{P_{i,t}}{P_{i,t-1}}).$$

The market-adjusted model is calculated using the S&P 500 index as the market.

A.3 Corporate bonds

Daily Returns Daily corporate bond returns are defined as

$$R_{i,t} \quad = \quad log(\frac{P_{i,t}}{P_{i,t-1}}).$$

We calculate daily bond prices as the average price across all transactions on that day. If there are no transactions on a specific day in the event window, we use the last available daily price. If there are more than five days in the event window with missing prices we discard the bond.

Abnormal returns Abnormal return is computed over the Bank of America Merrill Lynch US Corporate Bond Master Index (see Campani and Goltz (2011) for a review of corporate bond indices). We use a market-adjusted model with an estimation window of 30 days, i.e. approximately 22 business days. We use a shorter estimation window than for CDS and equity returns because a significant number of bonds do not have a long enough transaction history and we set α_i in equation (17) to zero for stability.

To calculate a t-statistics we calculate the mean, μ and standard deviation, σ, of the cross-section of cumulative abnormal returns for all bonds as suggested by Bessembinder, Kahle, Maxwell, and Xu (2009). To account for the correlation between returns of bonds issued by the same firm we use the number of firms, N_f, as the degrees of freedom in the t-statistics. Thus, the t-statistics is

$$\frac{\sqrt{N_f}\mu}{\sigma}.$$

This test assumes that returns of bonds issued by the same firm are perfectly correlated. This may not be the case and therefore this t-statistics is conservative, i.e. is less likely to reject a null hypothesis.

B Structural models with LBO risk

In this Appendix we derive credit spreads in two structural models with LBO risk. The first is the Merton model (as implemented in Chen, Collin-Dufresne, and Goldstein (2009)) and the second is Collin-Dufresne and Goldstein (2001)'s stationary leverage model.

Assume that firm value follows a Geometric Brownian Motion under the risk-neutral measure

$$\frac{dV_t}{V_t} = (r - \delta)dt + \sigma dW_t^V \tag{18}$$

where r is the riskfree rate, δ the payout rate, and σ is the asset volatility. We define $y = \log(V)$ and have

$$dy_t = (r - \delta - \frac{1}{2}\sigma^2)dt + \sigma dW_t^V. \tag{19}$$

B.1 Merton model with LBO risk

Assume that the firm has issued one zero-coupon bond with maturity T and face value of K. The firm can only default at bond maturity and it does so if firm value is below the face value of all debt K_T. If the firm defaults bondholders receive a fraction α of the face value of debt. If the firm has not undergone an LBO between time 0 and T there is only one bond outstanding and the face value of debt at time T is equal to the face value of debt at time 0, namely K.

The firm can potentially undergo an LBO that occurs at time τ after which no more LBOs can occur. If an LBO occurs the firm issues more debt with the same maturity and seniority as existing debt. The total amount of debt after the LBO is Ke^J where J is normally distributed with mean η and standard deviation ς. We assume that the LBO event follows a Cox process with intensity λ_t (see Lando (1998)). This implies that in a short time interval between t and $t + \Delta$ the probability of an LBO occuring is approximately $\lambda_t \Delta$. We assume that λ_t follows a CIR process,

$$d\lambda_t = \kappa(\theta - \lambda_t)dt + \xi\sqrt{\lambda_t}dW_t^{\lambda}. \tag{20}$$

We assume that there is no risk premium associated with LBO risk, such that the dynamics of LBO risk are the same under the natural and risk-neutral measure. If we are at time 0 and define the expected payoff at maturity T of the risky zero coupon bond as $w(T)$ we have that

$$\begin{aligned} w(T) &= E[1_{\{V_T>K_T\}} + \alpha 1_{\{V_T\le K_T\}}] && (21)\\ &= E[\alpha + (1-\alpha)1_{\{V_T>K_T\}}] && (22)\\ &= E[\alpha + (1-\alpha)1_{\{V_T>K_T\}}|\tau > T]P(\tau > T) + E[\alpha + (1-\alpha)1_{\{V_T>K_T\}}|\tau \le T]P(\tau \le T) && (23)\\ &= E[\alpha + (1-\alpha)1_{\{V_T>K\}}]P(\tau > T) + E[\alpha + (1-\alpha)1_{\{V_T>Ke^J\}}]P(\tau \le T) && (24)\end{aligned}$$

According to Lando (1998) we have that

$$P(\tau > T) = E[e^{-\int_0^T \lambda_s ds}] \tag{25}$$

and we know from Cox, Ingersoll, and Ross (1985) that

$$E[e^{-\int_0^T \lambda_s ds}] = A(T)e^{-B(T)\lambda_0} \tag{26}$$

where

$$\begin{aligned} A(T) &= \left(\frac{2he^{(h+\kappa)T/2}}{2h + (h+\kappa)(e^{hT}-1)}\right)^{\frac{2\kappa\theta}{\xi^2}} && (27)\\ B(T) &= \frac{2(e^{hT}-1)}{2h + (h+\kappa)(e^{hT}-1)} && (28)\\ h &= \sqrt{\kappa^2 + 2\xi^2}. && (29)\end{aligned}$$

Define $L_t = \frac{K}{V_t}$. We have that

$$E[1_{\{V_T>Ke^J\}}] = P(L_T < e^{-J}) = P(\log(L_t) + J < 0) \tag{30}$$

and because – using (19) – $\log(V_T)$ is normally distributed with mean $\log(V_0) + (r - \delta - \frac{1}{2}\sigma^2)T$ and variance $\sigma^2 T$, we have that $\log(L_T) + J$ is normally distributed with mean $\log(L_0) - (r - \delta - \frac{1}{2}\sigma^2)T + \eta$ and variance $\sigma^2 T + \varsigma^2$. Therefore

$$E[1_{\{V_T>Ke^J\}}] = N\Big(\frac{-\log(L_0) + (r-\delta-\frac{1}{2}\sigma^2)T - \eta}{\sqrt{\sigma^2 T + \varsigma^2}}\Big) = N\Big(\frac{-\log(L_0) + ([r-\delta-\frac{\eta}{T}+\frac{1}{2}\frac{\varsigma^2}{T}] - \frac{1}{2}[\sigma^2 + \frac{\varsigma^2}{T}])T}{\sqrt{[\sigma^2 + \frac{\varsigma^2}{T}]T}}\Big) \tag{31}$$

where N is the normal cumulative distribution function. Overall, this implies that the price of the zero coupon bond, $w(T)$ is

$$w(T) = v^M(T)P(\tau > T) + e^{-rT}\Big[\alpha + (1-\alpha)E[1_{\{V_T>Ke^J\}}]\Big]\Big[1 - P(\tau > T)\Big]$$

where

$$v^M(T) = e^{-rT}\Big[\alpha + (1-\alpha)N\big(\frac{-\log(L_0) + (r - \delta - \frac{1}{2}\sigma^2)T}{\sqrt{\sigma^2 T}}\big)\Big] \tag{32}$$

is the price of a zero coupon bond in the standard Merton model without LBO risk.

