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ABSTRACT

Bond Ratings Matter: Evidence from the Lehman Brothers Index Rating Redefinition*

The 2005 inclusion of Fitch ratings in the Lehman composite index ratings provides a quasi-natural experiment to identify rating-based market segmentation in the corporate bond market. Split-rated bonds with favorable Fitch rating that were mechanically upgraded to investment-grade status exhibit abnormal returns and order flows, whether or not they enter the Lehman investment-grade index itself. An asymmetric impact of favorable Fitch ratings on bonds around the HY-IG boundary whose index rating did not initially change suggests that mechanical changes in future index rating transition probabilities also affect bond pricing. Our results highlight the importance of rating-based industry norms and practices for market segmentation, in addition to rating-based regulation.

JEL Classification: G12 and G14
Keywords: corporate bond market, index addition, industry practices, institutional investors, liquidity, market segmentation, rating agencies and rating-based regulation

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In segmented markets, different securities are held, and thus priced, by different investor clienteles.[1] One potentially segmented market is the US corporate bond market where bond ratings by Nationally Recognized Statistical Rating Organizations (NRSROs) play a highly visible role.[2] Official regulation, client investment mandates, and internal policies and procedures all restrict ownership of bonds rated below-investment grade at banks, pensions, insurance companies, and mutual funds. A possible consequence of the widespread use of bond ratings is that the bond market may be segmented into different investor clienteles for bonds rated investment grade and bonds rated high yield. If so, then bond ratings can affect bond pricing through a direct impact on segmented investor clienteles as well as via information about bond cash flow fundamentals.

The empirical importance of rating-based market segmentation in the bond market is an open question. Simply put: Would bonds be priced differently if, holding fixed the available cash flow information, their ratings changed from high yield to investment grade? This question is hard to answer because it is difficult to disentangle rating–induced investor clientele effects from cash flow information in bond ratings. In this paper, we use a 2005 change in the *rules* governing the eligibility of split-rated bonds in Lehman Brothers corporate bond indices to circumvent this identification problem. In practice, the willingness of rating-sensitive institutional investors to hold a given split-rated bond—i.e., where different rating agencies disagree on a bond's credit worthiness—depends on how investors *interpret* split ratings. A systematic change in what ratings investors consider investment grade can affect rating-sensitive investors' portfolio decisions, which, in turn, can affect the pricing of split-rated bonds while leaving cash flow information unchanged.

On January 24, 2005 Lehman Brothers announced a significant change in which split-rated bonds it considered to be investment grade. A bond's eligibility for inclusion in the Lehman (now Barclays Capital) corporate investment-grade bond index—an important benchmark for institutional investors—is based on a composite *index rating* which Lehman computes by aggregating a bond's credit ratings from various rating agencies. Effective July 1, 2005, the index rating for a

[1] Duffie (2010), Duffie and Strulovici (2011), and Gromb and Vayanos (2009) show how market segmentation and capital immobility can affect the ownership distribution of assets and how this feeds back into asset prices.

[2] As of early 2005, Moody's and S&P rated over 90% of corporate bonds issued, and Fitch rated about 70% of these bonds. Dominion Bond Rating Service, a Canadian credit agency, was recognized as an NRSRO by the SEC in 2003, and A.M. Best, a rating agency specializing in insurance companies, was recognized as an NRSRO in 2005.

split-rated bond changed to be the middle rating of the credit ratings issued by Moody's, S&P, and Fitch. Previously, Fitch ratings were ignored under the old Lehman rule which set a bond's index rating to be the more conservative of its ratings from Moody's and S&P.

Given Lehman's prominence in the corporate bond market, the change in Lehman's definition of "investment grade" likely influenced which bonds other investors deem to be investment grade. If so, the Lehman redefinition potentially altered rating-sensitive investors' net demand for split-rated bonds, thereby changing the ownership structure and pricing for these bonds. We call this the *rating–based market segmentation* hypothesis. In this context, two facts are important. First, the Lehman redefinition was arguably unaccompanied by new information about bond cash flow and default fundamentals. The prevailing Moody's, S&P, and Fitch ratings were already public, did not change with the Lehman announcement, and, presumably, were already reflected in bond prices. Rather, it is how bond ratings are *used* by Lehman, and possibly other investors, that changed. Second, Lehman's old index rating rule (which depended on the lower of Moody's and S&P ratings) was more restrictive than prevailing official regulations (which focused on middle ratings). Thus, there was some regulatory "slack" within which institutional investors could follow Lehman's lead vis-a-vis split-rated bonds and still satisfy the minimum standards set by official regulations. As a result, any increased demand by rating-sensitive investors for split-rated bonds with favorable Fitch ratings was due to changes in internal policies and procedures and client investment mandates. We call this the *industry practices channel*. In particular, the Lehman redefinition had no impact on any rating-based official regulations or on the investment-grade status of individual bonds under those regulations.

The Lehman rule change affected a significant number of bonds, since Fitch ratings were higher than the lower of the Moody's and S&P's ratings for 67% of all bonds rated by Fitch. Consequently, the Lehman index ratings for several thousand split-rated bonds ($640bn total market cap) improved by an entire letter or by one or two notches within the same letter rating. It also changed the future index rating transition probabilities for bonds whose investment-grade status did not change immediately. We document evidence of rating-based market segmentation in three different groups of bonds. First, we study a group of 57 high-yield (HY) bonds whose index ratings were immediately upgraded to investment grade (IG) after the Lehman redefinition.[3] For these bonds, we find that

- Upgraded bonds had statistically significant positive abnormal returns of about 1.3% around the Lehman announcement, 3.1% by the effective date, and then 3.1% by year-end (consistent with increased demand from rating-sensitive investors).

- These abnormal returns include a statistically significant permanent increase around the Lehman announcement and a component that is contingent on the subsequent differential performance of the IG and HY indices (consistent with a structural valuation change).

- Average daily turnover in the upgraded bonds doubled after the Lehman announcement, and net purchases by insurance companies rose (consistent with increased demand from rating-sensitive investors).

- Upgraded bonds with high post-announcement turnover outperform upgraded bonds with low turnover (consistent with price changes being caused by changes in bond ownership).

The second group we investigate are high-yield bonds whose investment-grade status did not change immediately, but whose future index rating transition probabilities improved because of a favorable bond rating by Fitch. Under the new Lehman rule—with its mechanical reclassification of some split-rating combinations from HY to IG—high-yield bonds with favorable Fitch rating need fewer S&P and Moody's credit rating upgrades to raise their index rating to IG. Consistent with improved IG transition probabilities and the attendant future demand from the IG investor clientele, we find that bonds with BB+ ratings from both Moody's and S&P but BBB– or better from Fitch had abnormal returns of 2.0% over the twenty-day Lehman announcement window, 2.5% by the effective date, and 3.2% by year-end. We also find abnormal returns in BB bonds with favorable Fitch ratings but not in BBB– or better bonds (except GM and Ford bonds on watch for downgrade to HY). This asymmetric impact of favorable Fitch ratings on bonds above and below the HY-IG boundary is, we will argue, consistent with rating-based segmentation.

[3] According to the financial press at the time of the Lehman announcement, the total number of bonds expected to switch index ratings was 59 (with a total market value of $33.4 billion comprising 2.1% of the IG index and 5.0% of the HY index). The difference between 59 bonds and our sample stems from a lack of TRACE transactions data.

