Leveraged Buyouts and Credit Spreads

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Abstract

We study the impact of LBO restructuring risk on corporate credit spreads. Using an extensive dataset of LBOs, CDSs and bonds, we first study the reaction of credit spreads of target firms to LBO announcements in the US during the years 2001-2015. We find that CDS spreads increase by around 60% for investment grade bonds and find a negative reaction in prices of corporate bonds. We then proceed to show that LBO risk is priced ex-ante by investors in debt markets. First, we find in a panel regression that firms more likely to undergo an LBO have spreads that are higher by 30-50 bps. Second, we show that intra-industry CDS spreads increase in response to LBO announcements, consistent with increased LBO activity causing higher credit spreads. Finally, we propose a structural Merton (1974) model with LBO risk to study the contribution to credit spreads over time and across maturity. The model implies an increase of 30-35 bps in credit spreads due to LBO risk in periods with high LBO activity and around 5 bps in periods with low LBO activity. The average contribution of LBO risk to credit spreads is 0 bps at one-year maturity, and increases to 15 bps at 10-year maturity. Overall, our results imply that LBO risk contribute significantly to corporate credit spreads.

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1 Introduction

The years 2004-2007 saw unprecedented leveraged buyout (LBO) activity, leading to a rise in credit risk and subsequent defaults. In 2013, The Federal Reserve provided new debt guidelines in a response to a worry that "while leveraged lending declined during the crisis, volumes have since increased and prudent underwriting practices have deteriorated".[1] In late 2015 Standard & Poors warned that excessive leverage in the leveraged buyout market had increased credit risk and 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".[2]

This paper studies the effect of leveraged buyouts on credit spreads and is the first to examine the effect in the cross-section, time series, and maturity structure of credit spreads. Using a dataset of LBOs, CDSs and bonds, we first study the reaction of credit spreads of target firms to LBO announcements in the US during the years 2001-2015. We complement this study by quantifying the effect in equity markets, to address the fundamental questions of value creation and wealth transfer in buyouts. After establishing LBOs as a significant concern for debt investors, we proceed to examine the importance of LBO risk on pricing in debt markets. First, using exogenous industry variables, we find that higher LBO risk is, indeed, associated with significantly wider spreads. Second, we document a significant increase in intra-industry CDS spreads around LBO announcements. Finally, we propose a structural model and investigate the varying impact over time and on the term structure of credit spreads.

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 very high leverage, and as a result, LBOs typically cause a dramatic change in the risk profile of the target firm; according to Fitch LBOs comprised 31% of total defaults in their U.S. High Yield index in 2007-2014.[3]

Using a comprehensive dataset of LBOs, CDS and bonds, we first study the reaction of target firm credit spreads to LBO announcements in the US during the years 2001-2015. We find that on average the 5-year CDS spread of investment grade firms widen by 56% or 95 bps around the announcement. We also study reaction in bond markets, differentiating between bonds protected by event risk covenants and those that are not, to control for takeover protection. We document a negative reaction of 5% in prices of unprotected bonds and a small but insignificant negative reaction of 0.6% for unprotected bonds. A similar analysis for the equity market shows a 13.5% abnormal return, and back-of-the-envelope calculation shows that gains to shareholders are due, in large, to value creation rather than wealth transfer from bond holders to equity holders.

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

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

[3] https://www.fitchratings.com/gws/en/fitchwire/fitchwirearticle/LBOs-31%25-of?pr_id=832029.

Despite the obvious negative consequences for existing debt holders in target firms ex-post, there has been almost no research examining the effect of LBO risk on the pricing of public corporate debt ex ante. This is the main question that we address and we approach the question in different ways, thereby providing robust evidence.

To separate the effect of LBO probability from the direct effect of firm characteristics on credit spreads, we use an exogenous industry-level probability. The probability is the number of recent LBOs in an industry divided by the number of firms in the same industry. We motivate this approach by showing that there is significant industry clustering in buyout activity over time, consistent with previous work (Harford, Stanfield, and Zhang (2015) and Lehn, Netter, and Poulsen (1990)). We find that firms that are more likely to undergo an LBO in the future have spreads that are higher by 30-50 bps. The effect is stronger in 2005-2007 and 2012-2014, periods with high LBO activity. Furthermore, we find the effect to be more pronounced in firms with low equity volatility, high asset tangibility, and low market-to-book; firm characteristics that are associated with likely LBO targets.

Harford, Stanfield, and Zhang (2015) find that LBOs predict more LBOs in the same industry and we therefore investigate intra-industry CDS spread reactions around LBO announcements. To the extent that investors revise upward the likelihood of future LBOs in the same industry, credit spreads should increase. We do find a significant intra-industry spread increase of 8.6% around the announcement, providing further evidence that LBO risk has a sizeable influence on credit spreads. An alternative explanation for the increase in spreads is that an LBO signals increased competition and investors revise downward firm values. In this case spreads would increase and equity values go down. However, we show that intra-industry equity values increase around LBO announcements, suggesting that higher LBO likelihood is the main driver of the spread increase.

In the final part of the paper, we propose a structural model with LBO risk and derive closed-form solutions for credit spreads. In Merton (1974)'s model the firm has issued a zero-coupon bond and defaults if firm value is below the face value of debt at maturity. We extend Merton's model by assuming that there is a time-varying probability – governed by an underlying intensity – that the firm undergoes an LBO in which case the value of debt jumps. To investigate the time series effect of LBO risk on credit spreads viewed through the lense of the model, we use the economy-wide number of LBOs divided by the number of firms as a proxy for the unobserved LBO intensity. We find that the impact on the five-year credit spread of a typical BBB-rated firm ranges from only five bps in the early eighties to around 30 bps in the active LBO periods 2005-2007 and 2012-2014. To examine the impact of LBO risk on the term structure of credit spreads we calculate the impact for a typical firm in an average year and find the contribution to be a trivial 0.2 bps at a one-year maturity while it is 10.3 bps respectively 14.8 bps at the five-year respectively 10-year maturity. Thus, LBO risk has little impact at very short maturities but increases the slope of the term structure of credit spreads.

There is an extensive early literature documenting ex-post wealth losses to bondholders around LBOs (Warga and Welch (1993), Asquith and Wizmann (1990), Marais, Schipper, and Smith (1989), and others), but despite this well-documented fact, there is almost no literature examining the effect of LBO risk on credit spreads ex ante: we are only aware of Crabbe (1991). Crabbe finds that the average difference in yield spread between bonds containing no protection from LBOs (i.e. no event risk covenants) and bonds that contain protection is 20-30 bps at the end of 1989. However, Billett, King, and Mauer (2007) show that if a bond includes any covenants, there is typically a wide basket of covenants included. Billett, King, and Mauer (2007) identify 15 major covenant categories providing a wide range of restrictions on dividends, share repurchases, debt issuance, stock issuance, sale and leaseback, asset sales, investment policies, mergers, and leverage. The fact that a bond typically has a basket of covenants covering a range of situations makes it difficult to use covenants to disentangle LBO risk from other risks. Furthermore, relative to Crabbe (1991) we study the variation of the impact of LBO risk in the cross section, time series, and across maturity.

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 credit spreads. In our model, LBO risk is an additional variable driving credit spreads and can help 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 and LBO data. Section 3 describes the CDS and cash bond markets in the context of LBOs. Section 4 describes the event study of CDS spreads and bond prices around LBO announcements. Section 5 presents an empirical study of the effect of LBO risk on the cross-sectional variation in credit spreads. Section 6 presents a structural model with LBO risk and Section 7 concludes.

2 Data

2.1 Credit Default Swaps

This dataset includes daily quotes for a broad cross-section of firms traded in the credit derivatives market. 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. The coverage spans 01/2001 to 12/2015. We use all CDS quotes written on U.S. corporate entities and denominated in U.S. dollars. For consistency, 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 they are the most common in the US. MR contract is used, except if the firm has more XR contracts traded. The data includes contracts of 0.5,1,2,3,5,7,10,15,20, and 30-year maturities, but since it is well-known that the 5-year contract is the most liquid we focus on this maturity.

2.2 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 and where the target is a US firm[4]. The total number of announcements between 1980-2015 is 12210.

Merging the data on LBO transaction announcements with the CDS spreads leaves 60 events. We exclude one event where the 5-year CDS price is missing in part of the event window and exclude 16 events where prices are stale around the event.[5] After the exclusions we have 43 events in the sample. Since the focus is on firms with public debt and actively traded CDS contracts, the firms are typically large, public firms, which are only a small fraction of LBO targets. A study of all LBOs from the years 1970-2007 by World Economic Forum (2009) finds that public-to-private transactions comprise 6.7% of all LBOs.

2.3 Bond transaction prices

Corporate bond transactions data are obtained from 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 in July 1, 2002 and ends in 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 drop all convertible bonds, as these might be expected to react differently from non-convertibles.

2.4 Bond issuance and covenants

We retrieve bond covenant information from The Fixed Income Securities Database (FISD). FISD contains detailed issue-level information on over 140,000 corporate, US Agency, US Treasury and supranational debt securities, collected from bond prospectus, issuers' SEC filings including 10-K, 8-K, Registration forms, etc. For each issue, FISD provides a variable indicating whether detailed covenant information is collected for that issue.

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[4] Based on 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 we did not find additional LBO events where the target firm had quoted CDS premiums.

[5] We define CDS prices to be 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.

3 Bonds vs Credit Default Swaps in LBOs

Credit default swaps are the most common type of credit derivative and have been actively traded in financial markets in recent years. Bank for International Settlements report that the total notional amount outstanding of CDS contracts was \$14.6 trillion at the end of June 2015. CDS spreads abstract from certain bond characteristics, such as different coupon rates,decaying maturity, and covenants. Furthermore, liquidity is consistently concentrated in the 5-year CDS contract while liquidity in corporate bonds switch from time to time depending on which bond is on-the-run (Ronen and Zhou (2013)). We, thus, opt to use credit default swap spreads to study the effect of LBO announcements on credit spreads of target firms.

Bond returns around LBOs are to a certain extent determined by the protection provided by their specific covenants (see Chava, Kumar, and Warga (2010) and Franco et al. (2015) for more on covenants). One covenant is directly related to LBOs, namely a put which gives the bondholders the option of selling the issue back to the issuer in case of a change of control on the issue, often at 101% of par value.[6] We refer to this covenant as an "Event risk" covenant. Out of the 9.1% bonds where information about covenants are provided in FISD 41.6% are reported to have a change in control put provision. In anticipation of triggering this covenant, prices of protected bonds might rise following an LBO announcement, regardless of the implication of the buyout on firm default risk.

Event risk covenants were introduced in 1985 and Figure 1 shows how common they have been over time.[7] Even after the buyout wave in the late eighties, they were quite uncommon in investment grade bonds until 2007, as these had been less prone to be buyout targets in the past. Following the last buyout wave in 2005-2007, all firms are believed to be susceptible to takeover risk and event risk covenants are becoming more prevalent. However, covenants vary in strength and in recent years the quality of covenants has decreased. For example, Moody's report a Covenant Quality Index for corporate bonds and report a score of 4.20 in November 2015, with 1 denoting the strongest investor protections and 5 the weakest. Moody's note that "the weakest-level covenant quality indicates that despite marginal improvements, investors continue to trade away covenant protection in search of higher yield".[8]

Although strong event risk covenants provide a certain degree of protection against LBOs, bondholders may still occur losses. For example, if the bond is trading at a price substantially above par, putting the bond back at 101% of par in case of a change of control will lead to bondholder losses. Also, in certain cases, a change of control clause is only triggered if, at the same time, or shortly after a change of control event occurs, the rating of the company is downgraded to sub-investment grade. As

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[6] The covenant is denoted "Change Control Put Provisions" in FISD.

[7] We exclude bonds with missing covenant information. 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 no bias is expected in the selection of bonds examined.

[8] See Moody's Investors Service, "Announcement: Moody's: North American bond covenant quality slightly improves Global Credit Research", 08 Dec 2015.

a rating action can happen before the legal change of control occurs, this could lead to investors being unprotected.[9]

The CDS contract is written on all bonds of a seniority class, and upon default, the buyer of protection can deliver any of the reference bonds in return for par value. Consequently, the CDS spread reflects the value of the cheapest bond (typically, an unprotected bond) among all deliverable obligations (”cheapest-to-deliver” feature). Thus, CDS spreads and bond yields might move in opposite directions following an LBO announcement.

Figure 2 illustrates how Safeway's bond prices reacted differently to an LBO announcement depending on the strength of event risk protection. 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 had no event risk covenant and lost around 10% in value in the period around the announcement. A Safeway bond maturing in 2020 had an event risk covenant and the price did not decrease following the announcement. Interestingly, a bond maturing in 2017 did have a change of control put, but since the bond was trading at a high price of around \$108 (due to a high coupon) and the strike price of the put was only \$ 101, the bond lost around five percent in value. Thus, the bond illustrates that even with event risk covenants in place bond prices may decrease following an LBO announcement. Finally, we see in the figure that the five-year CDS premium jumped from around 200bps to 300bps.

4 Event study

4.1 Credit Default Swaps

We proceed to study the effect of LBO announcements on the credit spreads of target firms. Figure 3 shows the distribution of the sample firm ratings immediately prior to the event and one year after the event.[10] The distribution of ratings post buyout is clearly centered lower and is less dispersed, almost entirely concentrated in the speculative grade rating classes. The median rating before the LBO is BBB- while it is BB- after the LBO.

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[9] See Moody's (2006). As an example, following the leveraged buyout of Safeway on March 7, 2014 an analyst at Covenant Review noted “not all CoC protection is equal. There is a wide variety of drafting differences and how those provisions are drafted can influence the strength of the put right.” A senior portfolio manager at the Bank of Montreal said ”there are games that can be played with the ownership structure and the timing of the downgrade relative to the 'change of control' which pits the acquirer against the bond investor”. See Reuters' article “Safeway LBO puts spotlight on need for bond protection” on http://www.reuters.com/article/us-ig-bonds-protection-idUSL1N0M41MG20140307.