B.2 A model with stationary leverage ratios and LBO risk

Assume as in Collin-Dufresne and Goldstein (2001) that the firm targets a long-run leverage ratio and that the dynamics of the log of the amount of debt, k_t, are given by

$$dk_t = \phi(\nu - (k_t - y_t))dt. \tag{33}$$

If we define log-leverage as $l_t = k_t - y_t$, then the intuition is that if l_t is less than ν, the firm increases the amount of debt and vice versa, i.e. log-leverage is stationary around a mean leverage of ν. This specification captures the idea that the firm tends to issue more debt when leverage is low and tends to retire debt when leverage is high. Ito's Lemma gives that

$$dl_t = \phi(\bar{l} - l_t)dt - \sigma dW_t^V \tag{34}$$

where $\bar{l} = \frac{-r+\delta+\frac{1}{2}\sigma^2}{\phi} + \nu$. We assume that all debt has equal priority and matures at time T, i.e. if the firm issues more debt, it issues more debt with the same maturity and seniority as existing debt. The firm can only default at bond maturity T and it does so if firm value is below the face value of all debt K_T. If the firm defaults, bondholders receive a fraction α of the face value of debt.

As in the previous section, we assume that the firm can potentially undergo an LBO that occurs at time τ (and thereafter no more LBOs can occur), in which case the firm issues more debt (with same maturity and seniority as existing debt). To capture that leverage jumps after the LBO and that the target leverage is higher after an LBO, we assume that the total amount of debt immediately after the LBO is $K_\tau e^J$ where J is normally distributed with mean η and standard deviation ς, while the target log-leverage after the LBO changes from ν to $\nu + J$. We assume that the LBO event follows a Cox process with intensity λ_t where λ_t follows a CIR process,

$$d\lambda_t = \kappa(\theta - \lambda_t)dt + \xi\sqrt{\lambda_t}dW_t^\lambda. \tag{35}$$

and that there is no risk premium associated with LBO risk. If we are at time 0 and define the expected payoff at maturity T of the risky zero coupon bond as $w(T)$ we have that

$$w(T) \quad = \quad E[\alpha + (1-\alpha)1_{\{l_T>0\}}|\tau > T]P(\tau > T) + E[\alpha + (1-\alpha)1_{\{l_T>0\}}|\tau \leq T]P(\tau \leq T) \tag{36}$$

where $P(\tau > T)$ is given in equations (25)-(29).

In the event of no LBO ($\tau > T$), we have that the dynamics of l_t given in equation (34) are an Ornstein-Uhlenbeck process, and it is well-known that the conditional distribution $l_t|l_0, \tau > T$ is normally distributed with mean $\bar{l} + (l_0 - \bar{l})e^{-\phi t}$ and variance $\frac{\sigma^2}{2\phi}(1 - e^{-2\phi t})$. This implies that

$$E[1_{\{l_T>0\}}|\tau > T] = N\Big(\frac{\bar{l} + (l_0 - \bar{l})e^{-\phi T}}{\sqrt{\frac{\sigma^2}{2\phi}(1 - e^{-2\phi T})}}\Big). \tag{37}$$

It is useful to define the l_t^{LBO} as the leverage process in case of an LBO at time τ and l_t as the leverage process if no LBO happens before T. Then $l_t^{LBO} = l_t$ when $t < \tau$ and $l_\tau^{LBO} = l_\tau + J$. Because the new target log-leverage is $\nu + J$, the dynamics of log-debt immediately after the LBO are

$$dk_\tau^{LBO} = \phi(\nu + J - l_\tau^{LBO})dt = \phi(\nu + J - (l_\tau + J))dt = \phi(\nu - l_\tau)dt, \tag{38}$$

and we see that k^{LBO} and k have the same rate of change at all times except when leverage jumps at τ. Since asset value is not affected by an LBO, l^{LBO} and l have the same rate of change at all times except at τ, so $l_t^{LBO} = l_t + J$ for any $t > \tau$. Thus, the conditional distribution $l_t|l_0, \tau \leq T$ is normally distributed with mean $\bar{l} + (l_0 - \bar{l})e^{-\phi t} + \eta$ and variance $\frac{\sigma^2}{2\phi}(1 - e^{-2\phi t}) + \varsigma^2$. Overall, this implies that

$$E[1_{\{l_T>0\}}|\tau \leq T] = N\Big(\frac{\bar{l} + (l_0 - \bar{l})e^{-\phi T} + \eta}{\sqrt{\frac{\sigma^2}{2\phi}(1 - e^{-2\phi T}) + \varsigma^2}}\Big). \tag{39}$$

window	ΔCDS	E(ΔCDS)	abn. return	t-stat
Panel A: 5-year CDS				
[-22,-12]	17.4	1.6	3.90	1.68
[-11,-1]	28.5	2.6	14.89**	2.89
[0,1]	45.4	22.7	24.65*	2.61
[2,21]	11.2	0.5	0.33	0.77
[-22,5]	94.2	2.1	43.77**	3.69
Panel B: All bonds				
[-22,-12]			-0.99	-1.19
[-11,-1]			-0.73	-1.32
[0,1]			-2.75**	-3.40
[2,21]			0.22	0.34
[-22,5]			-4.18**	-3.71
Panel C: Unprotected bonds				
[-22,-12]			-1.18	-1.02
[-11,-1]			-0.84	-1.11
[0,1]			-3.29**	-3.00
[2,21]			0.20	0.18
[-22,5]			-5.05**	-3.35
Panel D: Protected bonds				
[-22,-12]			-0.18	-0.48
[-11,-1]			-0.25	-0.59
[0,1]			-0.44	-0.94
[2,21]			0.38	1.01
[-22,5]			-0.40	-0.60
Panel E: Equity				
[-22,-12]			0.49*	2.40
[-11,-1]			1.82**	3.26
[0,1]			10.86**	7.47
[2,21]			0.75	1.72
[-22,5]			13.58**	7.80

Table 1: *Reaction of CDS, bond, and equity prices of the target firm around LBO announcements.* This table displays the results of the event study of CDS returns around LBO announcements. The first column reports the time window in days relative to the announcement day. The second column reports the average total change in the CDS spread (in basis points) in the window, while the third volumn reports the average change per day in the CDS spread (in basis points) in the window. The fourth column reports the average total abnormal return (in percent) in the window. The fifth column reports the t-statistics of the average total abnormal return (one star denotes significance at the five-percent level and two stars at the one-percent level). Panel A is based on 42 firm observations, Panel B on 230 bonds (issued by 45 firm), Panel C on 187 bonds (issued by 28 firms), Panel D on 43 bonds (issued by 21 firms), and Panel E on 93 firm observations. The t-statistics in Panel B-D account for return correlation of bonds issued by the same firm. The sample period is 2002-2015.

dep.var: LBO^i_t				
t equals one month				
LBO^i_{t-1}	0.58** (0.004)	0.56** (0.005)	0.37** (0.005)	0.37** (0.005)
Constant	0.13** (0.004)			
Number of observations	34480	34480	34480	34480
adjusted R^2	0.337	0.351	0.429	0.429
time fixed effects	No	Yes	No	Yes
industry fixed effects	No	No	Yes	Yes
t equals one quarter				
LBO^i_{t-1}	0.81** (0.006)	0.79** (0.006)	0.63** (0.007)	0.63** (0.007)
Constant	0.19** (0.014)			
Number of observations	11440	11440	11440	11440
adjusted R^2	0.636	0.643	0.675	0.675
time fixed effects	No	Yes	No	Yes
industry fixed effects	No	No	Yes	Yes
t equals one year				
LBO^i_{t-1}	0.97** (0.008)	0.97** (0.008)	0.86** (0.012)	0.86** (0.012)
Constant	0.35** (0.072)			
Number of observations	2800	2800	2800	2800
adjusted R^2	0.830	0.848	0.854	0.854
time fixed effects	No	Yes	No	Yes
industry fixed effects	No	No	Yes	Yes