The third group of bonds which exhibit rating-based segmentation effects are 850+ bonds issued by General Motors and Ford. These bonds are prominent in the back-story around the Lehman rule change. Under the old Lehman rule, GM and Ford bonds had index ratings of BBB– (due to a BBB– rating by S&P together with higher ratings by Moody's). In early 2005, S&P was widely expected to downgrade these bonds which, under the old Lehman rule, would lower their index rating to junk, forcing them out of the IG index. Given the enormous size of the outstanding GM and Ford debt,[4] severe capital immobility effects were expected as it would be difficult for high-yield investors to absorb these bonds in the short term. Consequently, GM and Ford bonds were under considerable selling pressure as investors reduced their holdings in anticipation of likely forced sales in the near future. The new Lehman rule gave the GM and Ford bonds a reprieve. So long as their investment-grade ratings from Moody's and Fitch held, GM and Ford bonds would maintain an investment-grade index rating notwithstanding any S&P downgrade. Consistent with rating-based segmentation, we find that selling pressure in the GM and Ford bonds abated, and that these bonds experienced strong positive announcement returns.

We consider several alternative explanations for the market's response to the Lehman redefinition. One alternative is a possibly informational *Fitch reputation effect*. The Lehman announcement may have raised the general reputation among investors of the informativeness of Fitch ratings for bond cash flows, which, in turn, may have caused a general revision in the market's perception of the credit risk of bonds with favorable Fitch ratings, leading to higher prices (Kliger and Sarig, 2000; Boot, Milbourn, and Schmeits, 2006). However, we find evidence against the Fitch reputation hypothesis. First, the announcement window price impact is disproportionately concentrated in BB+ bonds just below the IG-HY boundary where market segmentation effects from immediate and probabilistic future upgrades should be strongest. In addition, the stock prices of companies with favorable Fitch ratings on their bonds did not react to the Lehman announcement.[5] A second alternative explanation is an *index inclusion effect*.[6] Inclusion of the upgraded bonds in the IG

[4]Based on their 2004 annual reports, the total debt outstanding as of Dec 31, 2004 was $300 billion for GM and $173 billion for Ford. Ford also has additional indirect debt obligations because of off-balance sheet borrowing arrangements. Approximately 90% of this debt was issued by their financial services subsidiaries.

[5]Holthausen and Leftwich (1986), Hand, *et al.* (1992) and Goh and Ederington (1993) show that bond rating changes have an impact on stock prices.

[6]Vijh (1994), Barberis, *et al.* (2005), and Hendershott and Seasholes (2009) provide evidence from equity markets

index may have forced passive indexers to buy these bonds. However, while indexation may itself be a source of market segmentation, it does not fully explain the market response to the Lehman announcement. Splitting our sample of immediately upgraded bonds into subsamples of upgraded bonds which were not eligible for the IG index due to small issue size—we call these *orphan bonds*—and the remaining IG index-eligible bonds, we find both groups of bonds had significant positive post-announcement returns. Thus, investment-grade status, not just index membership alone, seems to matter for rating-based segmentation and bond pricing after the Lehman redefinition. A third alternative explanation is changes in priced liquidity. However, the changes in liquidity associated with increased turnover in the upgraded bonds after the Lehman announcement are not statistically significantly different from those in the control bonds.

A large literature investigates the economic role of rating agencies, market segmentation, and, more generally, the effects of shocks to the supply of investor capital.[7] A few recent papers are particularly relevant to our study. Kisgen and Strahan (2010) exploit the SEC's designation of Dominion Bond Rating Service as an NRSRO to investigate the regulatory role of bond ratings. Bongaerts, Cremers, and Goetzmann (2010) find time-series evidence of market segmentation in that multiple credit ratings play a "tie-breaking" role in bond pricing but only around the IG–HY boundary. Ambrose, Cai, and Helwege (2009) and Ellul, Jotikasthira, and Lundblad (2010) find mixed evidence on the price effects of fire sales of downgraded bonds by insurance companies.

Our paper contributes to this research in several ways. First, the Lehman redefinition (like the Dominion NRSRO designation) is a rare quasi-natural experiment which lets us test for a causal impact of bond ratings on bond pricing in the absence of confounding cash flow information. Our results are direct evidence that investment-grade status is valuable in and of itself, and that capital shocks affect asset pricing. Second, we find that the tie-breaking role of Fitch ratings increased after

on stock index additions and deletions.

[7]Coval and Stafford (2007) examine asset fire sales in equity markets, Mitchell and Pulvino (2007) examine large capital redemptions of convertible bond hedge funds, and Newman and Rierson (2004) analyze the impact of large issues by European Telecom firms. Steiner and Heinke (2001) examine price pressure in eurobonds associated with announcements of watchlistings and rating changes by S&P and Moody's. Holthausen and Leftwich (1986) and Hand, *et al.* (1992) examine the effects of bond rating agency announcements on bond and stock prices. Kisgen (2007) studies the market for credit ratings and the link to corporate capital budgeting. Becker and Milbourn (2010) show that the quality of S&P and Moody's ratings gradually deteriorated after the entry of Fitch. Chernenko and Sunderam (2011) study the real consequences of market segmentation.

the Lehman announcement. Third, our analysis highlights that rating-sensitive industry practices can induce market segmentation in addition to rating-based regulation. In light of the Dodd-Frank Act of 2010 and ensuant SEC proposals to reduce regulatory reliance on ratings by NRSROs, industry norms and practices are likely to be increasingly important in the future. Understanding their consequences for investor behavior and asset pricing is important for future policy making.[8]

1 Background and Hypotheses

The US corporate bond market is a natural venue for segmentation effects. First, it is an opaque decentralized over-the-counter (OTC) market where traders incur search costs in locating counterparties. Because of the relatively small number of potential counterparties, shocks to the ownership structure of bonds should lead to order flow imbalances and price changes that are larger and more persistent than capital shocks in the more liquid equity markets that have been the focus of much of the previous research on capital immobility.[9] Second, the use of credit ratings in official regulation, client investment mandates, and industry practices may segment the bond market into high-yield and investment-grade investor clienteles. In the following, we discuss the institutional setting and provide background information on the Lehman redefinition.

1.1 Rating-based segmentation

Credit ratings are widely used in regulatory oversight of financial institutions. The Securities and Exchange Commission (SEC), the Bank for International Settlements (BIS), and the National Association of Insurance Commissioners (NAIC) all use credit ratings to measure the credit risk exposure of institutions under their purview. The number of rating-based regulations has grown steadily. US Senate (2002) describes at least 8 federal statutes, 47 federal regulations, and over 100 state laws and regulations that use credit ratings from Nationally Recognized Statistical Rating

[8]Section 939 of the Dodd-Frank Act, which amends the major acts governing the FDIC, SEC, Federal housing agencies and the World Bank, specifically directs Federal agencies to remove references to NRSRO-issued credit ratings and replace them with an alternate standard. See SEC releases 34-58070 and 33-9193 for regulatory proposals.

[9]Duffie, Garleanu, and Pedersen (2007) show that illiquidity discounts in a search market are higher when counterparties are harder to find and when sellers have less bargaining power.

Organizations (NRSROs). These regulations typically restrict institutional holdings of bonds with low credit ratings. For example, SEC Rule 15c3-1 requires broker-dealers to take a larger discount ("haircut") on below-investment grade corporate bonds when calculating their net-capital. Savings and loan associations have been prohibited from investing in high-yield bonds since 1989. The NAIC restricts junk bond holdings to less than 20% of insurance company assets. Investment-grade bond mutual funds may only hold up to 5% of their assets in junk bonds and must sell any security falling below a B rating (see Cantor and Packer, 1994; and Kisgen, 2007).