[10] The rating is defined as the lowest of Moody's and S&P's rating and obtained from Mergent FISD.

4.1.1 Event study methodology

Event Window We use an event window of 22 business days prior to the event and 22 business days following it (22 business days correspond to approximately one calendar month). The impact of the announcement is tested over a two day interval because the announcement might have been made after markets closed for the day. If the event is rumored (as might be the case given the large average deal size in the sample), one might expect to see a reaction in prices in the windows preceding the announcement, in particular in the days leading up to it. It may also be the case that the firm has announced that it is "up for sale" as in the case of Safeways examined in the previous section, where most of the price reaction occurred two weeks before the announcement of an LBO deal.

Daily Returns To measure the effect of the LBO announcements on credit 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 the spread is

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

where $s_{i,t}$ is the CDS premium for issue i at day t.

Abnormal Returns Abnormal return is computed over a market-wide CDS index. The index is calculated by computing on a daily basis the average CDS premium across all firms present in the sample on that day, where the maturity of the CDS premium when calculating the index is the same is the maturity of the CDS for which abnormal returns are calculated. When computing abnormal returns, we use the market-adjusted model with an estimation window of 100 days, i.e. approximately 70 business days. We include only events where there are spread changes on at least half of the days in the estimation window.

Abnormal returns calculated using the market-adjusted model are

$$AR_{i,t} \quad = \quad R_{i,t} - (\alpha_i + \beta_i R_{IDX,t}) \tag{2}$$

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 (1)), $R_{IDX,t}$ is return on 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 must be careful to address two issues which may affect the variance of abnormal returns: 1. error in estimation of α_i and β_i in the estimation window and 2. event-induced variance: LBO announcements could potentially lead to a change in the variance of CDS spreads due to a change in the firm's perceived risk. We use Boehmer, Musumeci, and Poulsen (1991)'s test statistics that correct for both issues (see Micu, Remolona, and Wooldridge (2006) for details).

4.1.2 Empirical results

The top graph in Figure 4 shows that the 5-year CDS premium increases on average in the period leading up to the LBO announcement and in particular on the day of the announcement and remains stable after the announcement. For investment grade firms the CDS spread increases from approximately 120 basis points 22 days before the event to around 220 basis points after the event. It is not surprising that there some reaction before the announcement given that there may be rumours or as in the case of Safeways (discussed in the previous section) the firm announces that negotiations are ongoing. The change in CDS spread, measured in basis points, is of similar magnitude for investment grade and speculative grade firms.

The bottom graph in Figure 4 shows the average abnormal returns of the 5-year CDS contract. The graph shows that the average abnormal returns are large during the period of the announcement at around 60% for investment grade firms and 30% for speculative grade firms (returns are in logs; the corresponding arithmetic average returns are approximately 80% respectively 35%). We test the statistical significance of the abnormal returns in Table 1. Panel A shows that there is a significant abnormal return in the 10 days leading up to the announcement of 14.89% and a large and significant abnormal return of 24.65% on the two days surrounding the announcement. There is also evidence of a smaller 3.90% abnormal return in day -22 to -12, significant at a 10% confidence level. There is no statistical evidence of any reaction after the announcement. When we split the sample into investment grade firms (Panel B) and speculative grade firms (Panel C), we see a stronger reaction for investment grade firms.

In Panel D-F in Table 1 we see the abnormal CDS returns for different maturities. In the time period from 22 days before the event to five days after the event, the 3-year, 5-year, 10-year, and 30-year CDS premium increase on average 58.6, 94.2, 113.5, and 148.2 basis points respectively, showing that the effect measured in basis points increases with maturity. However, measured in abnormal returns the increases are similar and between 36.98% and 51.77%.

Overall, cumulative abnormal returns of 43.77% on average (across firms) are statistically significant and economically large, implying a significant increase in firm default risk when firms undergo an LBO.

4.2 Corporate bonds

In the previous section we study the reaction of CDS spreads to LBO announcements to learn about the effect of LBOs on target firm default risk. We now proceed to learn about the effect on bondholder return. To measure the effect of LBO announcements We study the daily returns to bondholders:

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

Abnormal returns Abnormal return is computed over the The Bank of America Merrill Lynch US Corporate Bond Master Index (see Campani and Goltz (2011) for a review of corporate bond indices).

In computing abnormal returns, the market-adjusted model is used with an estimation window of 30 days, i.e. approximately 22 business days.[11] Test statistics are the same as those used in the CDS study. For a given bond and day, we calculate a daily bond price by computing the average bond price of all transactions on that day. If there are no transactions on a specific day in the event window, we use the last previously available daily price. If there are more than five days in the event window with missing prices we discard the bond.

4.2.1 Empirical results

As aforementioned, bond price reaction is correlated with the level of protection, therefore, we differentiate between bonds with event risk protection and bonds that do not have such protection. Out of the 232 bonds in the event study, 44 have event risk protection; we refer to these as the "protected" bonds, and to the rest as "unprotected".[12] For unprotected bonds, Figure 5 shows a negative abnormal return of approximately five percent in the event window. For bonds protected by event risk covenants, a small negative abnormal return between -1 and 0 percent. Table 2 (Panel C and D) shows that the negative returns for unprotected bonds are highly statistically significant while the small negative returns for protected bonds are insignificant. Table 2's Panel A shows that the average abnormal return for all bonds is around -4% and highly statistically significant. Thus, although event risk covenant to a large extent mitigate – on average – a negative bond return to LBO announcements, the majority of bonds are unprotected and bondholders experience significant negative losses.

4.3 Wealth transfer and value creation

Overall, the cumulative return to bondholders is on average approximately -4% in an event window of 45 days around LBO announcements, a result that is highly statistically significant. This shows that for bond investors, the costs of an LBO clearly outweigh any potential benefits.

Given the previous literature on the gains to target firm shareholders, these results suggest at least part of this gain is due to wealth transfer from bondholders. To evaluate whether this wealth transfer alone is large enough to constitute a buyout incentive for shareholders, we wish to understand whether the loss to bondholders is a large fraction of shareholder gains. We therefore examine the effect of the LBO announcements on the stock prices of the target firms (stock prices are from CRSP). Abnormal returns are computed over the S& P 500 index.

Figure 6 shows the abormal equity return and the abnormal bond return (where all bonds, both protected and unprotected, are used). We observe a positive reaction of 13-14% of equity prices and

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[11] We use a smaller estimation than when calculating abnormal CDS returns because a significant number of bonds do not have a long transaction history and a short estimation window therefore increases the bond sample.

[12] In Figure 1 we plot the fraction of bonds that have event risk covenants out of bonds with event risk information. Among all bonds in Mergent FISD, 90.9% have no information about event risk covenants, 5.3% explicitly have no event risk covenant, and 3.8% explicitly have an event risk covenant. Here, 'unprotected bonds' include bonds that have no information about event risk covenants in Mergent FISD.

most of the reaction happens on the announcement day. Panel B of Table 2's shows this reaction to be statistically significant. For both the equity and bond market the table shows a statistically significant reaction in the period leading up to the announcement and no reaction after the announcement date. This suggests that both markets incorporate market rumors and the announcement is partially anticipated.

Overall, we observe a positive cumulative abnormal return for shareholders and a negative cumulative abnormal return for bondholders. Since the value of the firm equals the value of debt plus the value of equity, we need the average ratio between equity and debt to make conclusions regarding the effect on firm value. The mean and median rating immediately before the announcement is BBB, and Feldhutter and Schaefer (2016) document that the average leverage ratio for BBB-rated firms is 38% (using book value of debt as a proxy for the market value of debt). The average effect on firm value is roughly $0.38 * -4\% + 0.62 * 13.5\% = 8.2\%$. Of the total gain of 8.2%, shareholders gain 9.7% (=13.5%*0.62) of firm value, while bondholders lose 1.5% (=4%*0.38) of firm value. These results suggest that losses to bondholders are around 15% of shareholder gains. While this is not an unsubstantial fraction of gains, it would not appear that wealth expropriation from bondholders is enough to constitute a major shareholder buyout incentive. These rough calculations imply buyouts result in other, more substantial sources of gains, suggesting LBOs do, indeed, create value.

5 Pricing of LBO Restructuring Risk

The event studies in the previous section show that LBOs are a viable risk for investors in debt markets. A natural hypothesis is that LBO restructuring risk is priced ex-ante and that variation in LBO risk can help explain the cross-section of credit spreads. Credit spreads are forward-looking and should reflect all risks priced in by investors. The hypothesis we test is therefore:

Hypothesis: Investors demand a premium for restructuring risk ex-ante, therefore we expect higher credit spreads in firms more prone to be LBO targets.

We provide two tests of the hypothesis in this section. In the first test in Section 5.2 we use patterns of buyout activity both at the firm and industry level in a panel regression. Before proceeding to the test we present evidence in Section 5.1 on the time series and cross-sectional variation in LBO activity to motivate the test. In the second test in Section 5.3 we look at the reaction of intra-industry industry credit spreads to LBO announcements.

5.1 Time series and cross-sectional variation in LBO activity

Figure 7 shows the number and total value of LBO announcements on US firms each year and we see that there are clear trends in buyout activity over time.[13] There was increased LBO activity in the

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[13] We retain only deals with status "completed", which leaves a sample of 10851 announcements out of the 12210 mentioned in Section 2.2.

late 1980's, the 2004-2007 period preceding the financial crisis, and 2012-2015, both in number and magnitude of deals.[14]

Figure 8 presents over time the percentage of LBOs occuring in different industries out of the total number of LBOs. Industry is classified according to two-digit SIC codes and the figure shows industries where the percentage was more than three percent in some decade. The composition of LBO-intense industries has clearly changed over time. In the early period 1980-1989 there was a higher frequency of LBOs in Primary Metal Industries (Kaiser Aluminium & Chemical, NorthWest Industries Inc) and Paper Products (Fort Howard Corp, Jefferson Smurfit Corp). This is consistent with the finding in Lehn, Netter, and Poulsen (1990) that LBOs occurred in low growth and low R&D industries. A different picture emerges when studying the more recent LBOs. In 2010-2015 LBOs are heavily concentrated in services, with a clear focus on technology and telecommunications.[15] Particularly striking is the gradual increase in the LBO activity in Business Services from 3.4% in 1980-1989 to 19.0% in 2010-2015, out of which Computer and Data Processing Services account for 1.5% and 13.3% respectively.[16]

5.2 Cross-sectional variation in credit spreads

To separate the effect of LBO probability from the direct effect of firm characteristics on credit spreads, we use an exogenous industry-level probability. This is based on much empirical evidence of cross-industry variation in event risk. Crabbe (1991) reports LBOs are less common in industries such as financial and utilities due to regulatory restrictions on leverage, asset sales and dividend payouts; Lehn, Netter, and Poulsen (1990) use industry as a proxy for LBO risk. Mitchell and Mulherin (1996) relate inter-industry patterns in the rate of takeovers and restructurings to economic shocks borne by the sample industries (e.g. deregulation, changes in input costs, innovations in financing technology). Their results suggest that takeover activity is, to a significant extent, driven by broad industry fundamental factors. The previous section showed that there are large variations both in the cross-section and time series in takeover activity and we, thus, opt to use an industry-level probability of LBO, which is exogenous to the firm.

5.2.1 Industry-level probability of LBO

We construct an industry-level probability of LBO using industry LBO realizations. Specifically, we use the sample of US LBO announcements and compute this probability to be the ratio of: 1. the number

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[14] The value is the equity value of target firms, but since only 13.5% of the deals in Thomson One Banker have information on the equity value, the total value is a lower bound on the actual total value (although we do expect that the 13.5% for which there is information are some of the largest LBO deals).

[15] Examples of LBO firms are BMC Software Inc and Informatica Inc in Business Services, REsCare Inc and American Dental partners Inc in Health Services, and InVentiv Health Inc and eResearch Technology Inc in Engineering & Management Services.

[16] An interesting question in itself is the reason for the documented clustering in these specific industries and the change in focus of LBO sponsors over time. Mitchell and Mulherin (1996) find inter-industry patterns to be directly related to the economic shocks borne by the sample industries, e.g. deregulation, changes in input costs, innovations in financing technology, suggesting a similar shock might have driven recent trends.

of LBO targets in an industry to 2. the number of firms in the industry. The number of industry firms is determined using Compustat. This construction creates a proxy, as Compustat lists only public firms. However, we are not aware of a comprehensive source on private firms. This proxy assumes the ratio of private to public firms is not significantly different across industries, in which case there is no bias in the cross-sectional study. To be able to interpret the proxy as a probability we adjust it in the following way. The fraction of LBO firms in Thomson 1980-2015 with a reported equity value at announcement is 0.1624, so we multiply all calculated probabilities by 0.1624.

We compute the LBO probabilities at the 3-digit sic level, where sic code is as reported in Compustat and run the following regression:

$$\log(CDS_{j,t}) \quad = \quad \alpha + \beta \cdot pLBO_{I,t} + \gamma \cdot characteristics_{j,t}(leverage_{j,t}, equityvolatility_{j,t}, ...)$$

where j is firm in industry I at year t. The dependent variable is log of the 5-year CDS spread, and the explanatory variables consist of probability of LBO ($pLBO$) and firm-level controls. To avoid any look-ahead bias we use LBO probability based on LBOs during the year and year-end CDS spreads.