Table 2: *LBOs in an industry predict further LBOs.* This tables shows the regression of the number of LBOs at time t in industry i on the number of LBOs at time $t-1$ in industry i. LBOs are according to Thomson Financial LBO announcements and from 1980-2014. Industry is determined at the 2-digit SIC level. Standard errors are in parantheses. ** and * indicate significance at the 1 and 5% level, respectively.

window	ΔCDS	E(ΔCDS)	abn. return	t-stat
Panel A: 5-year CDS				
[-22,-12]	0.6	0.1	0.65	-0.28
[-11,-1]	1.0	0.1	0.93	1.17
[0,1]	1.8	0.9	3.00**	3.98
[2,21]	1.1	0.1	5.35**	4.90
[-22,5]	4.5	0.1	9.93**	5.52
Panel B: All bonds				
[-22,-12]			-0.04	-0.32
[-11,-1]			-0.66**	-6.38
[0,1]			-0.12	-1.51
[2,21]			-0.10	-0.47
[-22,5]			-0.95**	-6.27
Panel C: Unprotected bonds				
[-22,-12]			-0.08	-0.76
[-11,-1]			-0.68**	-6.36
[0,1]			-0.14	-1.62
[2,21]			-0.08	-0.38
[-22,5]			-1.02**	-7.44
Panel D: Protected bonds				
[-22,-12]			0.62	0.65
[-11,-1]			-0.39	-1.11
[0,1]			0.12	0.70
[2,21]			-0.33	-0.68
[-22,5]			0.10	0.20
Panel E: Equity				
[-22,-12]			0.22	0.86
[-11,-1]			-0.34	-1.75
[0,1]			0.91**	9.99
[2,21]			-0.39	-1.77
[-22,5]			0.74**	3.31

Table 3: *Intra-industry reaction of CDS, bond, and equity prices around LBO announcements.* For every LBO announcement, this event study examines the CDS, equity, and bond return reaction of all firms in the same industry as the LBO target (and excludes the LBO target). Industry is defined according to 2-digit SIC code. The first column reports the time window in days relative to the announcement day. The second column reports the average total change in the CDS spread (in basis points) in the window, while the third volumn reports the average change per day in the CDS spread (in basis points) in the window. The fourth column reports the average total abnormal return (in percent) in the window. The fifth column reports the t-statistics of the average total abnormal return (one star denotes significance at the five-percent level and two stars at the one-percent level). Panel A is based on 462 firm observations, Panel B on 1148 bonds (issued by 333 firm), Panel C on 1075 bonds (issued by 312 firms), Panel D on 73 bonds (issued by 30 firms), and Panel E on 524 firm observations. The t-statistics in Panel B-D account for return correlation of bonds issued by the same firm. The sample period is 2002-2015.

	mean	quantiles						
		0.05	0.10	0.25	0.50	0.75	0.90	0.95
Intercept	46.10	-145.51	-116.10	-63.00	16.07	112.17	186.40	314.56
	(38.90)							
Event risk covenant	8.59*	-18.35	-9.48	-2.94	6.51	18.69	29.92	33.56
	(3.38)							
AA+	0.49	-40.22	-21.45	0.00	0.00	5.90	19.39	32.97
	(2.94)							
AA	5.50	-56.69	-39.71	-6.88	8.13	21.09	40.49	49.94
	(4.51)							
AA-	11.57**	-55.07	-33.53	-6.25	13.67	33.18	45.54	57.65
	(4.18)							
A+	26.19**	-43.85	-23.11	6.72	29.72	43.79	63.44	80.00
	(5.12)							
A	33.28**	-29.28	-11.21	16.13	35.16	51.27	72.69	89.46
	(5.21)							
A-	62.10**	-29.07	7.81	37.15	55.74	83.51	111.33	159.86
	(10.03)							
BBB+	92.24**	18.47	35.41	60.95	80.43	103.95	148.46	235.81
	(15.10)							
BBB	114.48**	28.39	45.55	71.54	107.34	141.91	178.45	237.34
	(16.87)							
BBB-	162.68**	51.61	77.79	109.90	151.34	202.93	262.07	319.01
	(20.47)							
Maturity	−4.28*	-22.53	-16.34	-7.08	-0.98	1.68	3.45	5.08
	(2.07)							
Maturity^2	0.13*	-0.12	-0.05	-0.01	0.05	0.21	0.43	0.60
	(0.05)							
Call	−9.65	-50.59	-37.98	-22.20	-9.51	4.54	17.03	25.10
	(5.40)							
Log amount outstanding	4.99*	-8.50	-6.14	-0.59	5.37	10.56	15.80	20.44
	(2.01)							
R^2	0.52	0.33	0.38	0.46	0.53	0.59	0.62	0.65
Sample size	259	147	152	201	253	326	374	400
E(Yield spread)	161.21	97.41	107.12	124.16	140.16	174.19	214.88	306.12

Table 4: *Event risk covenant regression as in Crabbe(1991).* On a monthly basis we estimate a cross-sectional regression as in Crabbe(1991) in the period 2002:07-2015:09. This results in 159 monthly cross sectional regressions and the table shows the distribution of the 159 regression coefficients. The sample in a given month includes senior unsecured U.S. industrial bonds issued in the previous 14 months, a maturity between 7 and 100 years, a rating of BBB- or higher, and excludes putable, convertable, asset-backed, and variable-coupon bonds. The dependent variable is the bond yield spread (relative to a maturity-matched Treasury yield) and is based on the last transaction in the TRACE database for the bond in the corresponding month. Each month negative yield spreads are set to 0 and winsorized at 99%. 'Event risk covenant' is 1 if the bond has an event risk covenant and 0 otherwise. The variables AA+ to BBB- are dummy variables for the bond rating at transaction date and 'Maturity' is the remaining time to maturity at transaction date. 'Call' is 1 if the bond is callable and 0 otherwise. 'Log amount outstanding' is the log of the face value of the issue. For a given month 'Sample size' is the number of yield spread observations, 'E(Yield spread)' is the average yield spread, and 'R^2' is the R^2 of the cross sectional regression. The parentheses in the panel show adjusted Fama-MacBeth standard errors and '*' denotes significance at the 5% level and '**' at the 1% level.

	bonds with Event Risk Covenant	bonds without Event Risk Covenant
Senior unsecured	yes	yes
Puttable	no	no
Convertable	no	no
Asset-backed	no	no
Fixed coupon	yes	yes
US-denominated	yes	yes
Callable	yes	yes
Industry	industrial	industrial
Maturity	17.09	18.39
Log amount outstanding	13.15	12.08
Other covenants	0.176	0.110
Amihud ($\times 10^9$)	2,180	8,229
Roll	0.0113	0.0141
Number of observations	14,850	14,066

Table 5: *Sample of bonds with and without a event risk covenant issued by the same firm.* This table provides summary statistics of the bonds used in a panel regression that examines the relation between the bond yield spread and inclusion of an event risk covenant. We restrict the sample to senior unsecured U.S. industrial bonds with a maturity of more than seven years, an investment grade rating (BBB- or higher), and exclude non-callable, putable, convertable, asset-backed, and variable-coupon bonds. In a given month we furthermore find all firms that have at least one bond outstanding with and one bond outstanding without an event risk covenant and use all bonds from these firms in the corresponding month. We do this for 159 months in the sample period 2002:07-2015:09. The yield spread (relative to a maturity-matched Treasury yield) in a given month is based on the last transaction in the TRACE database for the bond in the corresponding month (each month negative yield spreads are set to 0 and winsorized at 99%). 'Maturity' is the remaining time to maturity at transaction date. A bond can have up to 47 covenants, excluding the event risk covenant, and 'other covenants' is $\frac{\text{number of other covenants}}{47}$. 'Log amount outstanding' is the log of the face value of the issue. 'Amihud' and 'Roll' are bond liquidity measures calculated using all transactions within the month following the methodology in Dick-Nielsen, Feldhütter, and Lando (2012). 'Number of observations' is the number of yield spread observations.