For split-rated bonds—where rating agencies disagree on a bond's creditworthiness—some amount of judgement is called for in determining whether a bond is investment grade. Official regulations set minimum standards, but nothing prevents portfolio managers and investment committees from being more conservative to avoid litigation.[10] Rating-based industry practices are, therefore, another channel, on top of official regulation, through which segmentation can arise in the corporate bond market, with only a subset of buyers allowed—and *willing*—to hold large positions in risky bonds. In this regard, institutions are influenced by prevailing industry norms and best practices. Many investment mandates, for instance, specifically reference Lehman index ratings. Hence, Lehman, as an industry leader, had presumably the standing and visibility to influence industry norms and, thereby, affect institutional demand for split-rated bonds.

1.2 Lehman's index rating rule change

The Lehman Brothers (now Barclays Capital) bond indices have been in existence since January 1, 1973.[11] With their long history, they are widely used benchmarks in the fixed-income market. The specific indices of interest for this study are the investment grade US Corporate Index (IG index) and the US Corporate High-Yield Index (HY index). The IG index is composed of investment-grade,

[10]Official regulations focus on the middle (or higher) ratings. For instance, SEC Rules 15c3-1 and 206(3)-3T require a bond to be rated in one of the four highest categories by at least *two* NRSROs to be investment grade. SEC Rules 3a1-1 and 3a-7 require a rating in one of the four highest categories by at least *one* NRSRO for a bond to be investment grade. The NAIC assigns a bond rated by three NRSROs the rating falling second lowest (see NAIC, 2009). Investor use of even stricter standards, such as the "lower of two" old Lehman rule, could reflect coordination between money managers (seeking safety in numbers from litigation) or a response to investor ambiguity aversion.

[11]On September 22, 2008 Barclays Capital acquired Lehman Brothers' North American investment banking and capital markets businesses. Barclays has continued the family of indices and associated index services.

US dollar-denominated, fixed-rate, taxable securities that also meet certain par size, maturity, and other criteria. The HY index is composed of below-investment grade corporate bonds that meet characteristic criteria that are generally looser than those for the IG index.[12]

A bond's status as investment grade or junk is based on its *index rating*. The Lehman index rating is simply a composite rating based mechanically on credit ratings issued by the major credit agencies. Index ratings do not provide any additional credit information beyond the underlying Moody's, S&P, and Fitch bond ratings. Table 1 provides a short history of Lehman index rating rules and a timeline of other potentially pertinent market events surrounding the 2005 redefinition.

Lehman Brothers has redefined its index rating methodology only three times over its history. Under the original Lehman rule, a bond's index rating was the average of its Moody's and S&P ratings. A bond with a split rating of investment-grade by one agency and high-yield by the other contributed half of its weight to both the investment-grade and the high-yield indices (conditional on meeting the respective indices' bond characteristics criteria). In August 1988, the index rule was changed so that a bond's index rating was just its Moody's rating (or, if not rated by Moody's, its S&P rating). In October 2003, the rule was again changed so that a bond's index rating was the more conservative of its Moody's and S&P ratings (or, if not rated by both agencies, its rating from the single agency). We refer to the 2003 procedure as the *old rule* and the corresponding index ratings as the *old index ratings*.

In this paper, we investigate the most recent rule change.[13] On January 24, 2005 Lehman Brothers announced that, effective July 1, 2005, index ratings would also depend on Fitch credit ratings. In particular, a bond's index rating would be the middle rating assigned by Moody's, S&P, and Fitch. (For bonds rated by only two agencies, the index rating is the more conservative of the

[12] Additional details on the Lehman bond indices is available at `https://ecommerce.barcap.com/indices/`.

[13] We have insufficient data on transaction prices for the earlier Lehman index rule changes or for earlier redefinitions by other index providers. In particular, Merrill Lynch announced on October 14, 2004 changes in the selection criteria for the Merrill Lynch global bond indices. Effective December 31, 2004, Merrill Lynch switched its index rating rule from the average of Moody's and S&P to the average of Moody's, S&P, and Fitch. According to Business Wire ("Merrill Lynch Announces Changes to Global Bond Index Rules," October 14, 2004), the new methodology resulted in adjusted ratings on roughly 12% of all Merrill Lynch index constituents, the vast majority of which moving up by one rating grade. A total of 17 bonds fell below investment grade and none moved from below-investment grade to investment grade. The Lehman corporate indices are generally considered to be more widely followed than the Merrill Lynch corporate indices.

two ratings. If rated by only one agency, a bond's index rating is simply this single rating.) We refer to the 2005 rule as the *new rule* and the corresponding index ratings as *new index ratings*. Depending on their Fitch ratings, the new rule caused some bonds to transition mechanically from a high-yield to an investment-grade index rating, even though there was no change in credit ratings by any of the major rating agencies and, presumably, no change in credit fundamentals.

The 2005 Lehman index rating redefinition provides a quasi-natural experiment to examine market segmentation and bond ratings in the absence of concurrent information about bond creditworthiness. Although bond credit ratings themselves did not change, we argue that the Lehman announcement influenced how institutional investors *use* split credit ratings in their portfolio decisions. If true, this event allows us to circumvent the identification problem that bond credit rating changes themselves potentially convey new credit information as well as trigger changes in investor portfolio holdings. Whether the Lehman announcement caused industry norms to change or was itself a response to evolving industry norms is not crucial for our purposes. In either case, if the bond market is segmented because of rating-based industry practices which changed around this time period, then bonds upgraded from high yield to investment grade should experience additional investor demand. Given downward-sloping demand curves, the prices of these bonds should rise.

The Lehman redefinition was largely a surprise since index rule changes typically require consultation with three advisory councils, comprised of major fixed-income investment firms, that only meet once a year. On Monday, January 24, Lehman unexpectedly scheduled a conference call with its advisory councils to discuss the rule change. It had not had such a conference call for several years. The context in which this announcement occurred was one of market stress about potential GM and Ford downgrades. An article (Eisinger, 2005) in the *Wall Street Journal*—revealingly titled "GM Bond Worries Fade With Some Magic From Lehman"—provides an explanation for the redefinition, its motivation, and timing:

> "Lehman long had contemplated including Fitch, and it was on the agenda for a meeting later this year. So why the rush? Word had filtered into the media that Lehman was considering adding Fitch. 'We wanted to remove any attention to our indices, as quickly as we could' said a person familiar with the matter. And this person says Lehman had taken note of the market's GM jitters. Along with Moody's, Fitch rates GM bonds

higher than S&P, two notches above junk. Even if S&P downgrades GM, as long as the other two stand pat, the auto maker would remain in Lehman's investment-grade indexes under the new system."

Figure 1 plots the Lehman investment-grade and high-yield indices over time. We normalize them relative to the index level at the start of our control window, 50 trading days prior to the Lehman announcement. The vertical dotted lines indicate major events (as described in Table 1) relating to the Lehman index rating redefinition, the subsequent 2005 GM and Ford downgrades, and the three TRACE implementation phases. Clearly the performance of IG and HY debt diverged over this time period. Our analysis tests whether the pricing and trading of split-rated bonds with favorable Fitch ratings changed around the time of the Lehman announcement.

1.3 Hypothesis development

The rating-based market segmentation hypothesis can be summarized as follows: Before the Lehman redefinition, the status of bonds with split IG-HY ratings from S&P and Moody's and favorable Fitch ratings was ambiguous. Under official regulations they qualified as investment grade, but some in the industry, most notably Lehman, held a more restrictive view of these bonds as being below-investment grade. We conjecture that this ambiguity increased internal holding costs for these bonds. More time and effort was required for portfolio managers to justify the investment-grade status of these bonds internally with investment committees and externally with clients and any future litigants. Once the Lehman redefinition reduced this ambiguity and the associated shadow holding costs, net demand increased, leading to buying by rating-sensitive institutions, increased trading volume, and price appreciation. In addition, the redefinition improved the transition probabilities of some HY bonds being upgraded to IG status in the future and of some IG bonds (on watch for downgrades) remaining IG in the future. In particular, index rating transition probabilities changed because—holding future credit rating probabilities fixed for Moody's, S&P, and Fitch—the Lehman rule change redefined which split-rating combinations would be considered investment grade in the future. An anticipated higher probability of investment-grade status in the future—and the associated demand from rating-sensitive IG investors—should cause current prices for these bonds to appreciate even if their current IG status did not immediately change.