5.2.2 Empirical Results

To test the hypothesis, we proceed to study the effect of LBO risk on the cross-sectional variation in credit spreads. We include all CDS contracts denominated in U.S. dollars and written on senior unsecured debt. This dataset is described in detail in Section 2.1. We use only the 5-year maturity contract, which is the most common. The dependent variable is log annual closing CDS spread, and the explanatory variables consist of probability of LBO ($pLBO$) and firm-level controls. The firm-level controls are year-end leverage ratio, equity volatility, distance-to-default, and ROA.[17]

Regression results are detailed in Table 4. The first column of Table 4 reports results for the entire dataset.[18] The coefficient on industry probability of LBO positive at 0.5418 and statistically significant. The average CDS spread in the sample is 179 basis points and an increase of the LBO risk of 10 percentage points leads to an increase in the spread of 10 basis points.[19]

A high probability of LBO is associated with certain firm characteristics. Appendix B shows that high LBO risk is associated with stable cash flows, high asset tangibility, and low market-to-book and we use these firm characteristics to further support the identification of the effect of LBO risk on CDS prices.

Stable cash flows make a firm a more attractive target and we expect the effect of LBO risk to be more pronounced in these firms. To test this hypothesis, we use equity volatility as a proxy for

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[17] Equity volatility for a given year is calculated as the annualized standard deviation of monthly equity returns in that year and the previous two years. Distance-to-default is based on Moody's KMVs and calculated as log of leverage divided by equity volatility.

[18] Since not all firms had data available for 2015 in Compustat, we could not compute reliable LBO probabilities for 2015 and left this year out of the analysis.

[19] Calculated as $e^{\log(1.7942)+0.1*0.5418}$.

cash flow stability and divide the sample into high-volatility and low-volatility firms (here and in the following splits the cutoff is set at the median). Columns 2 and 3 of Table 4 show that industry LBO probability is indeed highly significant for low-volatility firms, but is not significant for high-volatility firms. The magnitude of the coefficient for high-volatility firms is more than twice that of the entire sample, showing that the impact on pricing is stronger for low-volatility firms.[20]

Firms with high asset tangibility are more likely LBO targets because tangible assets lower costs of financial distress, and in Columns 4 and 5 of Table 4 we split according to tangible assets, calculated as the ratio of Property, Plant, and equipment to total assets. We see a much stronger effect of LBO risk on firms with high tangibility. A regression coefficient of 2.2408 for highly tangible firms imply that a 5 percentage point increase in the LBO probability increases the average spread of 179 basis points by 45 basis points.

Firms with high growth require more investments in R&D and Capex, making it harder to service a heavy debt load. Therefore, we expect the effect of LBO risk to be more pronounced in firms with lower growth. The last columns in Table 4 report results when dividing the sample into high and low market-to-book. Results show that industry LBO probability is indeed more important for low market-to-book firms.

LBO activity has been increasing since 2000 and in particular the periods 2005-2007 and 2012-2014 had a large number of deals and high deal values. In accordance with these statistics, we expect LBO risk to have become a growing concern for investors over time. Consequently, we divide the sample into very active (2005-2007 and 2012-2014) and less active (2001-2004 and 2008-2011) periods. Regression statistics are presented in Table 5. Results show that LBO risk is, indeed, a significant and strong factor in the two active periods and not so in the less active periods.

Overall, our results suggest that an increase in the industry probability of LBO has a statistically and economically significant effect on credit spreads. This effect is more pronounced for firms which are more prone to undergo an LBO; firms with low volatility, low growth, and high tangibility. The effect of LBO risk is stronger in periods with high LBO activity, namely 2005-2007 and 2012-2014.

5.3 Industry-wide effects of LBO announcements

In the previous section, we document the detrimental effect of LBO announcements on credit spreads of target firms. Given industry-level clustering in LBO activity, we expect to find an industry-wide reaction to LBO announcements. We proceed to study the effect of these announcements on the credit spreads of other firms in the same industry.

We collect firms' 3-digit SIC code from Compustat by matching with Markit's ticker and for each LBO event, the sample consists of spreads of non-targets around LBO announcements in the industry.

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[20] We have also split the sample according to *unlevered* equity volatility, calculated as (1-leverage) times equity volatility. The results are very similar with a coefficient on LBO probability of -0.1712 for the high-volatility firms and 1.4176 for the low-volatility firms.

We have a final sample of 267 event days in 133 firms in 15 industries. Event window, abnormal returns and test statistics are as detailed in Section 4.

Figure 9 shows the intra-industry abnormal returns around LBO announcements. We see an increase in CDS returns on the two days around the announcement and a further increase in the three weeks following the announcement. Table 3 shows that the increases both around and after the announcement are statistically significant. The cumulative abnormal return due to the LBO announcement is approximately 10% on average (for the 5-year contract) in a 2-month interval around the event, displaying a significant within-industry reaction to LBO announcements.

The reaction within industry is consistent with the hypothesis that an LBO announcement in an industry leads investors to revise upward the likelihood that other firms in that industry will be taken over. Consistent with this hypothesis, Harford, Stanfield, and Zhang (2015) find that LBOs predict more LBOs in the same industry.

An alternative explanation for the widening of intra-industry CDS spreads around LBO announcements is proposed by Mitchell and Mulherin (1996): buyout intra-industry patterns are directly 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. This explanation implies a widening of CDS spreads and *negative* equity returns, while the explanation of higher LBO likelihood imply *positive* equity returns (as shown in Section 4 equity returns are positive around LBO announcements). To determine which of the two effects appear to be dominant we calculate intra-industry abnormal equity returns in Panel E of Table 3 and plot cumulative abnormal returns in Figure 9. We see that there are significant positive abnormal equity returns around industry announcements, consistent with increased LBO risk being the main driver of the widening CDS spreads.

Anecdotal evidence from the press supports the hypothesis that the increase in CDS spreads is at least partially driven by increased probability of further LBOs. Bloomberg Business ("Dell Lifts Default Risk on Next Buyout Targets: Credit Markets") wrote in January, 2013 "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") "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."

6 Evidence from a structural model with LBO risk

In this section we present further evidence on the pricing of LBO risk over time and across bond maturity by viewing LBO risk through the lens of a structural model. We do so by extended the standard Merton (1974) model to allow for LBO risk.

6.1 The model

Assume that firm value follows a Geometric Brownian Motion

$$\frac{dV_t}{V_t} = \mu dt + \sigma dW_t^V \tag{3}$$

under the risk neutral measure and that the firm has issued one zero-coupon bond with maturity T and face value of K. Later we will let $\mu = r - \delta$ where r is the riskfree rate and δ is the total payout to debt and equity holders.[21] The firm can only default at bond maturity and it does so if firm value is below the face value of debt. In case of default bondholders receive a fraction α of the face value of debt. This is the Merton model as used in Chen, Collin-Dufresne, and Goldstein (2009) and Feldhutter and Schaefer (2016). If we define leverage as $L_t = \frac{K}{V_t}$ and the price of the zero coupon bond at time 0 as $v^M(L_0, \mu, \sigma)$ it is well-known that

$$v^M(L_0, \mu, \sigma, \alpha, r) = e^{-rT}\Big[\alpha + (1-\alpha)N\big(\frac{-\log(L_0) + (\mu - \frac{1}{2}\sigma^2)T}{\sqrt{\sigma^2 T}}\big)\Big] \tag{4}$$

We extend the model by assuming that the firm can potentially undergo an LBO that occurs 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.[22] 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,

$$d\lambda_t = \kappa(\theta - \lambda_t)dt + \xi\sqrt{\lambda_t}dW_t^\lambda, \tag{5}$$

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

$$P(\lambda_0, \kappa, \theta, \xi) = E[e^{-\int_0^T \lambda_s ds}] = A(T)e^{-B(T)\lambda_0} \tag{6}$$

where

$$A(T) = \Big(\frac{2he^{(h+\kappa)T/2}}{2h + (h+\kappa)(e^{hT} - 1)}\Big)^{\frac{2\kappa\theta}{\xi^2}} \tag{7}$$

$$B(T) = \frac{2(e^{hT} - 1)}{2h + (h+\kappa)(e^{hT} - 1)} \tag{8}$$

$$h = \sqrt{\kappa^2 + 2\xi^2}. \tag{9}$$

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[21] See Feldhutter and Schaefer (2016) for a more extensive discussion of the assumptions of the model.

[22] 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 and that investors invest the money in debt of another identical firm with the same debt structure.

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

$$
\begin{aligned}
& v^{LBO}(L_0, \mu, \sigma, \alpha, r, \lambda_0, \kappa, \theta, \xi, \eta, \varsigma) \\
&\quad = P(\lambda_0, \kappa, \theta, \xi) v^M(L_0, \mu, \sigma, \alpha, r) + \left[1 - P(\lambda_0, \kappa, \theta, \xi)\right] v^M(L_0, \mu - \frac{\eta}{T} + \frac{1}{2}\frac{\varsigma^2}{T}, \sigma^2 + \frac{\varsigma^2}{T}, \alpha, r) \qquad (10)
\end{aligned}
$$

The pricing formula shows that the bond price is a weighted average of the bond price in the standard Merton model and a 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.

6.2 Parameter estimates

We estimate the LBO risk parameters of the structural model assuming that there is no risk premium associated with LBO events. The parameters are based on the time variation in the market wide frequency of LBOs and on the empirical distribution of the change in leverage in case of an LBO.

Leverage jump parameters We assume that if there is an LBO, leverage jumps from K to Ke^J where $J \sim N(\eta, \varsigma)$. This implies that the change in log leverage is equal to J. Therefore, we calculate for every LBO in the sample the leverage in the year before and after the LBO and compute the change in log leverage. We are able to calculate the change for 15 LBO events in the sample and the mean, median, and standard deviation is 0.326, 0.289, and 0.555. We use 0.3 as an estimate for the mean jump size η. A significant increase in leverage is consistent with the firm typically being downgraded after an LBO as Figure 3 shows. To estimate how volatile changes in leverage ratio is in a "normal year" we calculate the change in log leverage for LBO firms between year -1 and -2. There are 46 observations and the mean, median, and standard deviation is 0.005, -0.007, and 0.484. Since the standard deviation in a "normal" year is only slighter lower than the standard deviation around an LBO year, the standard deviation of 0.516 overestimates the volatility of leverage changes around LBOs. We find that the mean parameter has a much greater impact on spreads than the standard deviation parameter and we therefore choose the standard deviation parameter $\varsigma = 0.1$ somewhat ad hoc.

LBO intensity parameters To calculate the LBO intensity parameters we calculate a market wide annual LBO probability by computing the ratio of the number of firms that were targets of LBO (according to Thomson Financial LBO announcements) to the number of industry firms (as reported in Compustat). As discussed in Section 5.2.1 we adjust this ratio by 0.1624. If we observe λ on a yearly basis, the LBO probability in year t is approximately equal to λ_t. We therefore assume that the time series of LBO probabilities is the observed path of λ.

The average LBO probability in for the period 1980-2014 is 2.76% and we use this number as the estimate of the unconditional mean θ. We estimate the remaining two parameters κ and ξ by Maximum Likelihood using the method in Kladıvko (2007) and they are estimated to be $\kappa = 0.124$ and $\xi = 0.0523$.

6.3 Results

We estimate the time variation in the spread contribution of LBO risk of a "typical" firm issuing corporate bonds. The most common rating of firms in the corporate bond market is A or BBB and the average leverage ratio of A respectively BBB rated firms is estimated in Feldhutter and Schaefer (2016) [FS16] to be 0.28 respectively 0.38. The most likely pre-event rating of firms in an LBO is BBB as Figure 3 shows 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 volatility of A respectively BBB rated firms is 0.23 and 0.25 respectively (FS16), 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) and 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 FS16.[23]. Finally, we set the recovery rate $\alpha = 37.8\%$, Moody's (2013)'s average recovery rate for senior unsecured bonds for 1982-2012.

With the estimated LBO risk parameters and the time variation in the LBO intensity λ proxied by the yearly LBO probability, we calculate the credit spread in the structural model for the typical firm with and without LBO risk and the difference in spreads is the contribution of LBO risk. Figure 10 shows the contribution of LBO risk to the five-year credit spread. We see that the importance of LBO risk increases over time and peaks in 2005-2007 and at the end of the sample period, consistent with the regression evidence. The contribution peaks at 30-32bps in 2007 and 2015 while it is much smaller in the early part of the sample period.

The first row in Table 6 shows the contribution of LBO risk to credit spreads for different maturities. We see that LBO risk is more important for long-maturity bonds compared to short-maturity bonds; the contribution is 15.2 bps for a 10-year bond and 0.0 for a one-year bond. Intuitively, LBO risk does not matter much 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.

There is a large literature on the "credit spread puzzle", the apparent inability of structural models to match actual credit spreads. Feldhutter and Schaefer (2016) show that the perceived failure of structural models to explain levels of credit spreads has less to do with the deficiencies of the models than the way in which they have been implemented. Although our results imply that LBO risk raises spreads in structural models relative to some benchmark riskfree rate, Feldhutter and Schaefer (2016) and others investigate corporate spreads relative to AAA yields and in this case the effect of LBO risk is not clear because AAA yields are also effected. The average leverage of both AAA and AA rated firms is 0.14 according to Feldhutter and Schaefer (2016) and the second row in Table 6 shows that the effect of LBO risk for firms with such a low leverage is smaller, suggesting that the overall effect of LBO risk on credit spreads relative to AAA is positive. However, we find that the correlation between pre-LBO

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[23] Feldhutter 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.

leverage and the change in log-leverage is -0.51 in our sample, so it may be that safer firms are exposed to larger LBO shocks leading to larger effects for the highest rated firms than what we find. This is an interesting topic for future research, but outside the scope of this paper.

We assume in the structural model that LBO intensity and firm value are independent processes. However, Axelson, Jenkinson, Stromberg, and Weisbach (2013), Demiroglu and James (2010), and Colla, Ippolito, and Wagner (2012) find that leverage in LBO deals is procyclical and peak during booming credit market conditions such as 2006-2007. This may influence our time series results by underestimating the effect of LBO risk during boom periods and overestimate the effect during recessions.