Dependent variable	Yield spread						
Specification	1	2	3	4	5	6	7
Event risk covenant	-25.04^{**}	-20.66^{**}	-26.20^{**}	-21.02^{**}	-20.65^{**}	-20.67^{**}	-20.67^{**}
	(3.94)	(2.71)	(3.20)	(2.76)	(2.71)	(2.71)	(2.71)
Other covenants		-10.37	10.99	-13.11	-10.37	-10.34	-10.33
		(31.79)	(36.61)	(31.95)	(31.79)	(31.81)	(31.80)
Log amount outstanding		1.09	1.22	1.64	1.09	1.09	1.09
		(3.94)	(5.23)	(3.94)	(3.94)	(3.94)	(3.94)
Maturity		1.82^{**}		1.16^{**}	1.82^{**}	1.82^{**}	1.82^{**}
		(0.18)		(0.15)	(0.18)	(0.18)	(0.18)
Maturity^2		-0.01^{**}			-0.01^{**}	-0.01^{**}	-0.01^{**}
		(0.002)			(0.002)	(0.002)	(0.002)
Amihud ($\times 10^9$)					0.40		0.67
					(0.38)		(0.50)
Roll						-3.48	-5.40
						(6.01)	(5.69)
firm $\times$ month fixed effects	yes	yes	yes	yes	yes	yes	yes
Mean dependent variable	181.13	181.13	181.13	181.13	181.13	181.13	181.13
R^2	0.837	0.850	0.837	0.849	0.850	0.850	0.850
Number of observations	28,916	28,916	28,916	28,916	28,916	28,916	28,916
Number of firms	136	136	136	136	136	136	136

Table 6: *Event risk covenant regression based on firms that have both bonds with and without a event risk covenant outstanding.* This table shows a panel regression of the bond yield spread on an event risk covenant dummy and controls. We restrict the sample to senior unsecured U.S. industrial bonds with a maturity of at least seven years, an investment grade rating (BBB- or higher), and exclude non-callable, putable, convertable, asset-backed, and variable-coupon bonds. In a given month we furthermore find all firms that have at least one bond outstanding with and one bond outstanding without an event risk covenant and use all bonds from these firms in the corresponding month. We do this for 159 months in the sample period 2002:07-2015:09 and estimate a panel regression. The dependent variable is the bond yield spread (relative to a maturity-matched Treasury yield) and is based on the last transaction in the TRACE database for the bond in the corresponding month. Each month negative yield spreads are set to 0 and winsorized at 99%. 'Event risk covenant' is 1 if the bond has an event risk covenant and 0 otherwise. A bond can have up to 47 covenants, excluding the event risk covenant, and 'other covenants' is $\frac{\text{number of other covenants}}{47}$. 'Log amount outstanding' is the log of the face value of the issue. 'Maturity' is the remaining time to maturity at transaction date. 'Amihud' and 'Roll' are bond liquidity measures calculated using all transactions within the month following the methodology in Dick-Nielsen, Feldhütter, and Lando (2012). 'Number of observations' is the number of yield spread observations and 'Mean dependent variable' is the average yield spread. The parentheses in the panels show standard errors that are clustered at the firm level. '*' denotes significance at the 5% level and '**' at the 1% level.

Panel A: Ex-post reaction to LBO (in percent)							
Bond maturity (in years)	0-2	2-4	4-6	6-8	8-10	10-20	20-40
Data	-0.5	-0.8	-3.6	-6.8	-8.7	-9.0	-7.7
Merton model	-0.1	-3.3	-5.8	-7.0	-7.5	-7.4	-5.3
Stationary leverage model	-0.0	-2.3	-5.0	-6.8	-7.9	-8.9	-7.1

Panel B: Ex-ante contribution of LBO risk to credit spreads (in basis points)												
Bond maturity (in years)	1	2	3	4	5	6	7	10	15	20	25	30
Merton model	1.8	5.5	9.0	11.7	13.7	15.2	16.2	17.6	17.8	17.0	15.9	14.8
Stationary leverage model	0.4	3.1	6.9	10.3	13.2	15.5	17.4	21.0	23.5	23.8	23.4	22.7

Table 7: *Contribution of LBO risk to credit spreads across maturities.* For a typical firm with leverage of 33% and asset volatility of 24%, we calculate the contribution of LBO risk to the credit spread in the structural models as outlined in Section 4.3. Panel A shows the actual and model-implied bond price reactions to an LBO announcement. Actual bond price reactions are calculated using the same set of unprotected bond as those used in Table 1 and the reaction is for the event period $[-22; 6]$. Panel B shows the difference (in basis points) in model-implied credit spreads with and without LBO risk. The intensity of an LBO in the structural model is given as $d\lambda_t = \kappa(\theta - \lambda_t)dt + \xi\sqrt{\lambda_t}dW_t^\lambda$ and if an LBO happens, the log change in the face value of debt is distributed by $J \sim N(\eta, \varsigma)$. The LBO intensity parameters are estimated in Section 4.3 to be $\kappa = 0.1946, \theta = 0.0215, \xi = 0.0511$. In the estimation of the contribution of LBO risk to credit spreads in Panel B, we set the value of λ equal to the average LBO probability during 1980-2014 of 0.0183. The leverage jump standard deviation is set to $\varsigma = 0.2$ and the jump mean η is estimated for each of the two structural models such that the RMSE of the mean difference between the percentage bond price reaction across bond maturity in the data and in the model is minimized. The estimated jump mean is $\eta^{Merton} = 0.4216$ in the Merton model and $\eta^{stationary\ leverage} = 0.3021$ in the stationary leverage model.