All of these predictions are driven by a reduction in institutional investors' internal holding costs. Expectations about future bond cash flows are presumed to be unchanged by the redefinition since the underlying S&P, Moody's, and Fitch ratings remained unchanged. All that the Lehman redefinition did, according to rating-based segmentation, is change how investors use existing (and future) bond ratings. Since the official regulatory treatment of bonds was unaffected by the Lehman announcement, these changes in rating-induced segmentation are occurring through, what we call, an *industry practices* channel.

2 Data and Methodology

We use an event study analysis to investigate the impact of the Lehman redefinition on different segments of the bond market. This section describes the main data sources. We also describe how we implement our event study.

2.1 Corporate bond characteristics

We obtain bond characteristics (e.g., coupon, maturity) from Mergent's Fixed Investment Securities Database (FISD), which contains comprehensive characteristic information on all bonds that are assigned CUSIPs. The FISD data also includes a complete ratings history from Moody's, S&P, and Fitch for all corporate bond issues.

To construct our sample, we start with all outstanding bonds as of the Lehman announcement date. We filter out redeemed bonds and bonds with special features. Specifically, we require that (i) the amount outstanding is positive at the announcement date, (ii) the remaining maturity is at least one year, (iii) the bond is not convertible or floating-rate, (iv) the bond is not a private placement bond, unless it is an SEC Rule 144A bond with registration rights, and (v) the bond was added to TRACE at least 10 days before the Lehman announcement date. This last criterion ensures that bonds in our sample have transaction prices before the announcement date (see Table 1 and the next section for the different phases of transaction price reporting and dissemination). Our final universe consists of 8,767 bonds, of which 2,336 are in the IG index, 722 are in the HY index, and 5,709 are not in any Lehman index. Of these, 5,943 are split-rated by Moody's, S&P and Fitch.

Table 2 presents summary statistics of the bond characteristics for various samples used in our study. The average par value outstanding as of the announcement date is approximately $250 million. Index members have, by construction, much larger issue sizes than bonds not in any Lehman index (around 10 times on average). Trading frequency also varies systematically between index and non-index members. Along other dimensions, IG index members (Panel A) have features comparable to HY index members (Panel B) and index non-members (Panel C).

Table 3 Panel A summarizes bond index ratings calculated according to the old and new rules. Under the new rule, index ratings increased for 3,108 bonds by at least one notch and, among these, for 729 bonds by an entire letter. The vast majority of bonds in our sample, 99.5%, are rated by Moody's and S&P, but only 70% of the sample is rated by Fitch. Panel B shows that Fitch assigned ratings higher than the lower of Moody's and S&P's to 4,149 (or 67%) of the 6,169 bonds they rated. This difference is pervasive across rating categories and industries.[14] Table 3 also shows that 26 bonds have lower index ratings under the new rule.[15]

2.2 Prices and transactions

Our main source for bond transactions data is the Trade Reporting And Compliance Engine (TRACE) which provides tick-by-tick data on transaction price, quantity, and supplementary information on all TRACE-eligible corporate bonds.[16] The TRACE system was instituted by the National Association of Securities Dealers (NASD) to meet demands from investors for greater transparency. Beginning on July 1, 2002, the NASD required all over-the-counter corporate bond transactions in TRACE-eligible securities to be reported to the TRACE system (see Table 1 for

[14] It is not crucial for our analysis whether ratings differences across agencies are due to different rating scales or different measurement objectives. Our interest is in the impact of ratings beyond their informational content.

[15] If a bond is rated by only one of Moody's and S&P, then a low Fitch rating can reduce its index rating.

[16] TRACE has two main limitations. First, transaction volume is truncated at $5 MM for investment-grade bonds and at $1 MM for high-yield bonds during our sample period. Second, the publicly disseminated version of TRACE does not provide a buy-sell indicator, which limits its ease-of-use for calculating transaction costs. See Bessembinder *et al.* (2009), Edwards *et al.* (2007) and Goldstein *et al.* (2007) for additional details on TRACE.

details).[17] To be in our sample, a bond must have transaction prices which were publicly disseminated before the Lehman announcement (see condition (v) in the previous section). The data were filtered to eliminate potentially erroneous entries. For instance, transactions flagged as canceled or corrected are deleted to ensure that our results are based on actual transactions. We also winsorize the price data at the 0.1% and 99.9% levels to mitigate the impact of outliers on our analysis.

The National Association of Insurance Commissioners (NAIC) database includes all corporate bond trades involving insurance companies. The NAIC data allows us to track the portfolio decisions of rating-sensitive investors. Equity prices for the companies in our sample are from the Center for Research in Security Prices (CRSP). We use daily end-of-day prices adjusted for splits and dividends. We obtain the three Fama-French factors—market excess returns (MKT), the size factor (SMB), and book-to-market factor (HML)—from Kenneth French's website.

2.3 Methodology

We face two methodological challenges in doing an event study around the Lehman announcement. The first is missing data due to infrequent bond trading. The second is determining an appropriate control for computing abnormal returns. We address these issues as follows.

2.3.1 Measuring cumulative returns in illiquid markets

Corporate bonds trade infrequently, with the typical bond trading only once, or less, every other day (Table 2 gives trading frequencies for various bond samples in this study). Since there is no standard method for computing returns given infrequent trading, we use two simple return imputation methods and verify our results are robust to both approaches.[18] Both approaches compute cumulative returns as the percentage difference between a bond's midpoint price and a pre-event reference price. When a bond does not trade on a given day, *Method 1* sets the missing

[17]Public dissemination of TRACE data was implemented in two stages. Transactions data on all corporate bonds considered to be reasonably liquid became publicly available on October 1, 2004. The remaining less liquid issues became publicly available on February 7, 2005. TRACE reported trades for around 4,100 bonds per day between October and February and 4,700 after February, but TRACE coverage dramatically falls off to roughly 1,600 bonds per day before October.

[18]Infrequent trading is less problematic when computing returns over longer than daily horizons.

price to be the last prior observed daily midpoint price. *Method 2* instead sets the imputed missing price to be the next subsequent observed daily midpoint price. The difference between the two approaches is the imputed timing of when missing returns are assumed to be realized. Method 1 delays imputed price changes to the end of the no-trade time interval, whereas Method 2 accelerates imputed price changes to the beginning of the no-trade interval. We then form cumulative returns on portfolios by taking the value-weighted average across all bonds in the portfolio.[19]

2.3.2 Matched-sample approach for measuring abnormal changes

Our estimation strategy for measuring abnormal returns and the impact of the Lehman redefinition relies on a matched sample methodology, as in Barber and Lyon (1997). The formation of a suitable control sample is of particular importance in our context. The looming potential downgrade of GM and Ford was presumably depressing the HY index. Thus, when the Lehman announcement gave GM and Ford a reprieve, this should have relieved some of the price pressure on the HY index bonds and caused HY bonds generally to appreciate. Our long-short matched sample design controls for these systematic dynamics and for other observable bond characteristics.