6.4 Robustness

The size of leverage jumps is important for the effects that we finds in the structural model. The third row in Table 6 shows that if the mean jump size is reduced from 0.3 to 0.15 we see a corresponding reduction in the contribution of LBO risk. Thus, the mean jump size is a key parameter determining the importance of LBO risk. In contrast we see in the last row that reducing the standard deviation of jump sizes from 0.1 to 0.05 has almost no effect of the LBO spread contribution.

7 Summary

Although LBO activity come and go in waves, the number of LBOs has generally increased in the past three decades as private equity activity has grown, showing that LBO risk has become a growing concern for investors in credit markets. This paper studies the effect of LBO announcements on credit spreads over time, in the cross section, and across bond maturity. To the best of our knowledge, there is no literature that identify and quantify the effect of LBO risk on spreads in any of these dimensions.

We first establish LBOs as a significant concern for debt investors by studying the reaction of credit spreads of target firms to LBO announcements in the US during the years 2001-2015. We find a widening of investment grade CDS spreads by 56% in a window of approximately one month around the announcement, showing that default risk increases because additional debt is issued. We then proceed to the main part of the paper and test the existence and magnitude of ex-ante pricing of LBO restructuring risk in debt markets. We approach the question in three different ways. First, we define an industry-level annual probability of LBO risk and show that firms more likely to undergo an LBO in the future have spreads that are higher by 30-50 bps and the effect is more pronounced in low-growth, low-volatility firms, with higher asset tangibility; typical LBO targets. Second, we show that intra-industry credit spreads increase around LBO announcement, consistent with the notion that investors revise upward the probability of future LBOs. To rule out 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. Finally, we propose and estimate a structural model with LBO risk. We find that the contribution of LBO risk to 5-year credit spreads has increased from 5 bps in 1980 to 32 bps in 2015, underpinning the increased importance of LBO risk. We also find that the effect of LBO risk is increasing with bond maturity.

Our results further the understanding of the variation in credit spreads. Standard structural model imply that only firm-specific variables such as leverage and asset volatility matter for credit 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 their findings and we believe LBO restructuring risk is a significant, omitted risk that has grown in importance. The reference entities of corporate bonds are exposed - more and more so - to corporate action, such as takeovers, which result in a dramatic change in risk profile, particularly for investment-grade debt. While buyout activity is subject to recurring boom and bust cycles, a significant part of the growth in private equity activity and institutions is according to Kaplan and Stromberg (2009) believed to be permanent.

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A A structural model with LBO risk: formulas

In this Appendix we derive a structural Merton model with LBO risk. The standard model without LBO risk is the same as the model in Chen, Collin-Dufresne, and Goldstein (2009) and Feldhutter and Schaefer (2016).

Assume that firm value follows a Geometric Brownian Motion

$$\frac{dV_t}{V_t} = \mu dt + \sigma dW_t^V \tag{11}$$

and that the firm has issued one zero-coupon bond with maturity T and face value of 1. It is without loss of generality to assume that the face value of debt is 1, because if face value of debt is K we set firm value at time 0 equal to V_0/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 of 1. 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 1.

The firm can potentially undergo an LBO that occurs 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 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,

$$d\lambda_t = \kappa(\theta - \lambda_t)dt + \xi\sqrt{\lambda_t}dW_t^\lambda. \tag{12}$$

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

$$\begin{aligned}
w(T) &= E[1_{\{V_T>K_T\}} + \alpha 1_{\{V_T\leq K_T\}}] && (13)\\
&= E[\alpha + (1-\alpha)1_{\{V_T>K_T\}}] && (14)\\
&= E[\alpha + (1-\alpha)1_{\{V_T>K_T\}}|\tau > T]P(\tau > T) + E[\alpha + (1-\alpha)1_{\{V_T>K_T\}}|\tau \leq T]P(\tau \leq T) && (15)\\
&= E[\alpha + (1-\alpha)1_{\{V_T>1\}}]P(\tau > T) + E[\alpha + (1-\alpha)1_{\{V_T>e^J\}}]P(\tau \leq T) && (16)
\end{aligned}$$

According to Lando (1998) we have that

$$P(\tau > T) = E[e^{-\int_0^T \lambda_s ds}] \tag{17}$$

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

$$E[e^{-\int_0^T \lambda_s ds}] = A(T)e^{-B(T)\lambda_0} \tag{18}$$

where

$$
\begin{aligned}
A(T) &= \Big(\frac{2he^{(h+\kappa)T/2}}{2h+(h+\kappa)(e^{hT}-1)}\Big)^{\frac{2\kappa\theta}{\xi^2}} && (19)\\
B(T) &= \frac{2(e^{hT}-1)}{2h+(h+\kappa)(e^{hT}-1)} && (20)\\
h &= \sqrt{\kappa^2+2\xi^2}. && (21)
\end{aligned}
$$

We also have that

$$E[1_{\{V_T>e^J\}}] = P(V_T > e^J) = P(\log(V_T) - \log(J) > 0) \tag{22}$$

and because – according to Ito's Lemma – $\log(V_T)$ is normally distributed with mean $\log(V_0)+(\mu-\frac{1}{2}\sigma^2)T$ and variance $\sigma^2 T$, we have that $\log(V_T)-\log(J)$ is normally distributed with mean $\log(V_0)+(\mu-\frac{1}{2}\sigma^2)T-\eta$ and variance $\sigma^2 T+\varsigma^2$. Therefore

$$E[1_{\{V_T>e^J\}}] = N\Big(\frac{\log(V_0)+(\mu-\frac{1}{2}\sigma^2)T-\eta}{\sqrt{\sigma^2 T+\varsigma^2}}\Big) = N\Big(\frac{\log(V_0)+([\mu-\frac{\eta}{T}+\frac{1}{2}\frac{\varsigma^2}{T}]-\frac{1}{2}[\sigma^2+\frac{\varsigma^2}{T}])T}{\sqrt{[\sigma^2+\frac{\varsigma^2}{T}]T}}\Big) \tag{23}$$

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

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

where

$$v^M(T) = e^{-rT}\Big[\alpha + (1-\alpha)N\big(\frac{\log(V_0)+(\mu-\frac{1}{2}\sigma^2)T}{\sqrt{\sigma^2 T}}\big)\Big] \tag{24}$$

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

B Likelihood of becoming an LBO target

In this Appendix we present evidence on which firms are likely LBO targets. The results update and supplement existing results in Lehn and Poulsen (1989) and Opler and Titman (1993) among others.

We run a regression of the likelihood of becoming an LBO target against firm characteristics using a probit model, in which the dependent variable equals one when the firm is an LBO target and zero otherwise. Firm characteristics are lagged. Given time and industry trends in LBO activity, the model also incorporates variables at the macro and industry level. At the macro level, we use lagged private equity funds (PE funds), i.e. US private equity fundraising as a percentage of total US stock market value, taken from Kaplan and Stromberg (2009) (other macro and business cycle variables were found to be insignificant when included along with PE funds). At the industry level, we use a lagged measure of industry probability of LBO, constructed using industry LBO realizations. Using the sample of US

LBO announcements (extracted from Thomson One Banker), we compute this probability to be the ratio of: 1. the number of LBO targets in an industry to 2. the number of firms in the industry (determined using Compustat firm listings). These probabilities are computed at the 3-digit sic level, where sic code is as reported in Compustat. Since US private equity fundraising is only available up until 2007, we study the period 1980-2007 using annual data from Compustat. The sample consists of 26330 firms, with an average of 21 annual observations per firm. This data is merged with data on LBO announcements to identify LBO targets in the sample.

We run the following probit regression:

$$LBO_{i,t} = \alpha + \beta \cdot PEfunds_{t-1} + \gamma \cdot pIndLBO_{I,t-1} + \delta \cdot firmVars_{i,t-1}$$

where $LBO_{i,t}$ is a binary variable, which equals 1 if firm i was an LBO target at time t and 0 otherwise, $PEfunds$ is private equity fundraising, $pIndLBO$ is the measure of industry probability of LBO and $firmVars_{i,t-1}$ are the firm-level characteristics being tested.

Table B1 reports the regression results. The table shows a negative relation with standard deviation of roa, suggesting steady cash flows are significant predictors of LBO likelihood. An LBO target has to be able to generate stable free cash flow from operations to service the large post-buyout debt payments. A firm with steady taxable cash flows would also benefit more from increased leverage. Results show LBO likelihood to also be positively associated with lower market-to-book values. Firms characterized by strong growth may not be suitable for LBOs, as their growth rate would require an excessive increase in net working capital, as well as absorbing capital for productive capacity enlargement and increased marketing and R&D expenses. These results are consistent with Jensen (1986)'s free cash flow theory and the argument presented in Opler and Titman (1993), that LBOs create value as they reduce agency problems in target firms with unfavorable investment opportunities and relatively high free cash flow. This motive for LBOs persists into the later part of the sample, yet, consistent with the previous finding on the shift in focus to higher growth sectors, LBO targets in the 2000's were, on average, larger than those in the 1980's, had higher market-to-book ratios and had slightly lower cash flows.

Table B1 shows tangibility (PPE) to be significant at the 1% level in explaining likelihood of LBO. Tangible assets might provide guarantees for the new debt and would allow raising extra cash through asset stripping. High asset tangibility also lowers costs of financial distress via asset sales. Leverage also has a highly significant positive coefficient throughout the sample (at the 5% level in the 1980's and 1% level afterwards), indicating that higher leverage increases the likelihood of being acquired in an LBO[24]. Apriori, the relation is unclear; on the one hand, a target firm must have a large enough capital base on its balance sheet to take on additional heavy debt. This might suggest low-leverage firms would be more attractive as potential targets. However, high leverage relative to peers is indicative of high debt capacity, a crucial requirement for LBO targets. Given possible restructuring of outstanding debt, it might, therefore, not be very surprising to find the latter to be a stronger argument. Moreover, assuming firms choose an optimal capital structure, firms with higher leverage would clearly be those

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[24] Results are similar both when studying gross debt and net debt, i.e. subtracting cash and equivalents from total debt.

able to benefit from an increased tax shield, shown to be a substantial source of value in LBOs [Kaplan (1989)].

Both industry and macro-level variables are highly significant at the 1% level throughout, which is not surprising given the strong evidence on cyclicality and industry trends in buyout activity. Psuedo R^2 values range from 4% to 7%.[25]

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[25] These R^2 values are comparable with previous results in the literature, e.g. Cremers, Nair, and John (2009).

window	ΔCDS	E(ΔCDS)	abn. return	E(abn. return)	t-stat	n
Panel A: All firms, 5-year CDS						
[-22,-12]	17.4	1.6	3.90	0.35	1.68*	462
[-11,-1]	28.5	2.6	14.89	1.35	2.89***	462
[0,1]	45.4	22.7	24.65	12.32	2.61**	84
[2,22]	11.2	0.5	0.33	0.02	0.77	882
[-22,5]	94.2	2.1	43.77	1.57	3.69***	1176
Panel B: Investment grade firms, 5-year CDS						
[-22,-12]	16.4	1.5	4.24	0.39	1.58	264
[-11,-1]	30.3	2.8	21.31	1.94	2.54**	264
[0,1]	50.3	25.2	34.22	17.11	2.14**	48
[2,22]	5.3	0.3	-3.68	-0.18	0.61	504
[-22,5]	95.4	2.1	56.12	2.12	3.22***	672
Panel C: Speculative grade firms, 5-year CDS						
[-22,-12]	19.9	1.8	3.63	0.33	0.63	187
[-11,-1]	27.7	2.5	6.75	0.61	1.48	187
[0,1]	41.1	20.6	12.59	6.30	1.51	34
[2,22]	20.1	1.0	5.66	0.27	0.63	357
[-22,5]	97.5	2.2	28.99	0.89	1.87*	476
Panel D: All firms, 3-year CDS						
[-22,-12]	13.4	1.2	4.90	0.45	1.75*	418
[-11,-1]	16.3	1.5	11.81	1.07	2.56**	418
[0,1]	29.9	14.9	27.56	13.78	3.56***	76
[2,22]	2.5	0.1	-3.46	-0.16	-0.28	798
[-22,5]	58.6	1.3	40.83	1.50	4.24***	1064
Panel E: All firms, 10-year CDS						
[-22,-12]	16.4	1.5	2.40	0.22	1.54	429
[-11,-1]	29.8	2.7	11.96	1.09	3.11***	429
[0,1]	61.4	30.7	24.78	12.39	2.92***	78
[2,22]	10.3	0.5	-1.00	-0.05	0.37	819
[-22,5]	113.5	2.5	36.98	1.38	3.77***	1092
Panel F: All firms, 30-year CDS						
[-22,-12]	25.5	2.3	4.25	0.39	1.36	272
[-11,-1]	28.7	2.6	9.72	0.88	1.50	286
[0,1]	71.9	35.9	31.78	15.89	2.84***	52
[2,22]	22.4	1.1	1.85	0.09	1.39	546
[-22,5]	148.2	3.3	51.77	1.74	3.52***	714

Table 1: *Event study in CDS spreads of LBO targets.* 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. The third column reports the average daily change in the CDS spread (in basis points) in the window. The fourth column reports the average total abnormal CDS return (in percent) in the window. The fifth column reports the average daily abnormal return (in percent) in the window. The sixth column reports the t-statistics of the average daily abnormal return calculated according to Boehmer, Musumeci, and Poulsen (1991) (one star denotes significance at the 10-percent level, two at the five-percent level, and three at the one-percent level). The final column reports the degrees of freedom in the t-test. The sample period is 2002-2015.