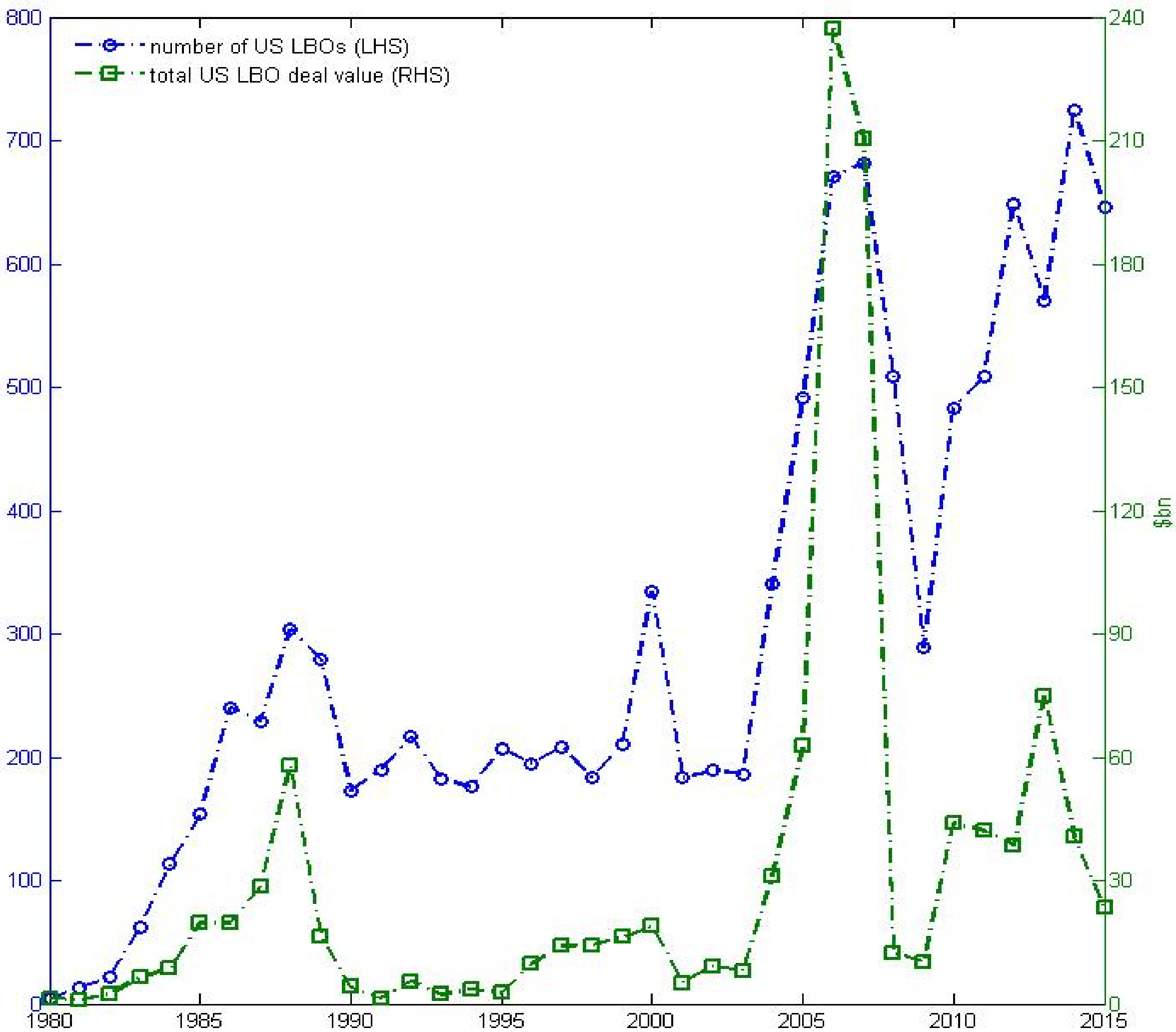

Figure 1: *LBO activity 1980-2015.* This figure displays the number (left axis) and total value (right axis, in billions of dollars) of announcements on US LBO targets over the years 1980-2015. Total value is calculated as the total value of equity of target firms and constitutes a lower bound on the actual value, as only 16.2 % of deals have information on the value of equity (likely because the target in these deals is not a public company). Data on LBO announcements are retrieved from Thomson One Banker.

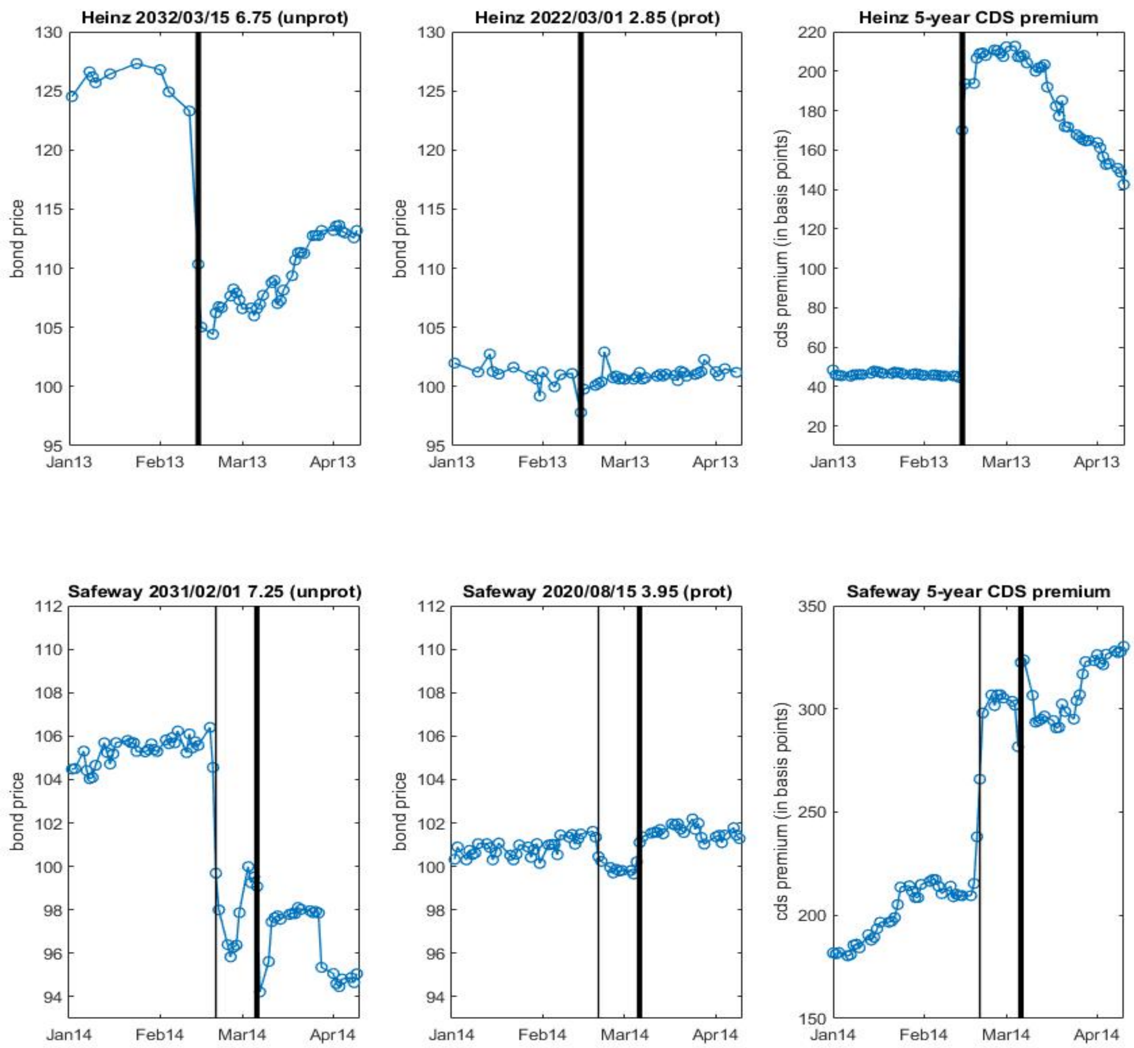

Figure 2: *Heinz and Safeway bond prices and CDS premiums around LBO announcement.* The top three graphs show Heinz bond prices and 5-year CDS premium and the vertical line marks February 14, 2013, the date where Heinz was taken private in an LBO deal. The Heinz bond expiring 2032 had no event risk covenant, while the 2022 Heinz bond had such a covenant. The bottom three graphs show Safeway bond prices and 5-year CDS premium. On February 19, 2014 Safeway announced that it was "in discussions concerning a possible transaction involving the sale of the company" and this date is marked with a thin vertical line. The thick vertical line marks March 6, 2014, when it was announced that Safeway was bought out in an LBO deal. The 2031 Safeway bond had no event risk covenant, while the 2020 Safeway bond did have an event risk covenant. The bond price on a given day is calculated as the average price of all transactions in TRACE.