Our matched sample methodology matches each bond in the treatment sample to a set of control bonds that are similar along all dimensions deemed relevant except their Fitch rating. The control sample for bonds with favorable Fitch ratings is drawn from the universe of all bonds that are either not rated by Fitch (the most numerous type of control bonds from Table 3) or have a Fitch rating below Moody's and S&P.[20] Bonds with equal rating from Fitch are excluded from the control group since the redefinition had a favorable mechanical impact on the likelihood of such bonds being upgraded (and not downgraded) in the future, even if their current rating was unchanged, and, therefore, these bonds also potentially benefitted from the Lehman rule change.[21]

[19]Bessembinder *et al.* (2009) find that value-weighted portfolio-matching approaches are better specified and more powerful than equal-weighted approaches. We, therefore, use value weighting. However, our results do not rely on this particular portfolio construction.

[20]We checked the *Financial Times* archives and the internet for major news stories. We could not identify materially relevant events on bonds affected by the redefinition. From the sample of control bonds, we have eliminated bonds issued by AT&T, since AT&T announced a merger with SBC Communications in January 2005 (see `http://www.corp.att.com/news/2005/01/31-1`). At the time, AT&T bonds had a BB+ rating by all three agencies.

[21]The new rule expands the set of ratings changes which can cause a below-IG bond to be upgraded to IG. With one (or both) of its S&P and Moody's ratings below-IG and a Fitch rating also below-IG, a bond can be upgraded to an IG index rating if any one (two) of its two (three) below-IG ratings is raised to IG. In contrast, under the old rule, only upgrades specifically by the bond's one (two) below-IG big-two ratings lead to an IG index rating.

Our baseline match pairs treatment and control bonds based on their credit risk by matching on their old Lehman index ratings up to the notch (e.g., BB+, BB, BB–, B+, etc.), their maturity bin (short=1-5 years or long=5 years or longer), and their size bin (<\$250 MM or ≥\$250 MM par value of bond issue outstanding). The number of matches ranges between three and 18 for each upgraded bond with 10 matches on average. In robustness checks, we also match on index betas, liquidity, coupon, and industry. Index betas for the IG index are estimated using Dimson's method with one lead and lag and are then used to define high-low bins (less or greater than 0.255). Liquidity is measured by the frequency of non-trading days and then high-low bins are defined (less or more than 13%). Coupons are grouped into high-low bins (less or more than 5.9%). The industry-matching is based on three broad sectors (utility, financial, and industrial). Fewer matches result when more match criteria are imposed, which potentially increases the impact of idiosyncratic price movements in the set of matched control bonds. Therefore, our baseline analysis matches just on old index ratings, maturity, and size. However, our main results are robust and do not rely on these particular matching criteria.

The sample of control bonds are used to form sets of long-short portfolios. That is, we compute returns for portfolios that are long the treatment bonds and short a set of control bonds. For each treatment bond there are multiple possible control bond matches. In each round, one potential match for each treatment bond is used as the control and then a bootstrap draws different matches from the set of potential matches. Each long-short portfolio provides a set of cumulative abnormal returns (CARs) for each day during the event window. The average of these returns across the 1,000 bootstrap rounds yields the point estimates for our reported CARs.

One small sample size concern is that hypothesis tests and confidence intervals based on aymptotic theory can be misleading. We therefore use the bootstrapped sample of long-short portfolio returns to form the empirical distribution of abnormal returns in order to compute significance levels. Bootstrapping p-values mitigates statistical issues related to the small sample size. Barber and Lyon (1997), Lyon, Barber and Tsai (1999), and Chhaochharia and Grinstein (2006) show that the bootstrap approach can improve the accuracy of hypothesis tests. The bootstrap procedure to compute empirical p-values is described in more detail in Appendix A.

An alternative way to measure abnormal returns is using cross-sectional regressions with characteristics added as controls. A potential econometric concern with this approach arises when the treated sample has characteristics that differ from the average characteristics in the population, or in the control sample, leading to selection bias (see Heckman, Ichimura, and Todd (1997)). To the extent that valuation-relevant unobserved characteristics are correlated with the observed characteristics, the regression estimate on the treatment dummy will be biased. Our matched sample design avoids this potential sample selection bias by explicitly constructing a control sample which is similar to the treatment sample in terms of the observed characteristics. However, as a robustness check, and to assess the magnitude of the potential sample selection bias, we also report results from cross-sectional regressions.

3 Evidence from Upgraded Bonds

The Lehman rule change immediately changed the index ratings of several thousand bonds. In this section we investigate high-yield bonds which were prospectively upgraded to investment-grade index ratings given their credit ratings at the time of the Lehman announcement. These bonds are the most likely to exhibit market-segmentation effects. The Lehman announcement also changed the future index rating transition probabilities for bonds whose index ratings did not change immediately. In Section 4 we test whether these changes in transition probabilities also affected bond prices consistent with market segmentation.

The sample of immediately upgraded bonds consists of 47 bonds with an old index rating of BB, 7 bonds with an old index rating of B, and 3 bonds without a prior index rating, for a total of 57 bonds for which TRACE data is available.[22] While this sample is somewhat small, we will see that it is sufficiently large to obtain statistical power. It also comprises all switching bonds, thus avoiding any bias arising from sample selection. The sample size is also comparable to other research of natural experiments, which, by their nature, are often rare (e.g., Kliger and Sarig (2000), Kisgen and Strahan (2010)).

[22]The three bonds upgraded from BB– to AAA in Table 3 previously experienced material changes in creditworthiness, leading to downgrades from AAA to BB– by Moody's, while S&P and Fitch kept their ratings at AAA.

We investigate returns, trading, ownership changes, and liquidity over event windows defined relative to five important dates. Our timing is measured in terms of the number of trading days before or after the Lehman announcement on January 24, 2005 (day $t = 0$). We use two weeks before the Lehman announcement (day $t = -10$) as the start for the announcement window to have a clean pre-event base price because S&P watchlisted GM that week which, in part, prompted the Lehman redefinition. A pre-announcement control window $(-50, -10]$ starts ten weeks and ends two weeks before the announcement date. The pre-announcement window is relatively short due to limited transaction price availability before TRACE Phase III. The effective date for the redefinition is July 1, 2005 (day $t = +114$) and marks the end of the post-announcement window $(-10, +114]$. The post-effective window $(+114, +245]$ starts with the effective date and continues through the end of 2005 (day $t = +245$).

3.1 Abnormal returns on immediately upgraded bonds

Figure 2 and Table 4 report cumulative abnormal returns around the Lehman announcement for the 57 upgraded bonds. CARs are computed using the matched sample procedure described in Section 2.3 and, as a robustness check, using cross-sectional regressions as described in Appendix B. We report results based on our baseline match and the alternative match with additional criteria. Empirical p-values are one-sided for the null hypothesis $H_0 : CAR_t \leq 0$ and calculated using the bootstrap procedure described in Appendix A.

As a check on the adequacy of our methodology, we first compare treatment and matched bond returns over the pre-announcement control window $(-50, -10]$. If the treatment and control bond portfolios have similar systematic exposures, then the expected difference in returns for the two portfolios should be 0. The first row in Table 4 shows that the pre-announcement CARs are insignificant statistically and economically for all empirical approaches (baseline/alternative matching and imputation by Methods 1 and 2, and OLS). This suggests that the control bonds in the matched sample approach adjust adequately for the treatment bonds' risk characteristics.

Bonds that were immediately upgraded to IG index rating status had an economically significant average abnormal return—based on imputation Method 1 and baseline matching—of 1.3% over the twenty–day window surrounding the announcement day.[23] This is statistically significant at the 1 percent level. Information about the rule change apparently leaked into prices days before Lehman's announcement, consistent with press coverage of the event (see Eisinger, 2005). Some of the positive post-announcement drift may reflect delayed price adjustments due to slow-moving capital in search markets. The CARs peak around day +10 after the announcement after which a short-term reversal occurs. The upgraded bonds then further outperformed the control bonds until their CAR reached roughly 3% around the effective date. By the end of 2005 (after 245 trading days), the CARs still remained around 3%. A priori, the magnitudes of these returns seem plausible. These patterns are robust to the imputation method used to compute returns (Method 1 or Method 2) and for our baseline and more detailed matching procedure. OLS also yields similar estimates. Hence, we just report the more conservative baseline Method 1 in the rest of our analysis.