window	abn. return	E(abn. return)	t-stat	n
Panel A: All bonds				
[-22,-12]	-0.71	-0.08	-2.73***	2541
[-11,-1]	-0.75	-0.06	-3.39***	2541
[0,1]	-2.69	-1.37	-7.78***	462
[2,22]	0.29	0.01	1.21	4851
[-22,5]	-4.09	-0.15	-6.81***	6468
Panel B: Equity				
[-22,-12]	0.47	0.04	2.42**	1012
[-11,-1]	1.81	0.17	3.16***	1012
[0,1]	10.85	5.31	7.41***	184
[2,22]	0.74	0.03	1.45	1932
[-22,5]	13.50	0.46	7.73***	2576
Panel C: Protected bonds				
[-22,-12]	-0.23	-0.02	-0.40	473
[-11,-1]	-0.36	-0.03	-0.64	473
[0,1]	-0.45	-0.23	-0.67	86
[2,22]	0.34	0.02	-0.15	903
[-22,5]	-0.56	-0.02	-0.58	1204
Panel D: Unprotected bonds				
[-22,-12]	-0.82	-0.10	-2.87***	2068
[-11,-1]	-0.84	-0.07	-3.47***	2068
[0,1]	-3.21	-1.64	-8.06***	376
[2,22]	0.27	0.01	1.40	3948
[-22,5]	-4.91	-0.17	-7.16***	5264

Table 2: *Event study in bond and equity returns in LBO targets.* This table displays the results of the event study of bond and equity 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 abnormal log return (in percent) in the window. The third column reports the average daily abnormal log return (in percent) in the window. The forth column reports the t-statistics of the average daily abnormal return calculated according to Boehmer, Musumeci, and Poulsen (1991) (one star denotes significance at the 10-percent level, two at the five-percent level, and three at the one-percent level). The final column reports the degrees of freedom in the t-test. The sample period is 2002-2015.

window	ΔCDS	E(ΔCDS)	abn. return	E(abn. return)	t-stat	n
Panel A: 5-year CDS						
[-22,-12]	0.7	0.1	0.65	0.06	0.03	2937
[-11,-1]	-0.4	-0.0	0.59	0.05	0.66	2946
[0,1]	3.1	1.5	2.99	1.50	4.09***	536
[2,22]	0.6	0.0	5.21	0.25	4.69***	5635
[-2,23]	2.9	0.1	8.57	0.34	6.24***	6707
Panel B: 3-year CDS						
[-22,-12]	0.4	0.0	0.54	0.05	-0.56	2629
[-11,-1]	-0.9	-0.1	0.86	0.08	0.42	2629
[0,1]	2.7	1.4	2.93	1.46	3.27***	478
[2,22]	0.3	0.0	6.51	0.31	3.88***	5026
[-2,23]	4.5	0.2	9.88	0.40	5.14***	5982
Panel C: 10-year CDS						
[-22,-12]	1.2	0.1	0.61	0.06	-0.37	2835
[-11,-1]	0.2	0.0	0.16	0.01	0.30	2847
[0,1]	3.1	1.6	2.13	1.06	3.64***	518
[2,22]	2.6	0.1	4.55	0.22	3.20***	5446
[-2,23]	9.1	0.3	6.61	0.26	4.35***	6482
Panel D: 30-year CDS						
[-22,-12]	4.2	0.4	2.37	0.22	0.61	1286
[-11,-1]	7.2	0.7	2.11	0.19	1.40	1300
[0,1]	3.7	1.9	3.10	1.55	2.49**	238
[2,22]	5.5	0.3	5.12	0.24	-0.91	2525
[-2,23]	13.0	0.5	7.53	0.30	-0.83	3001
Panel E: Equity						
[-22,-12]			0.24	0.02	0.87	5764
[-11,-1]			-0.32	-0.03	-1.73*	5764
[0,1]			0.91	0.45	10.00***	1048
[2,22]			-0.39	-0.02	-1.77*	11004
[-2,23]			0.80	0.03	3.33***	13100

Table 3: *Intra-industry abnormal CDS and equity returns around LBO announcements.* This table displays the results of the event study of intra-industry CDS and equity returns around LBO announcements. For every LBO announcement this event study examines the CDS and equity return reaction of all firms in the same industry as the LBO target (and excludes the LBO target). Industry is defined according to 3-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. The third column reports the average daily change 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 average daily abnormal return (in percent) in the window. The sixth column reports the t-statistics of the average daily abnormal return calculated according to Boehmer, Musumeci, and Poulsen (1991) (one star denotes significance at the 10-percent level, two at the five-percent level, and three at the one-percent level). The final column reports the degrees of freedom in the t-test. The sample period is 2002-2015.

	2001-2014	equity vol		tangibility		market-to-book	
dep. var: log(5y CDS spread)		high	low	high	low	high	low
industry probability of LBO	0.5418***	0.0613	1.4772***	2.2408***	0.3409**	-0.7122^{**}	0.6460***
	(0.1583)	(0.2205)	(0.2161)	(0.5055)	(0.1709)	(0.3057)	(0.1779)
leverage	1.6200***	1.9993***	1.6424***	1.4955***	1.8447***	1.5036***	1.7866***
	(0.0394)	(0.0609)	(0.0870)	(0.0557)	(0.0587)	(0.0696)	(0.0498)
equity volatility	2.3212***	1.7763***	4.9735***	2.2341***	2.1978***	1.8512***	2.4765***
	(0.0352)	(0.0462)	(0.2044)	(0.0460)	(0.0551)	(0.0554)	(0.0443)
distance-to-default	0.0467***	0.0394***	0.0144***	0.0708***	0.0342***	0.0521***	0.0403***
	(0.0018)	(0.0053)	(0.0029)	(0.0030)	(0.0024)	(0.0029)	(0.0023)
roa	0.0020	-0.1948^{**}	-0.5950^{***}	0.2556**	-0.4419^{***}	0.1961**	-0.6488^{***}
	(0.0781)	(0.0982)	(0.1283)	(0.1073)	(0.1216)	(0.0995)	(0.1189)
number of observations	15655	7827	7828	7727	7731	7827	7828
R^2	0.65	0.62	0.53	0.69	0.64	0.56	0.75

Table 4: *Pricing of LBO risk in CDS spreads.* This table presents results of regressing credit spreads of US firms from 2001-2014 on annual industry probability of LBO and firm-level controls. The dependent variable is *log(5y CDS spread)*, using annual closing spread per firm (quoted in percentages). *Industry probability of LBO* is computed per year as the ratio of: 1. number of industry firms that were targets of LBO (according to Thomson Financial LBO announcements) to 2. number of industry firms (as reported in Compustat). Industry is determined at the 3-digit sic level, where sic is as reported in Compustat. *Leverage* is long-term + short-term debt to total assets, *equity volatility* is the annualized standard deviation of monthly equity returns in the previous 36 months, *distance-to-default* is log leverage to equity volatility, *roa* is EBITDA to total assets, *stdev of roa* is the standard deviation of the last 10 years roa. The first column reports regression results for the entire sample of CDS contracts. The following columns report results where the sample is split into two samples above and equal to or below the median equity volatility, tangibility, and market-to-book. Tangibility is the ratio of PPE to total assets. Regression is run with year, restructuring clause and 2-digit sic fixed effects. ***,** and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	2001-2014	2001-2004	2005-2007	2008-2011	2012-2014
dep. var: log(5y CDS spread)					
industry probability of LBO	0.5418^{***} (0.1583)	-0.9604 (1.2386)	1.3419^{***} (0.3393)	-0.3914 (0.3561)	0.5063^{***} (0.1870)
leverage	1.6200^{***} (0.0394)	1.9690^{***} (0.0870)	1.8056^{***} (0.0867)	1.8293^{***} (0.0671)	1.0665^{***} (0.0827)
equity volatility	2.3212^{***} (0.0352)	2.1490^{***} (0.0671)	3.7977^{***} (0.1051)	1.9663^{***} (0.0503)	3.3998^{***} (0.1074)
distance-to-default	0.0467^{***} (0.0018)	0.0726^{***} (0.0056)	0.0346^{***} (0.0033)	0.0069^{*} (0.0040)	0.0385^{***} (0.0035)
roa	0.0020 (0.0781)	1.1531^{***} (0.1698)	-0.5891^{***} (0.1564)	-0.5701^{***} (0.1322)	-0.2062 (0.1687)
number of observations	15655	3239	4208	4540	3668
R^2	0.65	0.68	0.62	0.66	0.65

Table 5: *Pricing of LBO risk in CDS spreads over time.* This table presents results of regressing credit spreads of US firms from 2001-2014 on annual industry probability of LBO and firm-level controls. The dependent variable is *log(5y CDS spread)*, using annual closing spread per firm (quoted in percentages). *Industry probability of LBO* is computed per year as the ratio of: 1. number of industry firms that were targets of LBO (according to Thomson Financial LBO announcements) to 2. number of industry firms (as reported in Compustat). Industry is determined at the 3-digit sic level, where sic is as reported in Compustat. *Leverage* is long-term + short-term debt to total assets, *equity volatility* is the annualized standard deviation of monthly equity returns in the previous 36 months, *distance-to-default* is log leverage to equity volatility, *roa* is EBITDA to total assets, *stdev of roa* is the standard deviation of the last 10 years roa. The first column reports regression results for the entire sample of CDS contracts. The following columns report results for sub-periods. Regression is run with year, restructuring clause and 2-digit sic fixed effects. ***,** and * indicate significance at the 1%, 5%, and 10% levels, respectively.

maturity	1	2	3	4	5	6	7	8	9	10	12	14	16	18	20
benchmark	0.2	2.2	5.3	8.2	10.3	11.9	13.1	13.9	14.5	14.8	15.2	15.2	15.0	14.7	14.3
low leverage, leverage=0.14	0.0	0.0	0.0	0.1	0.3	0.6	0.9	1.4	1.9	2.4	3.3	4.2	4.8	5.4	5.9
robustness															
low jump size mean, $\eta = 0.15$	0.0	0.6	1.9	3.2	4.3	5.1	5.7	6.2	6.6	6.8	7.1	7.2	7.1	7.0	6.9
low jump size volatility, $\varsigma = 0.05$	0.1	1.8	4.8	7.7	9.9	11.5	12.7	13.6	14.2	14.6	15.0	15.0	14.9	14.6	14.2

Table 6: *Contribution of LBO risk to credit spreads across maturity.* For a typical firm in the corporate bond market with leverage of 33% and asset volatility of 24%, we calculate the contribution of LBO risk to the credit spread in the structural model outlined in Section 6. This Figure shows the difference (in basis points) in model-implied credit spread 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 jumps by $J \sim N(\eta, \varsigma)$. The parameters are estimated in Section 6.2 to be $\kappa = 0.124, \theta = 0.0276, \xi = 0.0523$. The value of λ is set equal to the average LBO probability during 1980-2014 of 0.0276. The first row shows the contribution of LBO risk with the benchmark parameters $\eta = 0.3$ and $\varsigma = 0.1$. The final two rows shows the contribution of LBO risk when the jump size mean is reduced by half and when the jump size volatility is reduced by half.

dependent: LBO	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-2007	1980-1990	2000-2007
roa	0.00125**					0.480***	1.192***	0.265***
	(0.0005)					(0.0973)	(0.1790)	(0.0585)
leverage		0.108***				0.290***	0.255**	0.412***
		(0.0361)				(0.0663)	(0.1050)	(0.1090)
market-to-book			-0.0662***			-0.0519***	-0.106***	-0.0358***
			(0.0096)			(0.0111)	(0.0246)	(0.0129)
stdev roa				-0.668***		-0.963***	-1.147*	-0.514***
				(0.1890)		(0.3070)	(0.6130)	(0.1950)
tangibility					0.148***	0.109**	-0.198***	0.257***
					(0.0363)	(0.0447)	(0.0704)	(0.0758)
ln(market cap)						-0.0160**	0.0276***	-0.0271***
						(0.0063)	(0.0087)	(0.0090)
prob Industry LBO	3.086***	3.029***	2.863***	2.965***	3.035***	2.587***	2.288***	2.122***
	(0.2910)	(0.2880)	(0.3030)	(0.2910)	(0.2900)	(0.3090)	(0.4440)	(0.4770)
PE funds	0.283***	0.295***	0.350***	0.244***	0.290***	0.333***	0.515***	0.348***
	(0.0458)	(0.0452)	(0.0470)	(0.0464)	(0.0458)	(0.0502)	(0.1010)	(0.0634)
num observations	215765	221507	171069	219343	217884	165134	52295	52573
R-squared	1.09%	1.13%	2.40%	2.93%	1.13%	4.66%	6.87%	4.02%

Table B1: *Estimation of LBO likelihood (US 1980-2007).* The table reports results of probit regressions of the likelihood of being an LBO target. Data sample is all Compustat firms 1980-2007. The dependent variable equals 1 for LBO targets at the year of announcement and 0 otherwise. Accounting data is from Compustat, LBO data is from Thomson Financial. *roa* is EBITDA to total assets, *leverage* is long-term + short-term debt to total assets, *market-to-book* is yearly closing price to common equity/common shares outstanding, *stdev roa* is standard deviation of roa, *tangibility* is net PPE to total assets, market cap is in millions of dollars. *prob Industry LBO* is Industry probability of LBO, computed per year as the ratio of: 1. number of industry firms that were targets of LBO to 2. number of industry firms. Industry is determined at the 3-digit sic level, where sic is as reported in Compustat. *PE funds* is US private equity fundraising as a percentage of total US stock market value, taken from Kaplan and Stromberg (2008). Errors are clustered at the firm level. ***,** and * indicate significance at the 1%, 5%, and 10% levels, respectively.