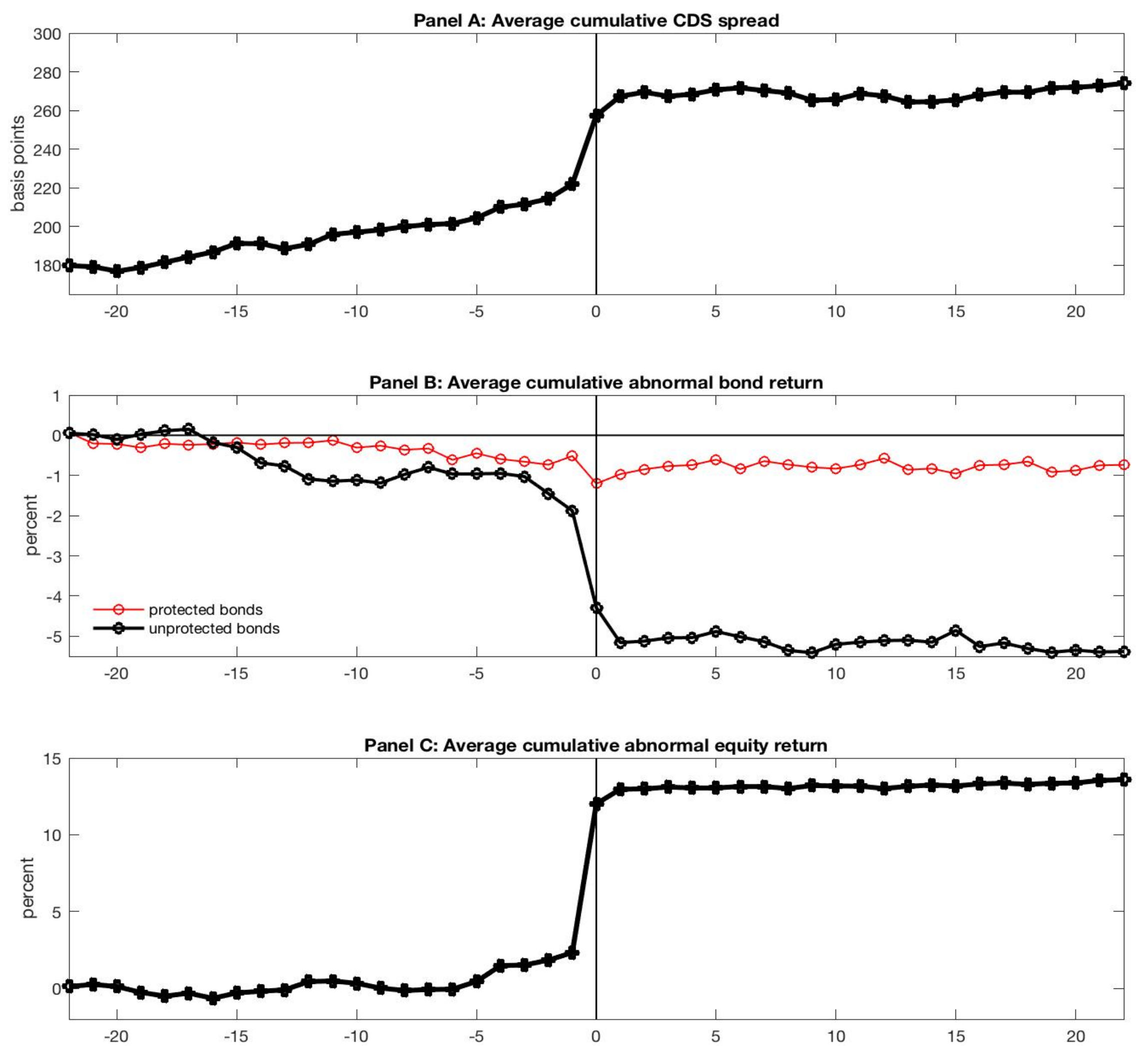

Figure 3: *CDS, bond, and equity returns of the target firm around LBO announcements.* Panel A shows the average 5-year CDS spread (based on 42 firms). Panel B shows the cumulative average abnormal percentage log return in the bonds. 'Protected bonds' is based on 43 (issued by 21 firms) bonds while 'unprotected bonds' is based on 187 bonds (issued by 28 firms). Panel C shows the average abnormal equity return (based on 93 firms). Day 0 is the day the LBO is announced and the time period is 2002-2015.