Cross-sectional evidence: Ownership effects should be more pronounced in bonds that need to be held for a long time. This is consistent with what we find. The first two sets of columns in Table 5 report CARs for maturity-based subsamples of 20 bonds with short-maturities (1-5 years) and 37 bonds with long-maturities (5 years or longer). The difference in abnormal returns for long– versus short–maturity bonds is 2.4% on day +10 and almost 4% by the year-end. If there is an economic link between clientele changes in bond ownership and prices, abnormal returns should also covary positively with trading volume in the cross-section of affected bonds. To check this, we split the sample based on ex-post turnover. The last two sets of columns in Table 5 summarize the results. Consistent with segmentation-based trading, the upgraded bonds with high turnover have higher abnormal returns than low turnover bonds, peaking at 4% around the effective date.

[23]To avoid look-back bias, our analysis of long-term price effects does not control for the fact that some upgraded bonds may subsequently experience downgrades and drop back into the HY index. Empirically, out of the 57 upgraded bonds in our sample, 56 maintained their new investment-grade index rating through the effective date but one dropped to high yield because of a downgrade before the effective date. We also exclude bonds that were unaffected by the rule change as of the announcement date but subsequently experienced index rating upgrades. In particular, three bonds with investment-grade status at the announcement were downgraded by S&P during the implementation period, but then reentered the IG index at the effective date because of the rule change. In addition, four high-yield bonds were newly issued during the implementation period and entered the IG index on the effective date because of the rule change. As already noted, our sample excludes bonds for which pre-announcement TRACE data to compute announcement returns was unavailable.

Abnormal return decomposition: Bond returns around the Lehman announcement and effective dates may reflect a variety of different components. First, the initial returns may include the previously mentioned pre-announcement information leakage and post-announcement slow-moving capital price adjustments. Second, returns may include a transitory component (due to costly liquidity) and a permanent component (since bonds in different market segments are priced using different investors' marginal rates of substitution). Third, events after the Lehman announcement may have price impacts which interact with the Lehman redefinition. For example, the CARs in Figure 2 peak around the time of the GM/Ford downgrades, which presumably affected spreads between all IG and HY bonds. We conjecture that the Lehman redefinition caused the upgraded bonds to react differently to subsequent events (like the GM and Ford downgrades) than they would have as HY bonds under the old index rating rule. We call this a *contingent price effect* of the redefinition. In particular, the upgraded bonds, as newly minted investment-grade bonds, should trade at a premium over otherwise similar high-yield bonds and the magnitude of this premium should change over time with the relative performance of the IG and HY indices.

To assess the magnitudes of the various permanent, transitory, and contingent components in returns, we decompose cumulative abnormal returns as follows:

$$\begin{aligned} CAR_t &= PC_t + TC_t, \\ PC_t &= PC_{t-1} + \alpha \frac{\mathbf{1}_{t_0<t\leq t_1}}{t_1 - t_0} + \beta_0\, IMH_t\, \mathbf{1}_{t>t_1} + \ldots + \beta_K\, IMH_{t-K}\, \mathbf{1}_{t>t_1+K} + \eta_t, \\ TC_t &= \delta_1 TC_{t-1} + \ldots + \delta_L TC_{t-L} + \epsilon_t, \end{aligned} \tag{1}$$

where the permanent component PC_t is an unobserved unit root process, the transitory component TC_t is an unobserved mean–reverting process with a zero long–run mean, IMH_t is the daily excess return of a portfolio that is long the IG index and short the HY index, and $\mathbf{1}$ is an indicator that equals one during the time period indicated by the subscript, and is zero otherwise. The permanent and transitory shocks η_t and ϵ_t are independent Gaussian random variables with variances σ_η^2 and, respectively, σ_ϵ^2. We allow for pre-announcement leakage and post-announcement slow-moving capital drift via the coefficient α, which lets the initial permanent impact of the redefinition accrete linearly over the initial announcement window $(-10, +10]$ (i.e., days $t_0 = -10$ through $t_1 = 10$). The coefficients $\beta_0, \ldots, \beta_K$ allow the permanent component of the redefinition's impact to change over time contingent on the subsequent differential returns *IMH* on the IG and HY indices. The lags allow for a delayed impulse response to *IMH*. While some variation in *IMH* comes from changing differential cash flow expectations for the two indices, *IMH* will also reflect changing pricing kernels in the two segmented markets. Ideally, we would like to test whether post-announcement βs changed relative to pre-announcement βs. However, with limited data availability before the Lehman announcement (due to the timing of TRACE Phase III) and only modest variation in pre-announcement returns, this is not practical. Thus, we just test whether the post-announcement return differential IMH_t affects the relative pricing of the upgraded bonds.

Table 6 reports Kalman Filter estimates of the decomposition in (1). Each column corresponds to a different specification (with varying lag lengths L and K). The Akaike information criterion (AIC) and the Bayesian information criterion (BIC) both indicate that specification (D), with $K = 1$ and $L = 2$, provides the best fit. The estimated $\widehat{\alpha}$ implies an initial permanent price reaction of 1.2% (p-value $< .001$). The $\widehat{\beta}$ estimates are consistent with a statistically significant contingent impact of the Lehman redefinition on subsequent returns. The estimated volatilities σ_η^2 of the residual permanent shocks are small because most of the variation in PC_t is due to IMH_t.

The estimated permanent returns from the Kalman Filter can be decomposed into a contingent component that depends on realized *IMH* differential returns, $\widehat{PC}_t^C = \sum_{s=t_1+1}^{t}(\widehat{\beta}_0\, IMH_s\, \mathbf{1}_{s>t_1} + \ldots + \widehat{\beta}_K\, IMH_{s-K}\, \mathbf{1}_{s>t_1+K})$, and an unconditional residual, $\widehat{PC}_t^U = \widehat{PC}_t - \widehat{PC}_t^C$, reflecting future events unrelated to differential *IMH* performance. Figure 3 plots this decomposition. As can be seen from $\widehat{PC}_t^C$, abnormal returns on the upgraded bonds are sensitive to the *IMH* differential return, consistent with the notion that the upgraded bonds trade at a time-varying premium relative to their former HY peers.

3.2 Impact on bond holdings and trading

Are the abnormal announcement returns for the upgraded bonds due to increased demand from rating-sensitive institutional investors? To answer this question, we examine turnover and order flow imbalances around the Lehman announcement. We also directly examine trading by insurance companies as a specific example of rating-sensitive investors.

Bond trading activity: Our first measure of trading activity is relative turnover, defined as TRACE trading volume divided by the FISD total outstanding bond par value. Figure 4 plots average daily turnover around the announcement date for the 57 upgraded bonds and for the matched sample of control bonds from Section 3.1. Table 7 reports statistics for average daily turnover over three time periods: the pre-announcement window $(-50, -10]$, the post-announcement window $(-10, +114]$, and the post-effective window $(+114, +245]$.[24] Consistent with a demand shock, turnover for the upgraded bonds exhibits a significant transitory increase. Between the announcement and effective dates, turnover for the upgraded bonds roughly doubles, from 0.19% to 0.39% per day and then, after the effective date, reverts somewhat to its former level before the rule change. However, the control bonds do not exhibit this same pattern. A formal Diff-in-Diff test rejects the null that changes in turnover in the upgraded and control bonds are the same. Thus, the upgraded bonds appear to have seen an elevated amount of trading—and ownership changes—following the Lehman announcement.