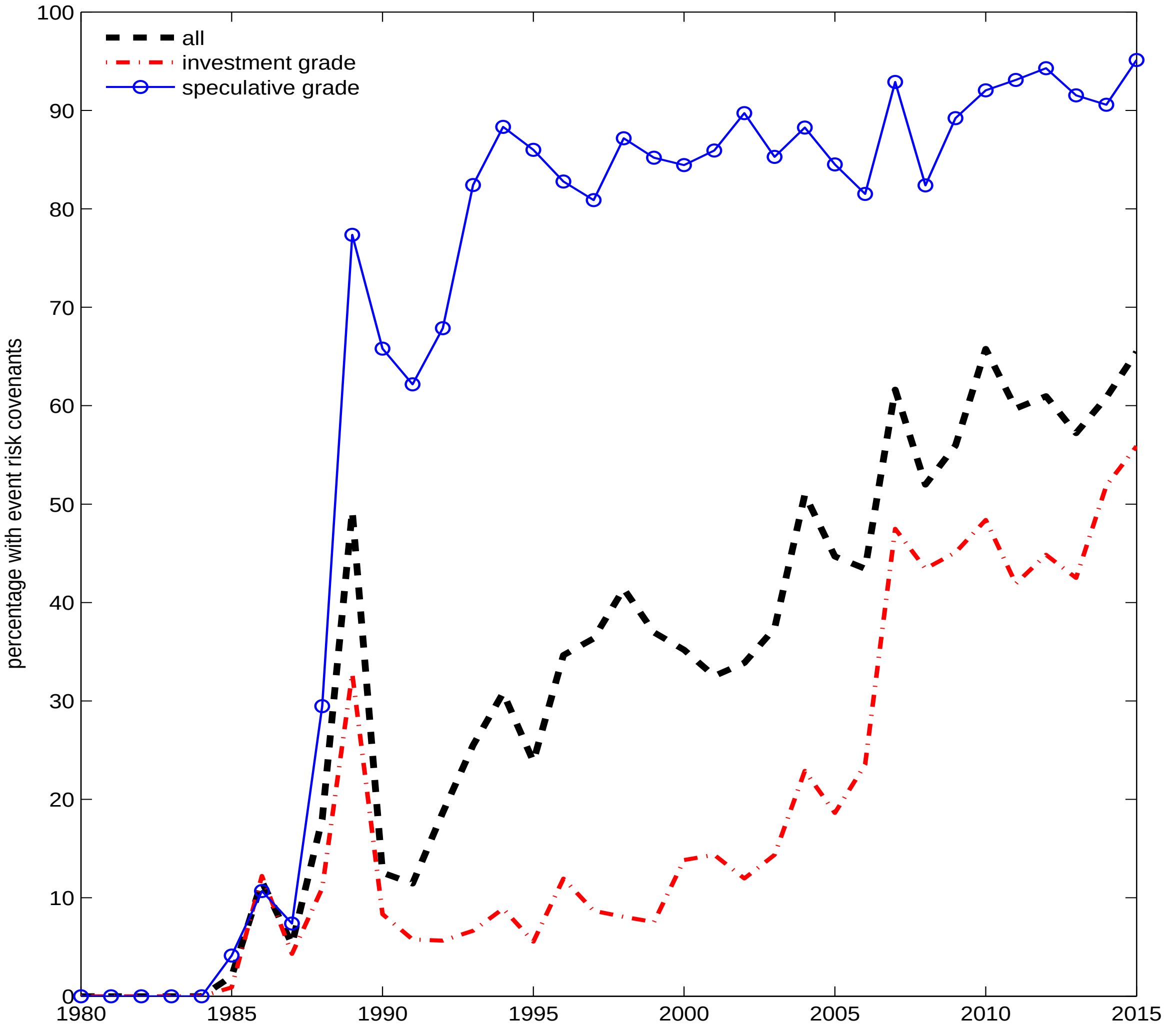

Figure 1: *New bond issues and event risk covenants.* This figure reports the percentage of new issues with event risk covenants over the years 1980-2015, as retrieved from the Mergent FISD database. Issue is marked as having an event risk covenant if the issue has a "change control put provision".

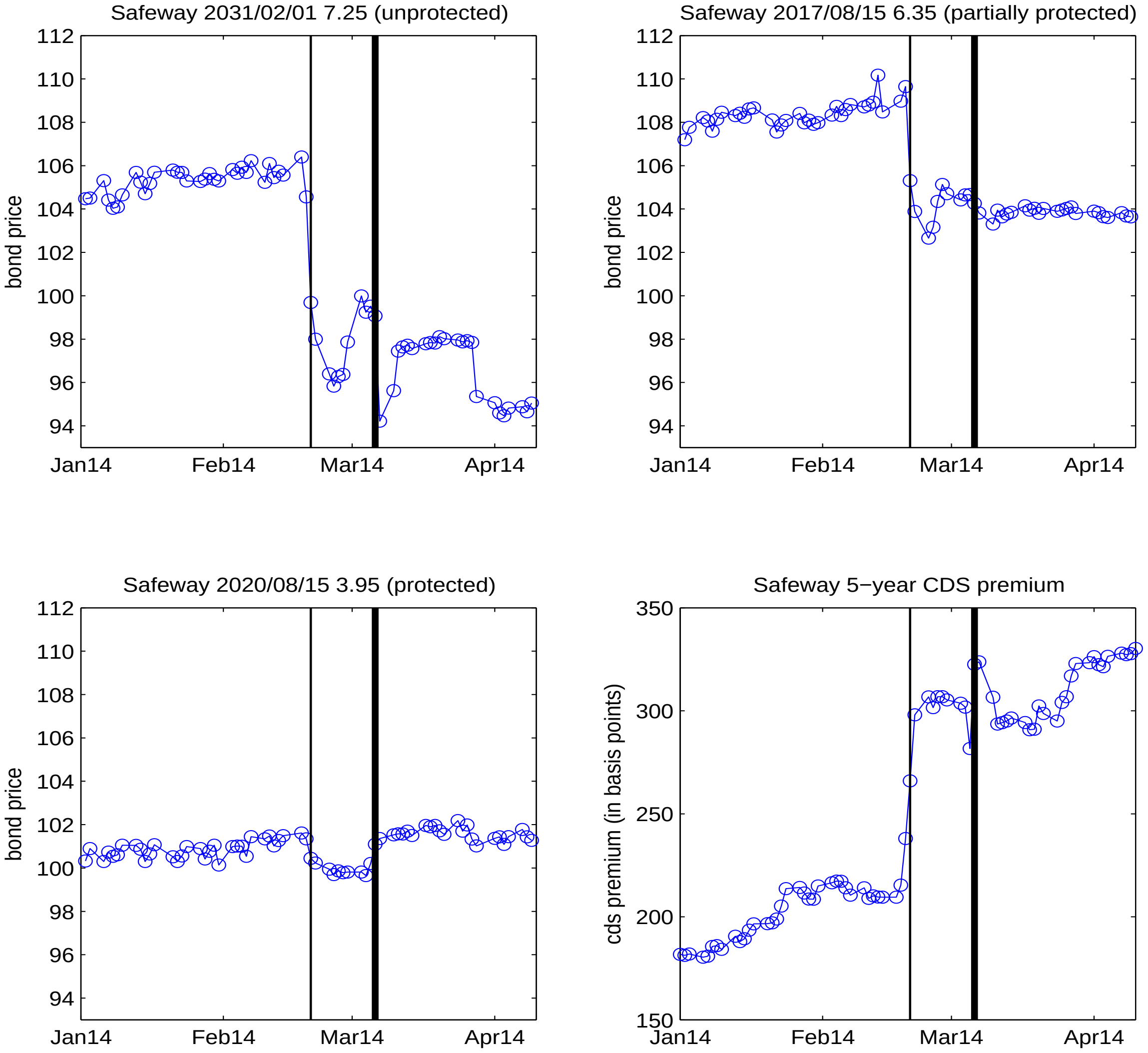

Figure 2: *Safeway bond prices and cds premiums around LBO announcement.* On February 19, 2014 Safeway announced that it was “in discussions concerning a possible transaction involving the sale of the company” and this date is marked with a thin vertical line. The thick vertical line marks March 6, 2014, where 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. The Safeway 2031/02/01 7.25 bond had no event risk covenant. The Safeway 2017/08/15 6.35 bond had a change of control put with a strike price of 101. The bond was only partially protected because the strike price was below pre-LBO market value. Safeway 2020/08/15 3.95 bond also had a change of control put with a strike price of 101. Since the strike price was not below pre-LBO market value, the bond was fully protected. the bond price on a given day is calculated as the average price of all transactions.

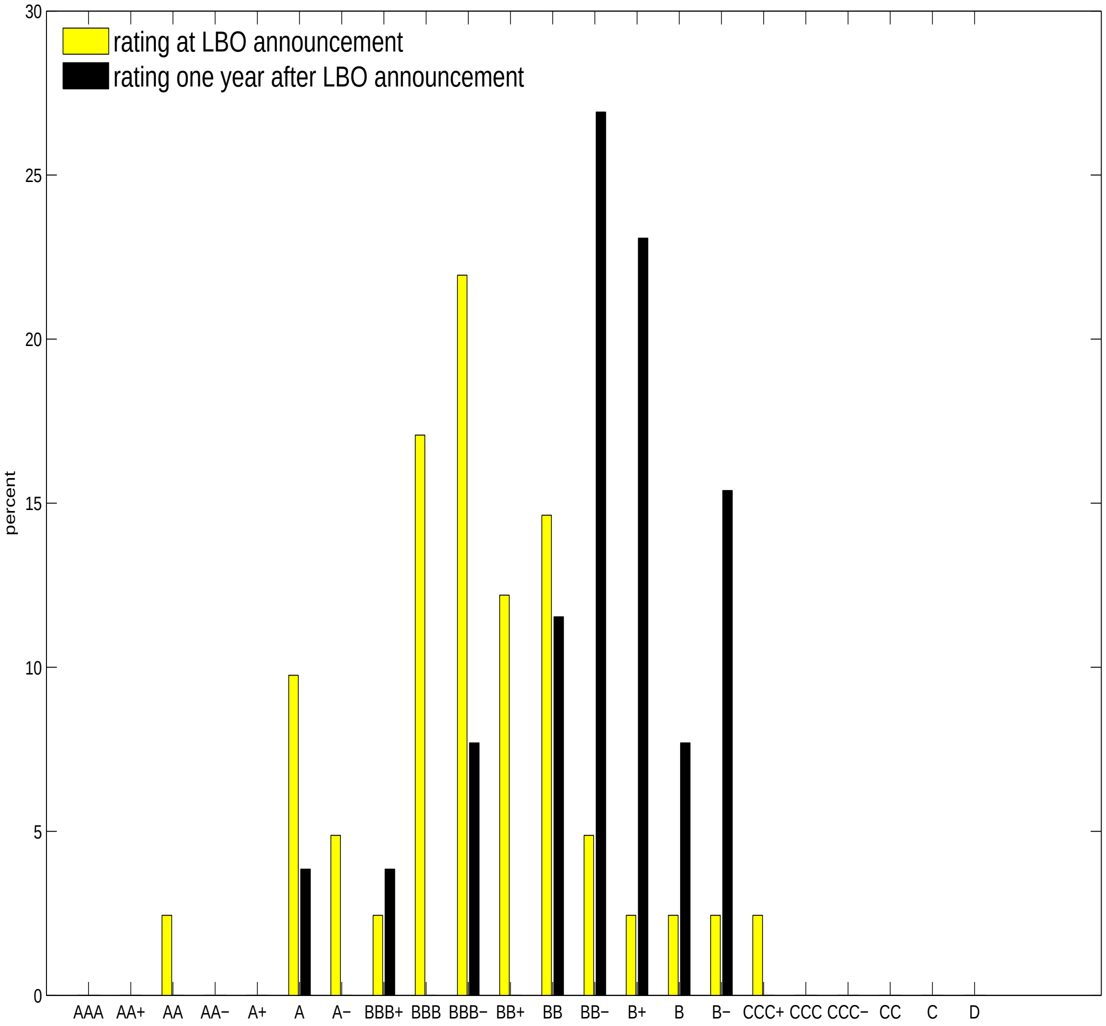

Figure 3: *Rating changes around LBO announcements.* This figure displays the distribution of ratings in the period 2002-2015 immediately prior to the LBO announcement (light-colored bars) and one year after the announcement (dark-colored bars). 41 firms in the sample had a rating immediately prior to the announcement and 26 one year after.