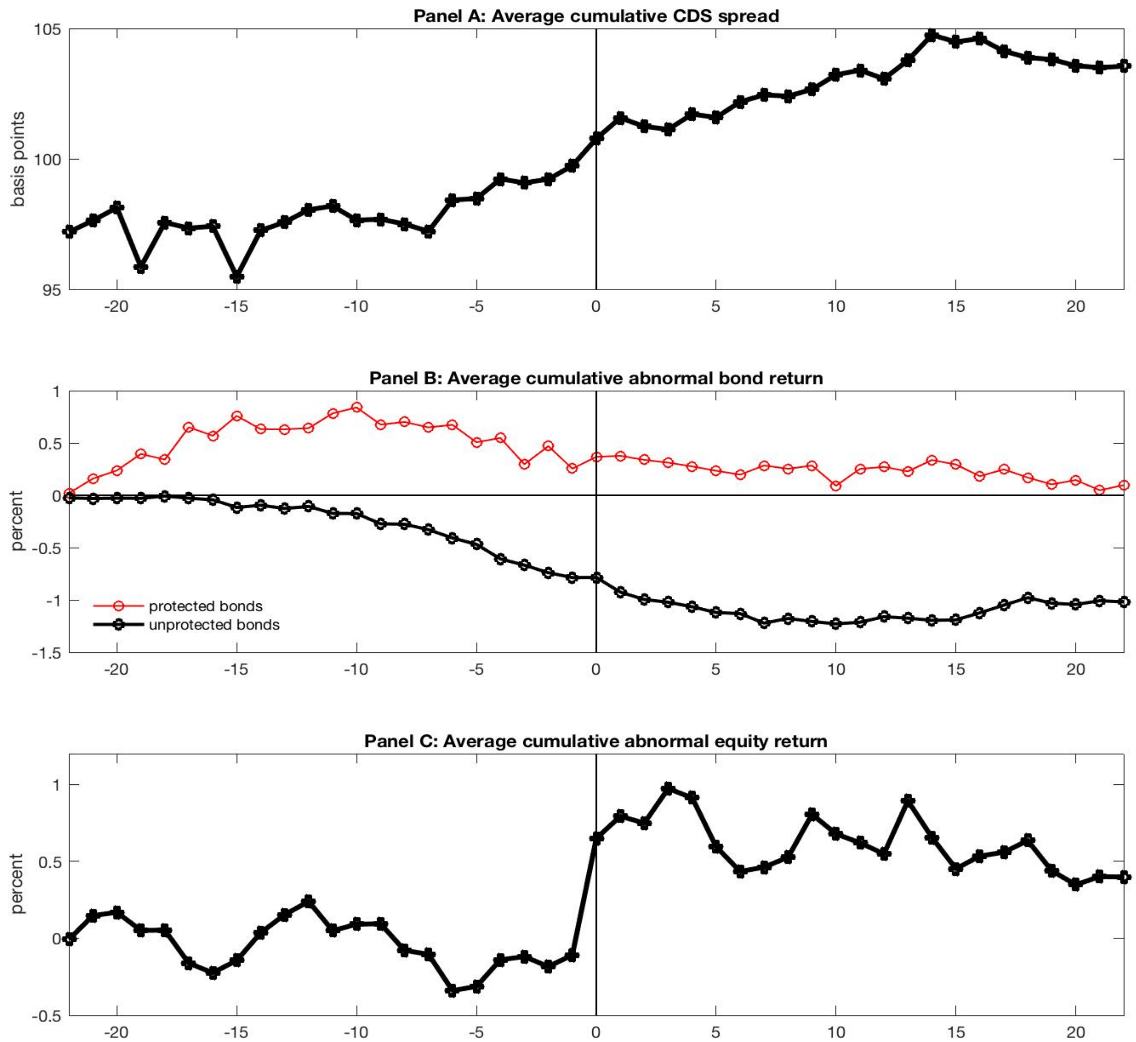

Figure 4: *CDS, bond, and equity returns of other firms in same industry around LBO announcements.* Panel A shows the average 5-year CDS spread (based on 462 firms). Panel B shows the cumulative average abnormal percentage log return in the bonds. 'Protected bonds' is based on 73 bonds (issued by 30) firms while 'unprotected bonds' is based on 1075 bonds (issued by 312 firms). Panel C shows the average abnormal equity return (based on 524 firms). Day 0 is the day the LBO is announced and the time period is 2002-2015.

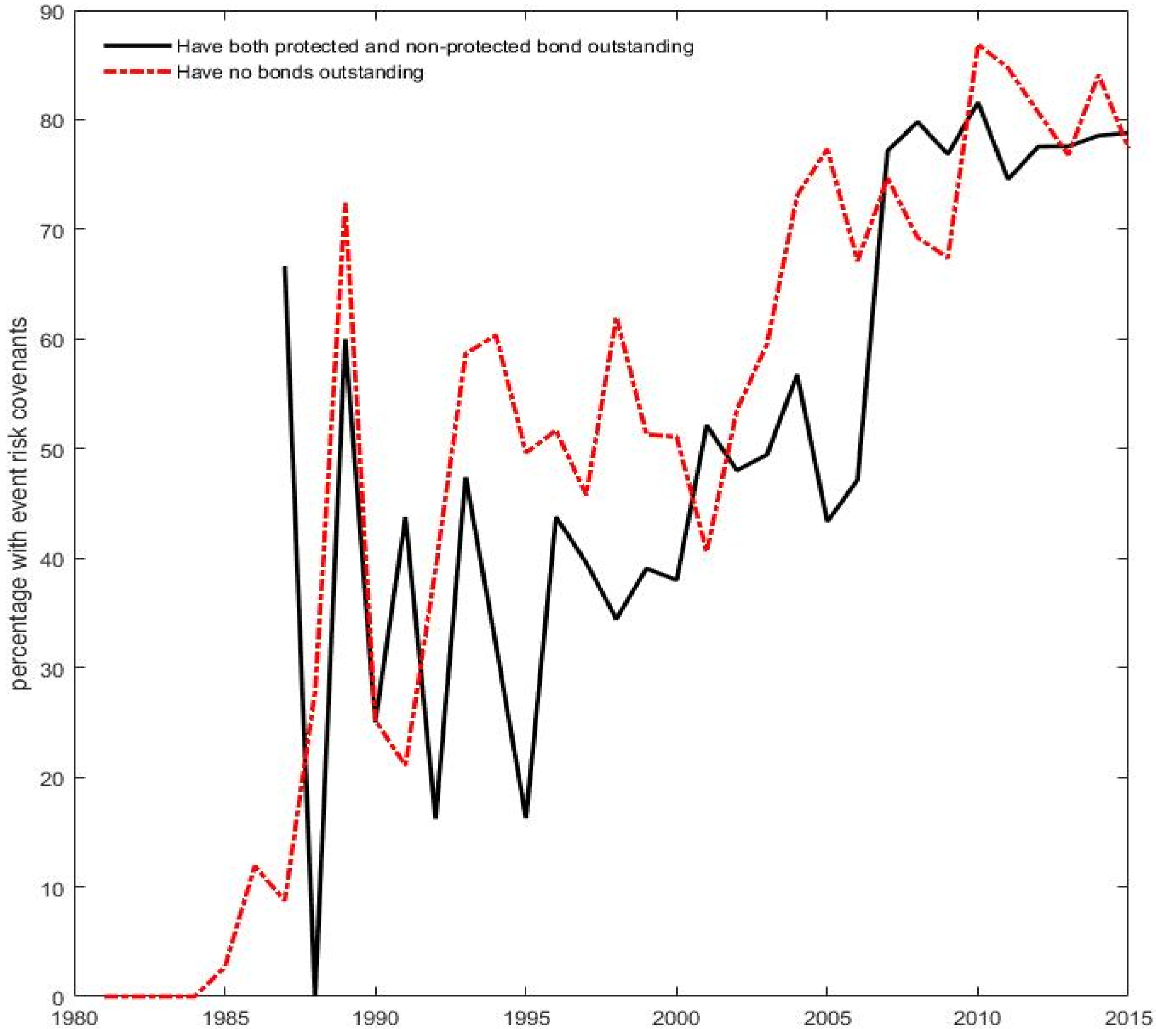

Figure 5: *New bond issues and event risk covenants conditional on past issuance.* This figure reports the percentage of new issues with event risk covenants over the years 1980-2015, as retrieved from the Mergent FISD database. The percentage is out of the issues for which information is available in FISD and an issue is marked as having an event risk covenant if the issue has a "change of control put provision". 'Have both protected and non-protected bond outstanding' reflects issues where at bond issuance the issuing firm had at least one protected bond and one unprotected bond outstanding. 'Have no bonds outstanding' refers to the case where the issuing firm had no outstanding bonds at issuance.