Next, we estimate the relation between order flow imbalances and bond returns. TRACE, unfortunately, does not provide explicit buy-sell indicators for which party initiates trades and gives no information on trader identities. Hence, we cannot directly observe trading by particular types of investors. We can, however, impute trade direction and investor type. Following a trade classification procedure similar to Lee and Ready (1991), we compare each transaction price with the closing price on the most recent prior trading day (i.e., we do not use imputed prices). If the transaction price is higher, the transaction is classified as a buy, and otherwise as a sell. The buy/sell indicators are then used to compute daily order flow imbalances. We use transaction size as an indicator for investor type, since large trades over $1 MM in par value are predominantly institutional.

[24]We start our post-announcement window before the announcement to capture any information leakage. Results are unchanged when we start the window after the announcement.

Table 8 describes the relation between daily returns and order flow imbalances for the 57 upgraded bonds. We report results from both pooled OLS regressions and average coefficients from time-series regressions for individual bonds. The dependent variable is the daily return. The independent variables of interest are various order flow imbalance measures (i.e., to control for TRACE trade size censoring and for investor type).[25] Trading volume is included as a control variable, but the results are very similar in the univariate case. We look at both the post-announcement window (-10,+114] (in Panel A) and the post-effective window (+114,+245] (in Panel B). The coefficients on all order flow variables are positive and significant. Hence, positive order flow imbalances in the upgraded bonds are causing bond prices to appreciate. The R^2s indicate that—despite the TRACE measurement errors—order flow imbalances explain up to 45% of the returns.

Bond portfolios of insurance companies: Bond trading data for insurance companies from NAIC allows us to investigate directly whether the increased turnover after the Lehman announcement is due, in part, to increased buying by rating–sensitive investors. Given their sizeable holdings, insurance companies are a prominent example of rating-sensitive investors.[26] According to Federal Reserve data, insurance companies own 25 percent of corporate bonds outstanding in 2004-5.[27] Insurance companies actively trade high-yield bonds (see Wells Fargo, 2009) for their own portfolio needs and to fund the separate accounts of variable insurance and annuity products.

Figure 5 summarizes trading by insurance companies around the Lehman announcement. The solid line plots the equal-weighted average cumulative change per bond in the aggregate dollar insurance company holdings of the 57 upgraded bonds. The dashed line plots the corresponding average for the matched sample of HY control bonds. Insurance companies clearly increased their holdings in the upgraded bonds over the post-announcement period and sold the HY control bonds.

Table 9 summarizes changes in insurance company holdings of upgraded and control bonds and tests statistically whether the portfolio shifts are abnormal. Panel A reports the changes in the

[25]We express all explanatory variables in logarithms in order to reduce fat tails. That is, *Order Imbalance* equals $ln(1 + \text{OI})$, if the raw order imbalance measure OI is positive, and $-ln(1 + |\text{OI}|)$ otherwise.

[26]NAIC imposes heavy reserve requirements on insurance company holdings of junk-rated bonds. In addition, in 1991 NAIC placed a 20 percent cap on the amount of junk bonds insurers may hold as a fraction of their assets.

[27]See Federal Reserve, Flow of Funds, Table L.212 Z.1.

inventory of insurance companies over the post-announcement window (-10, +114], and Panel B gives them over the post-effective window (+114, +245]. The first (second) set of columns measure insurance company transactions in dollar terms (in percent of issue size which controls for differences in bond size). On average, insurance companies bought \$15.4 million of each bond upgraded to IG status (\$3.9 million after the announcement plus a further \$11.5 million after the effective date), or 4.7% of the issue size on average. Most of these purchases occurred after the effective date, suggesting that some of the bond turnover before the effective date is due to anticipatory front-running. In contrast, insurance companies shunned the HY control bonds. The abnormal increase in insurance company holdings of upgraded bonds relative to control bonds is \$19.3 million per issue (\$6.5 plus \$12.8 million), or 5.9% of the issue size on average when compared to the control bonds. As indicated by the Diff-in-Diff p-values, the increase in holdings of the upgraded bonds is statistically larger than for the control bonds. These results are consistent with rating-sensitive investors buying the newly upgraded bonds.

4 Further Evidence and Alternative Hypotheses

This section documents rating-based segmentation effects in two additional groups of bonds. Recall from Section 1.3 that the Lehman index rating transition probabilities changed under the new rule due to the reclassification of some split-rating combinations as investment-grade. As a result, a favorable Fitch rating mechanically increases the probability of current HY (IG) bonds reaching (maintaining) investment-grade status in the future. This increased probability of future IG status translates into a higher probability of future bond demand from the rating-sensitive IG investor clientele and, thus, higher bond valuations due to a larger investor base. To the extent that these higher probabilities of future premium valuations are rationally anticipated by current bond holders, they should be impounded in current bond prices even if a bond's investment-grade status and ownership structure did not immediately change under the new Lehman rule. We call this the *priced transition probability* version of rating-based segmentation.

The first group of bonds where priced transition probability effects are likely are BB+ (and, to a lesser extent, BB) bonds with favorable Fitch ratings relative to their Moody's and S&P ratings.

Under the new Lehman rule, a favorable Fitch rating means that only one of the other two ratings needs to rise for a bond's index rating to change to IG (versus both needing to rise under the old rule). Section 4.1 shows that these BB+ (and BB) bonds reacted strongly to the Lehman announcement. The second group of bonds we investigate are GM and Ford bonds. Under the old index rating rule, these bonds were widely expected to be downgraded to junk status in the near future, and consequently experienced a substantial sell-off prior to the Lehman announcement. Section 4.2 shows that the sell-off was reversed and that GM and Ford bond prices rose after the Lehman announcement.

In addition, this section considers three alternatives to rating-based market segmentation. We call these the *Fitch reputation, indexation,* and *priced liquidity* hypotheses. Sections 4.1, 4.3 and 4.4 present evidence against these alternative hypotheses.

4.1 Rating-based segmentation or Fitch reputation?

The priced transition probability version of the rating-based segmentation hypothesis predicts that bonds with favorable Fitch ratings should appreciate after the Lehman announcement even if their investment-grade status is initially unchanged. We do not, however, expect this price appreciation to be equally large for all bonds. Under the new Lehman rule, the increased probability of future index rating upgrades for BB+ bonds with favorable Fitch ratings (arguably the best of the BB+ bonds and, thus, bonds likely to have a Moody's or S&P rating increase) is likely to be larger than the reduced probability of index rating downgrades for BBB– bonds with favorable Fitch ratings (the best of the BBB– bonds and, thus, bonds *unlikely* to have a Moody's or S&P ratings cut). Consequently, we expect returns to be *asymmetric* around the HY-IG boundary with BB+ bonds with favorable Fitch ratings outperforming BBB– bonds with favorable Fitch ratings.

An alternative hypothesis—which we call the *Fitch reputation* hypothesis—is that the Lehman announcement may, in fact, have changed the market's bond cash flow beliefs. By including Fitch ratings in its index rating methodology, Lehman may have prompted a general upward revision in investors' perceptions of the informativeness of Fitch ratings. Consequently, bonds with favorable Fitch ratings could have positive abnormal returns due to better expected cash flows given the greater credibility of the more optimistic cash flow forecasts implicit in their high Fitch ratings. In contrast to the asymmetric BBB– and BB+ returns predicted by rating-based segmentation, the Fitch reputation hypothesis implies that changes in the market's cash flow expectations should be fairly symmetric around the IG-HY boundary. We exploit this difference in predicted returns across ratings to distinguish between the two hypotheses.