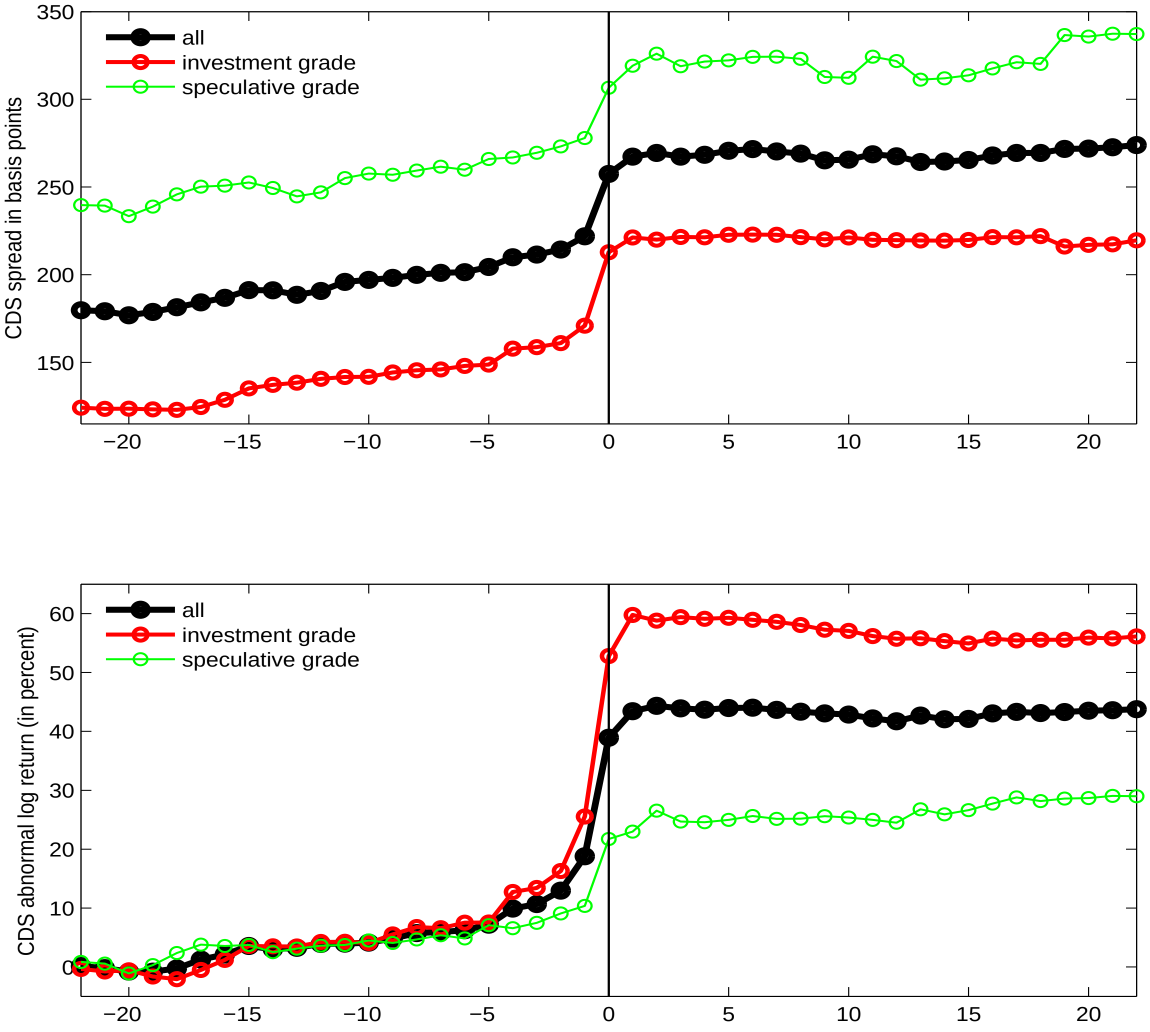

Figure 4: *Cumulative abnormal CDS returns around LBO announcements.* The top figure shows the average 5-year CDS spread of the target around LBO announcements (day 0 is the day where the LBO is announced). The bottom figure shows the average abnormal percentage log change in the 5-year CDS spread of targets around LBO announcements. In the figures firms are classified according rating, where rating is the rating immediately prior to the announcement. The time period is 2002-2015 and there are 43 firm events in the sample and 24 are investment grade firms while 17 are speculative grade firms (and two firms had no information on ratings).

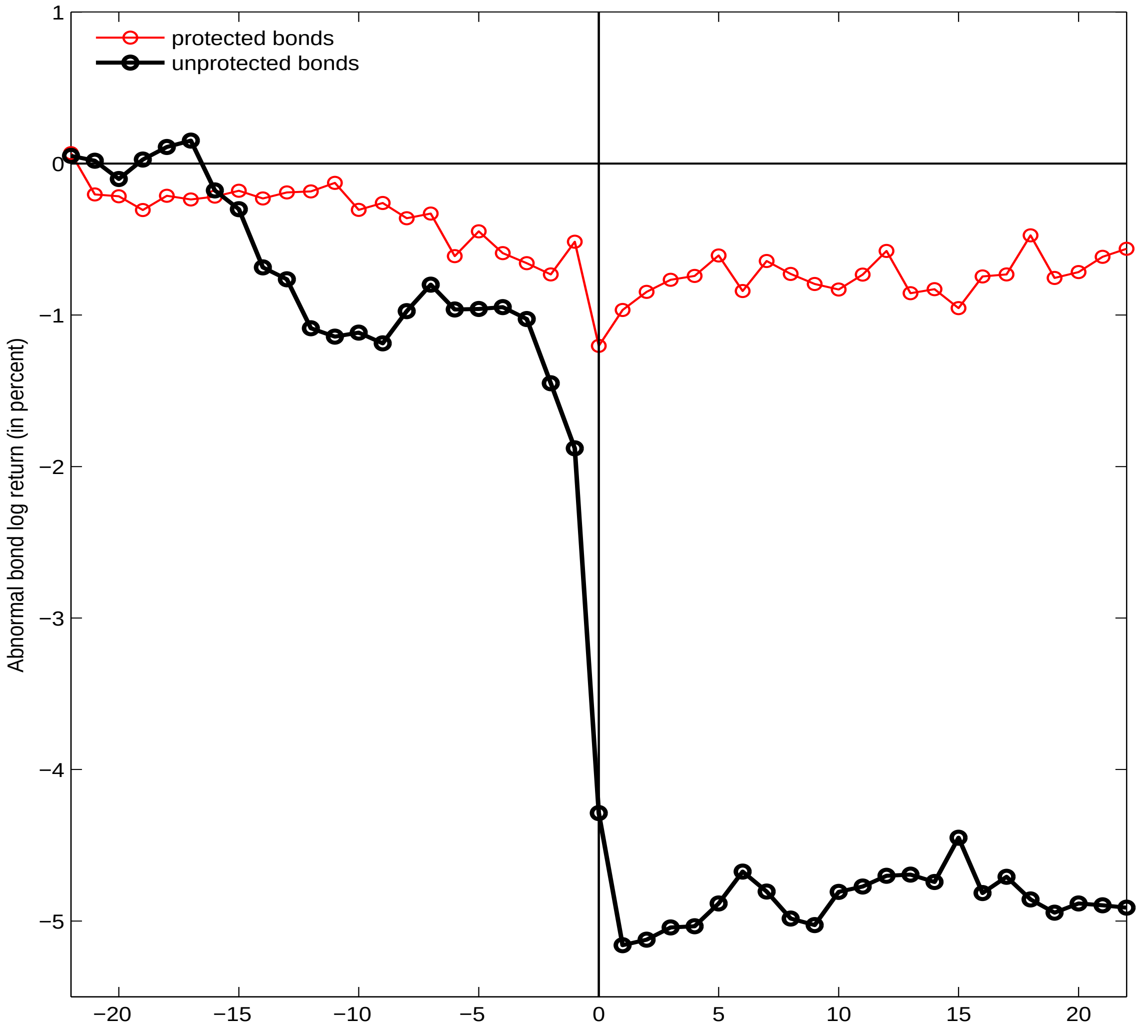

Figure 5: *Cumulative abnormal bond returns around LBO announcements.* The figure shows the average abnormal percentage change in the bond price of targets around LBO announcements. The time period is 2002-2015 and the figure is based on 232 bonds of which 44 are protected (i.e. have an event risk covenant).

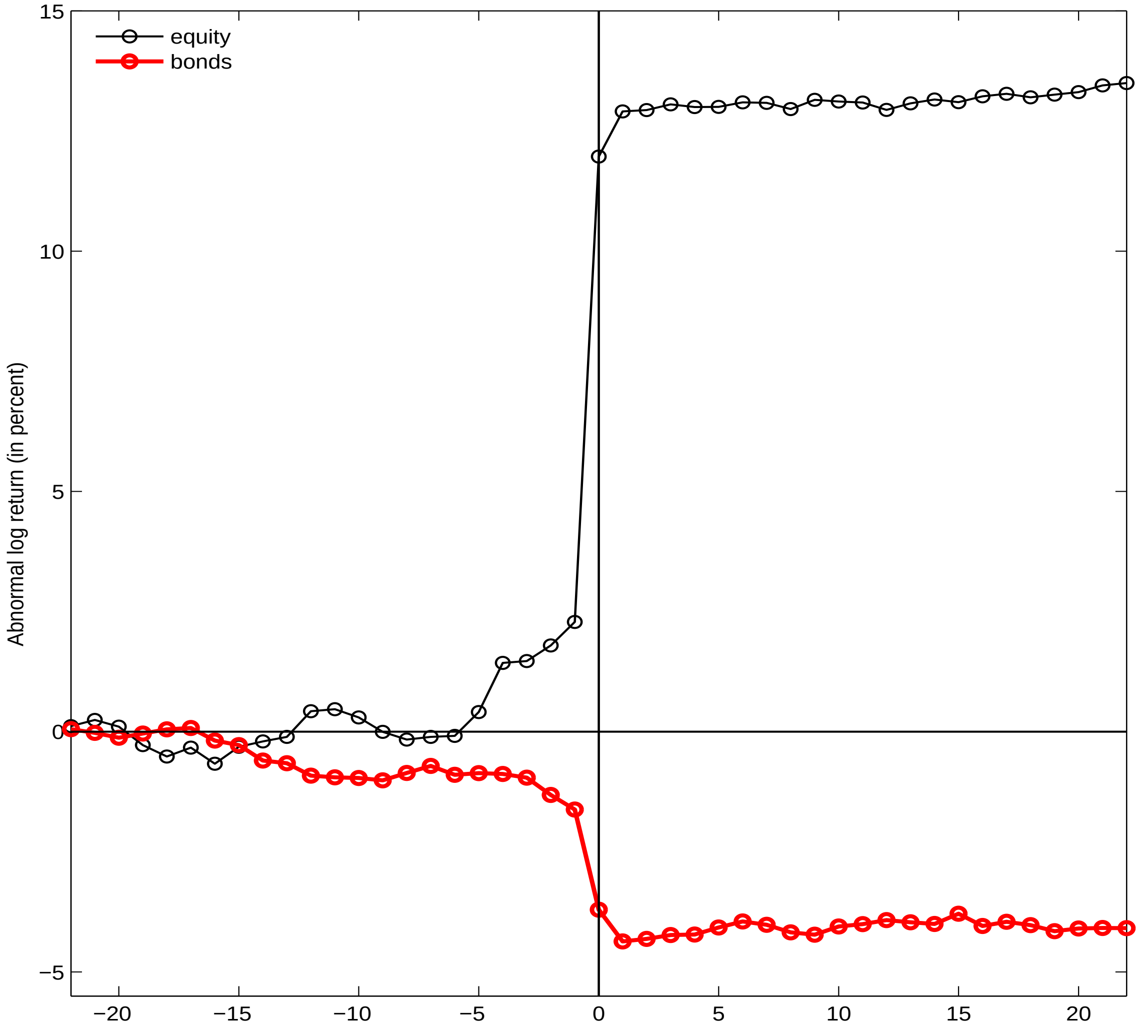

Figure 6: *Cumulative abnormal bond and equity returns around LBO announcements.* The figure shows the average abnormal percentage change in the equity and bond prices of targets around LBO announcements. The target had public equity outstanding in 94 LBO announcements in the period 2002-2015, while the total number of bonds for which transactions where available around announcements is 232.

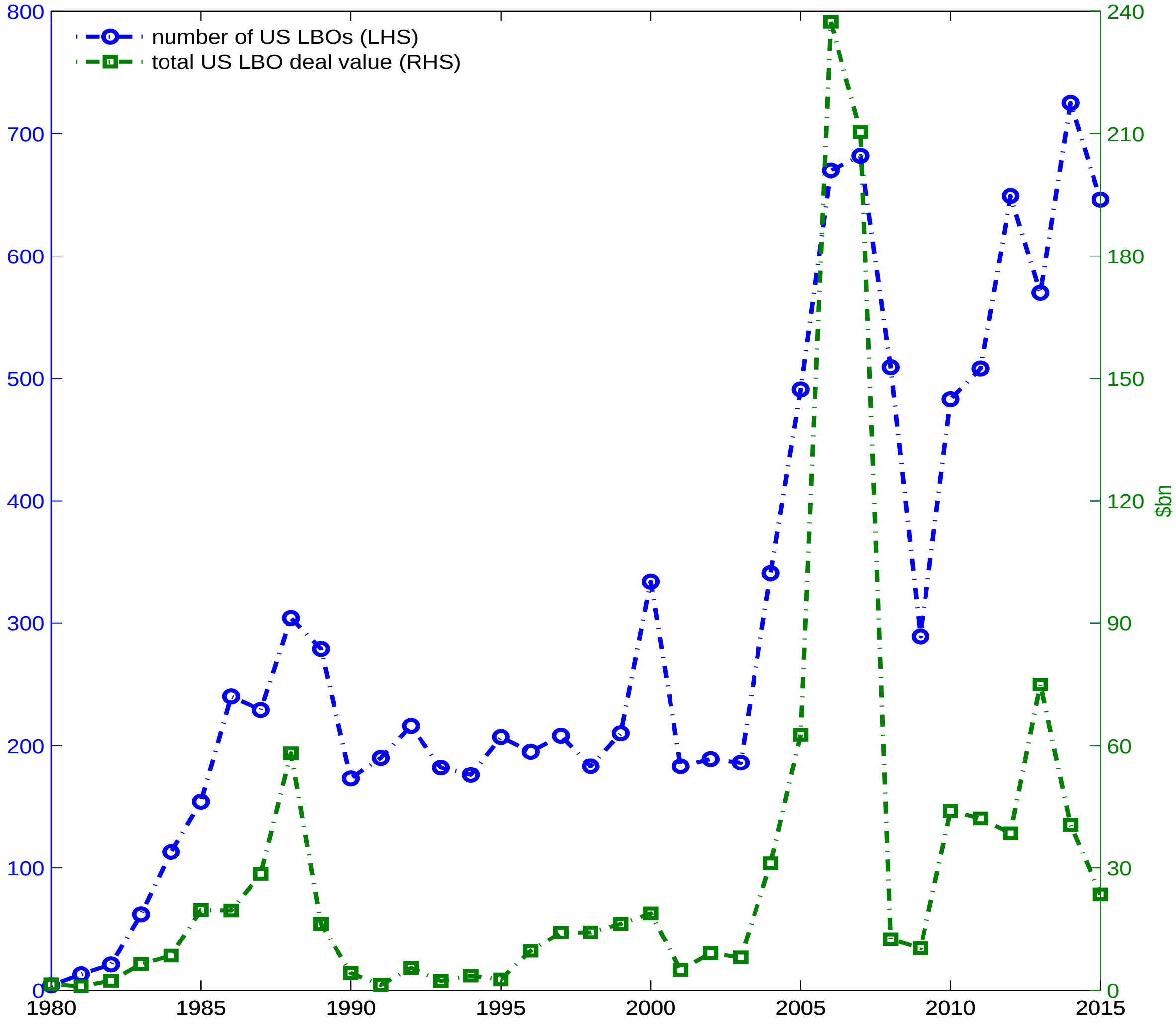

Figure 7: *LBO activity 1980-2015.* This figure displays the number (left axis) and total value (right axis, in billions of dollars) of announcements on US LBO targets over the years 1980-2015. Total value is calculated as the total value of equity of target firms and is a lower bound on actual total value because only 13.5 % of deals have information on equity value. Data on LBO announcements are retrieved from Thomson One Banker.