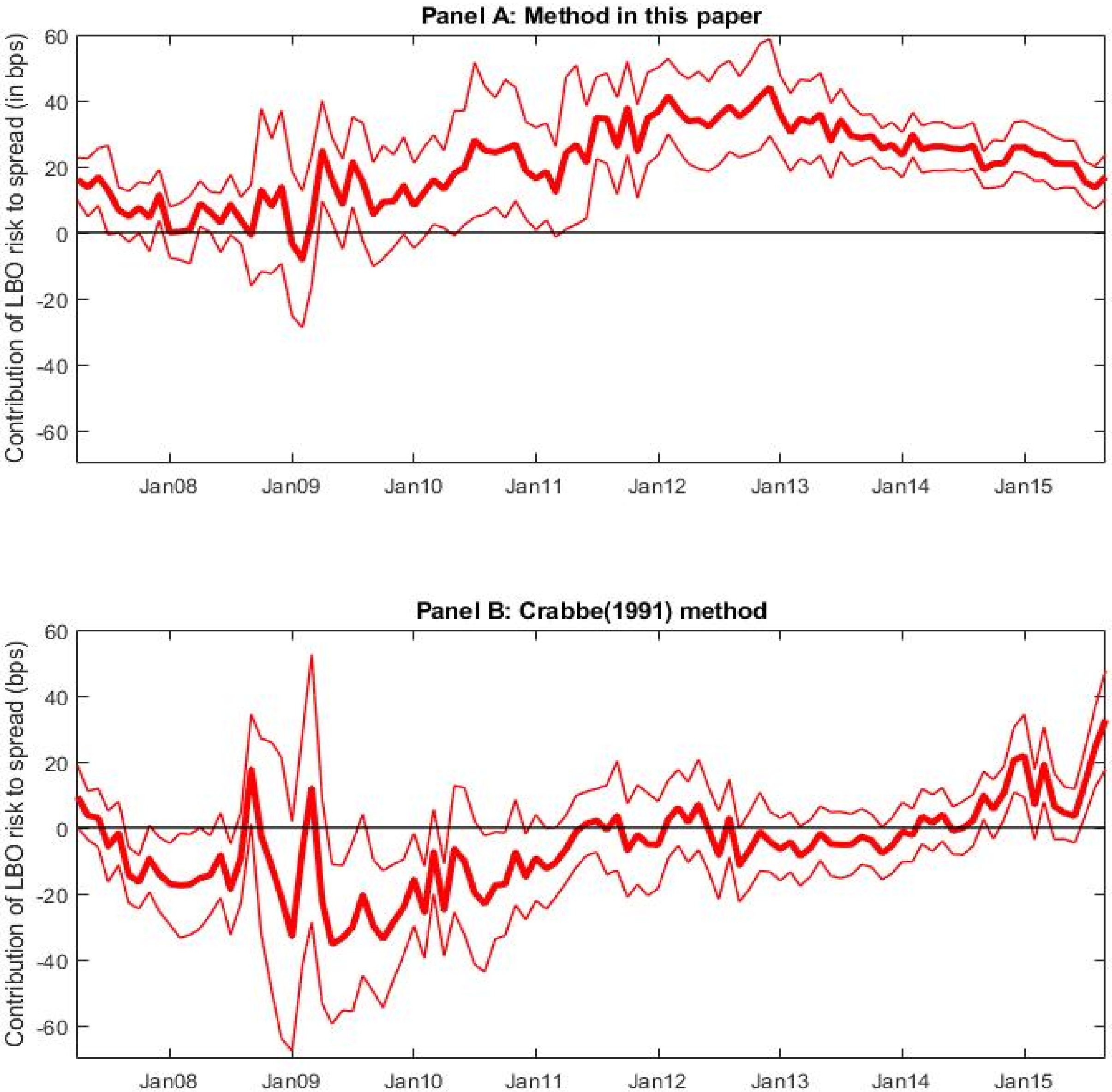

Figure 6: *The contribution of LBO risk to credit spreads estimated using event risk covenants in bonds.* We propose a regression approach where we restrict the firms to those that have both a bond with and without an event risk covenant outstanding and include firm-fixed effects in monthly regressions of the yield spread on a dummy for the inclusion of an event risk covenant and controls. The dummy is a measure of the contribution of LBO risk to credit spreads. Panel A shows the negative of the monthly regression coefficient, i.e. a positive value in the graph represents a positive contribution of LBO risk to credit spreads. On a monthly basis, Crabbe(1991) estimates a cross-sectional regression of corporate bond yield spreads on a dummy for the inclusion of an event risk covenant and controls and Panel B shows the negative of the monthly regression coefficient, i.e. a positive value in the graph represents a positive contribution of LBO risk to credit spreads. Both graphs show a 95% confidence interval based on the monthly standard deviations in the regressions.

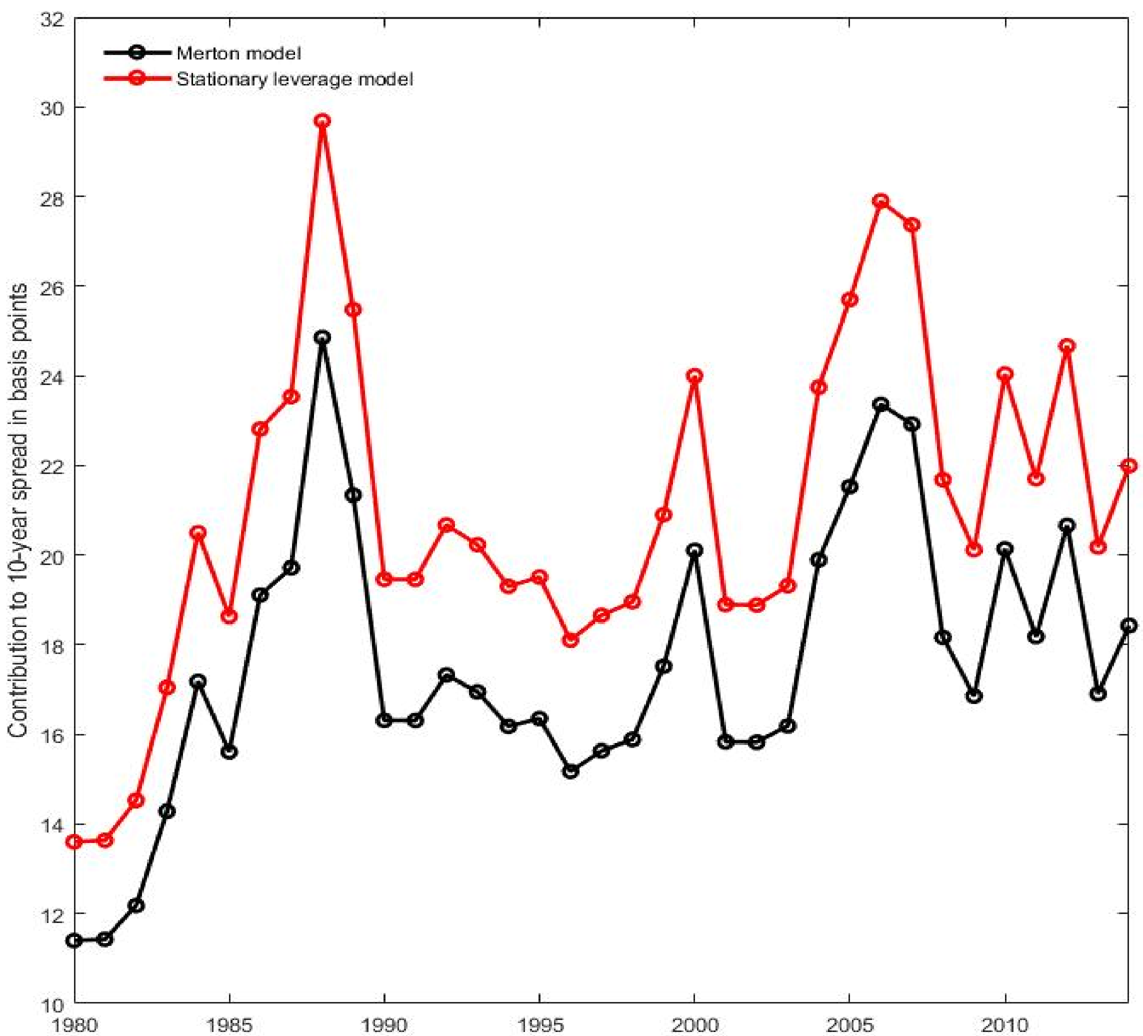

Figure 7: *The contribution of LBO risk to the ten-year credit spread of a typical firm.* For a typical firm in the corporate bond market with leverage of 33% and asset volatility of 24%, we calculate the time-varying contribution of LBO risk to the ten-year credit spread in the structural model outlined in Section 4.3. This figure shows the difference (in basis points) in model-implied credit spreads with and without LBO risk.