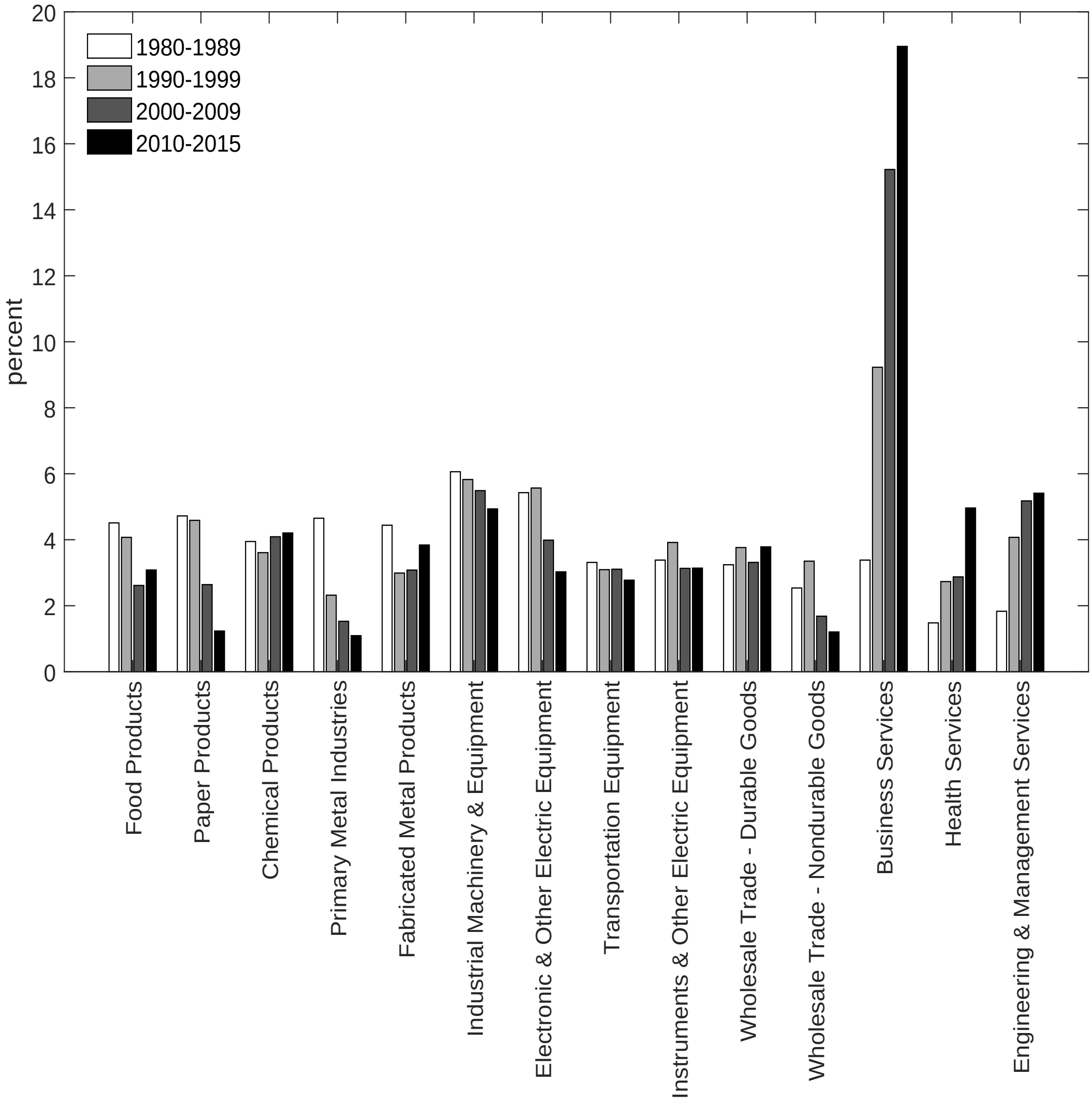

Figure 8: *Industry-level clustering in LBO activity.* This figure displays the percentage of LBOs in different 2-digit sic industries out of the total number of LBOs in the specified time frame. The total number of LBOs are 1419, 1940, 3863, and 3567 in the decades 1980-1989, 1990-1999, 2000-2009, 2010-2015, respectively. Industries displayed are those for which the percentage was higher than 3% in at least one of the decades. Data on LBO announcements are retrieved from Thomson One Banker.

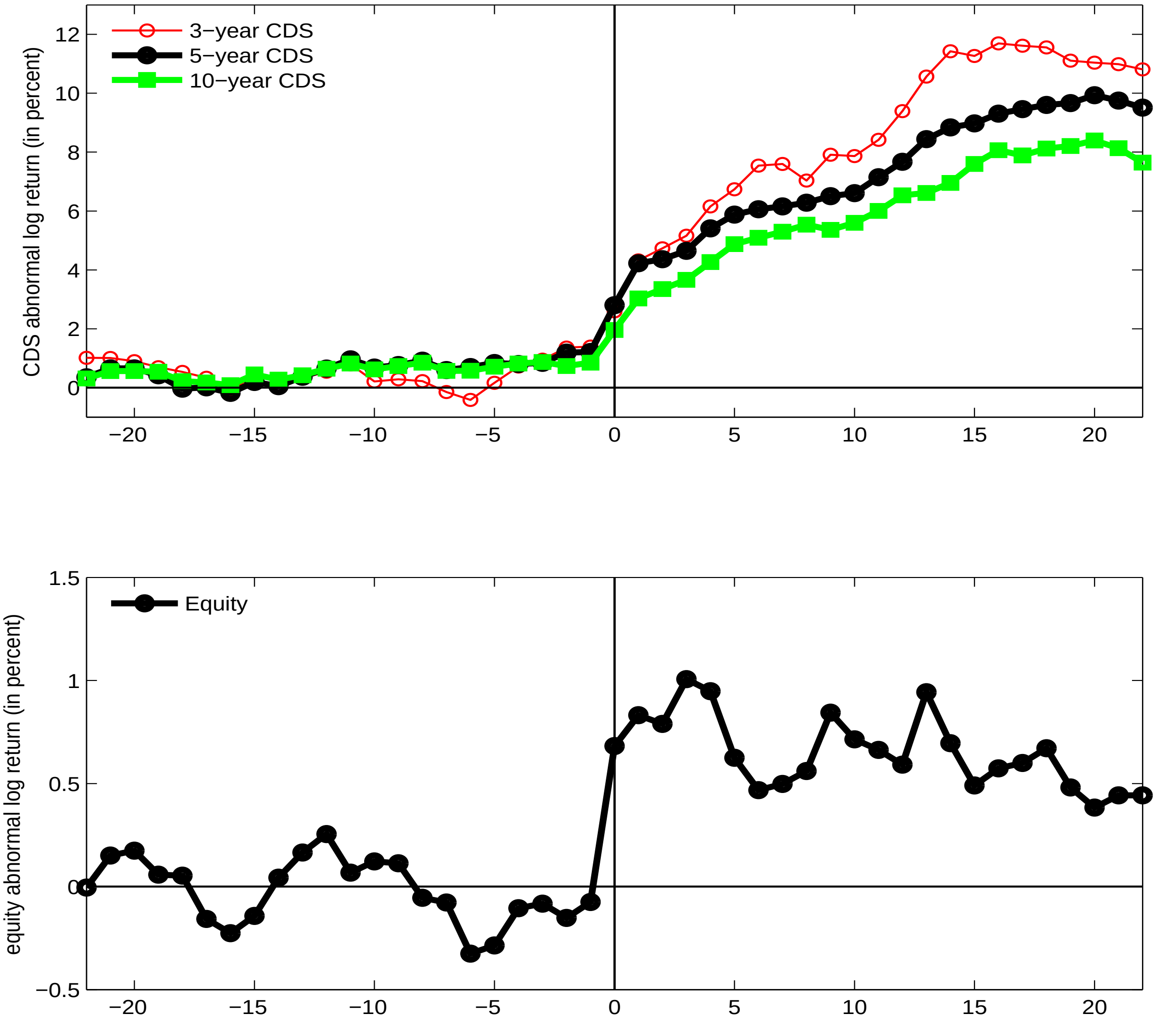

Figure 9: *Intra-industry cumulative abnormal CDS and equity returns around LBO announcements.* We define industry according to 3-digit SIC code and look at the CDS and equity reaction around LBO announcements of other firms that are in the same industry as the target firm (and we exclude the target firm). The top figure displays the cumulative abnormal CDS returns of all within-industry firms. The bottom figure displays the cumulative abnormal equity returns of all within-industry firms. The figures are based on 133 LBO announcements in the period 2002-2015.

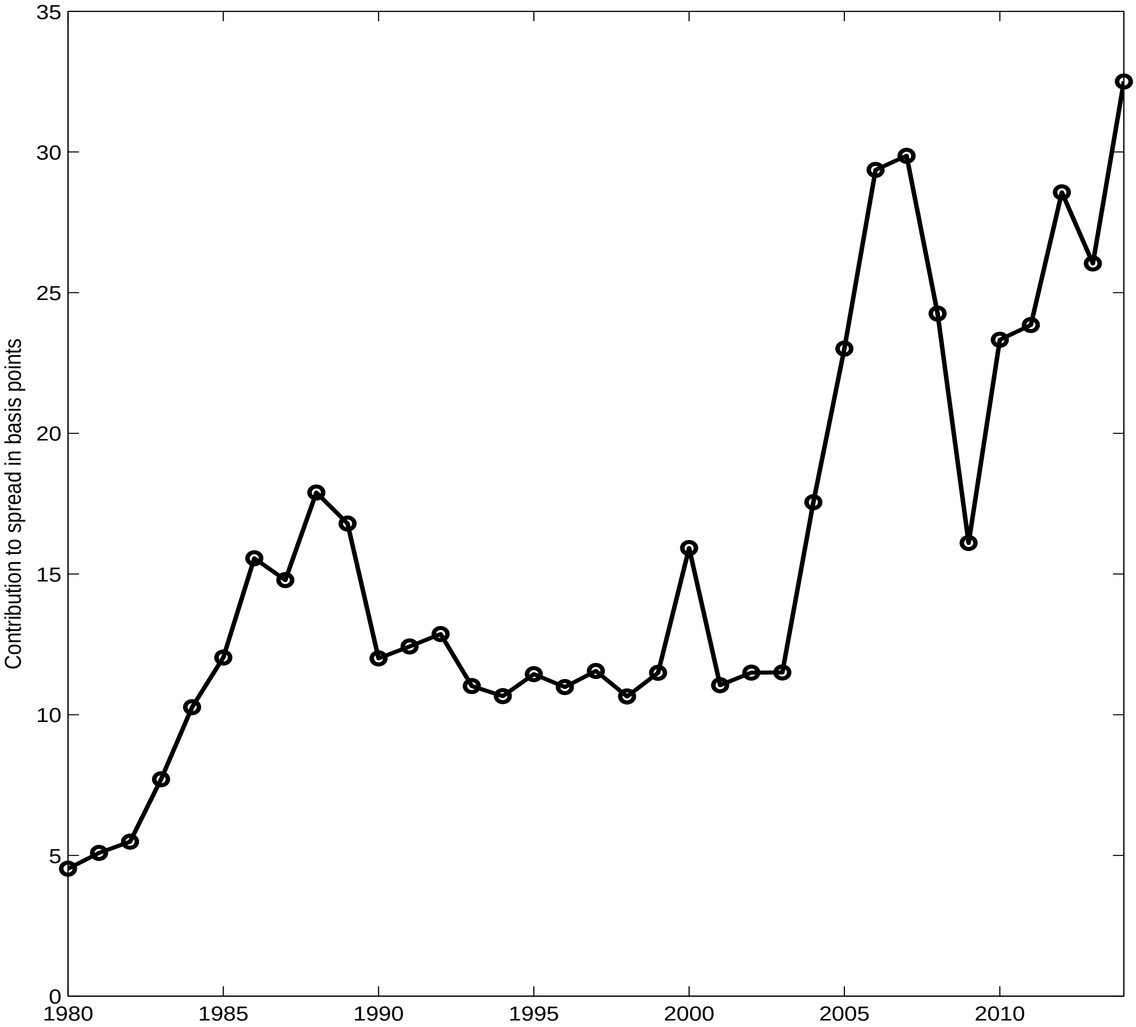

Figure 10: *The contribution of LBO risk to the five-year credit spread of a typical firm.* For a typical firm in the corporate bond market with leverage of 33% and asset volatility of 24%, we calculate the time-varying contribution of LBO risk to the five-year credit spread in the structural model outlined in Section 6. This Figure shows the difference (in basis points) in model-implied credit spread with and without LBO risk.