Table 10 presents CARs for bonds rated favorably by Fitch but whose investment-grade status did not initially change. We require the treated and matched bonds to be rated by both Moody's and S&P. We exclude GM and Ford bonds because they are studied separately in Section 4.2. The sample of bonds are split by their index ratings under the old rule. Abnormal returns are computed using the Method 1 imputation as described in Sections 2.3. The first row in Table 10 shows that the CARs over the pre-announcement control window $(-50, -10]$ are generally small. Again the control bonds appear to adjust adequately for the bonds' risk characteristics.

Comparing the columns under heading A, we find that the CARs of Fitch–favorable BB+ bond after the Lehman announcement are positive and dwarf the much smaller CARs for the Fitch-favorable BBB– bonds.[28] To confirm that this asymmetry is statistically significant, we computed modified CARs under heading B. The modified CARs differ from our standard CARs in that now the BBB– bonds are used as controls for the BB+ where we again match on size and maturity. This approach measures the relative abnormal performance of the two groups of bonds controlling both for basic bond characteristics and for differences in the composition of the BB+ and BBB– subsamples. Despite the comparatively small sample (12) of Fitch-favorable BB+ bonds, the valuation asymmetry is large enough that we have sufficient power to reject the symmetric performance null. Overall, the significant asymmetry in bond returns above and below the HY-IG boundary strongly supports rating-based segmentation over the Fitch reputation hypothesis.

Other high-yield bonds with favorable Fitch ratings also had positive abnormal returns. In particular, Fitch-favorable BB bonds have large returns which supports the robustness of our BB+ bond results. We note here that on day +80, towards the end of the period of GM and Ford

[28] Although the CARs in Table 10 for the Fitch-favorable BB+ bonds whose rating did not initially change appear larger than the CARs in Table 4 for the 57 upgraded bonds, a formal test in Table IA.2 in the Internet Appendix shows that this difference is typically not statistically significant.

downgrades, almost all HY bonds favorably rated by Fitch have positive CARs. Since this is well after the Lehman announcement and well before the Lehman effective date (on day +114), this later price rally appears to be unconnected to the Lehman redefinition.

Trading volume and priced transition probabilities: Rating-based segmentation attributes the price appreciation in the 57 upgraded bonds in Section 3 to changes in ownership as the IG investor clientele buys the upgraded bonds given their new IG status. The abnormal volume documented in Table 7 is consistent with such ownership changes happening fairly soon after the Lehman announcement. In contrast, the priced transition probability version of rating-based segmentation attributes the price appreciation in the Fitch-favorable BB+ bonds, not to immediate ownership changes, but rather to the anticipation that the IG clientele will buy these bonds if, in the future, the reclassified split-rating states occur. Panels A and B in Table 11 repeat the abnormal volume analysis for the Fitch-favorable BB+ bonds. Consistent with demand anticipation, the point estimates of abnormal volume are much smaller than for the upgraded bonds in Table 7 and the Diff-in-Diff test does not reject the null of no abnormal volume for the BB+ bonds.

Fundamental news and stock prices? As a second test of the *Fitch reputation* hypothesis, we examine how the stock prices of bond issuers in different rating-based portfolios reacted to the change in index rating procedure. In particular, an enhanced Fitch reputation should affect the stock prices of companies with favorable Fitch ratings.[29]

Table 12 reports results from a cross-sectional regression using equity CARs. The cross-section consists of the 734 companies which issued the 8,767 bonds in our sample. Many of these companies issued more than one bond. For firms whose bonds have different ratings, we compute the firm's aggregate rating as the average rating of its bond issues. We use the Fama-French three-factor model to compute equity abnormal returns (see Appendix C for the specifics). The explanatory

[29]If increased credibility of a favorable Fitch rating raises the market's estimate of a firm's asset value, this should be good news for stock prices. If instead the lower credit risk implied by a favorable Fitch rating is due to lower firm asset volatility, then this would be bad news for equity which is a call option on firm assets and, therefore, long asset volatility. Previous research in Holthausen and Leftwich (1986), Hand, *et al.* (1992) and Goh and Ederington (1993) has typically found stock return evidence consistent with the asset value channel.

variables of interest are indicator variables for a firm's weighted-average bond old index rating (up to the notch) interacted with a "favorable Fitch rating" dummy variable. As controls for credit risk, we include index rating indicators without the Fitch rating interaction, dummies for the company's industry segment, and firm size and book-to-market ratios. We present equity CARs over over the immediate announcement window [-10,+10] and, for robustness, over a longer window [-10,+30].

The results in Table 12 show little evidence of a significant price response in the stock market to the Lehman announcement. Almost all of the coefficients for Fitch-reputation effects are not statistically significant. In particular, the coefficients for upgraded and non-upgraded Fitch-favorable BB+ bonds are economically and statistically small. An information-based explanation for the Lehman announcement is, therefore, unlikely since a reduced default risk at companies with bonds highly rated by Fitch should also impact equity values. Instead, the impact of the Lehman announcement appears to be confined to the bond market (consistent with rating-based segmentation) rather than indirectly providing cash flow information to the stock market (as predicted by the Fitch reputation hypothesis).

4.2 Rating-based segmentation: Impact on GM and Ford bonds

Bonds issued by GM and Ford, including their General Motors Acceptance Corporation (GMAC) and Ford Motor Credit Corporation (FMCC) financial arms, constitute a significant portion of the Lehman investment-grade index—each representing about 2 percent of the total index. On January 14, 2005, S&P announced it would review GM ratings within the next six months, at which time market participants widely believed there was a high probability that S&P would downgrade GM. The S&P announcement also exacerbated market concerns about Ford bonds. Since both firms had index ratings of BBB– under the old rating rule, S&P downgrades would force GM and Ford out of the Lehman IG index, thereby triggering fire sales from rating-sensitive investors (see Da and Gao (2008)).[30] Given their enormous size, GM or Ford downgrades to high yield would have generated

[30] As of the announcement date, Standard and Poor's had assigned its lowest possible investment-grade rating of BBB– to all bonds issued by GM, GMAC, Ford and FMCC. In contrast, Moody's had a more favorable and diverse view on the credit risk of these bonds, assigning 300 bonds an A- rating, 671 bonds a BBB+ rating, and 13 bonds a BBB rating. None of the bonds were rated BBB–. Accordingly, under the old index rating rule, these bonds all

significant price spill-overs to other HY bonds, since the increased supply would tax the capacity of the high-yield market to absorb these bonds (Acharya, Schaefer, and Zhang, 2008). However, under Lehman's new index rating rule, GM and Ford would remain investment-grade, even if S&P downgraded them, so long as Moody's and Fitch maintained their investment-grade ratings.

The unique particulars of the GM and Ford bonds' situation explain their exclusion from the analysis is Section 4.1 and our decision to study them separately here. Given market worries about a possible downgrade, the probability of future split-rating states in which the new Lehman rule would be germane is actually high for GM and Ford bonds. Consequently, GM and Ford bonds should have priced transition probability responses which, unlike the typical Fitch-favorable BBB-bond, should be large. In particular, we expect to see selling pressure to abate and prices to recover.

Figure 6 shows trading and returns for GM and Ford bonds around the Lehman announcement split by the bonds' Moody's ratings. Bonds with lower Moody's ratings were presumably at a greater risk for an S&P downgrade and, thus, we expect the anticipatory sell-off, and the associated priced transition probability effects, to be largest for these bonds. Before the Lehman announcement, Panel (a) shows that turnover was high for the BBB Moody's rated bonds, and Panel (b) shows that their prices were falling. After the Lehman announcement, turnover in these bonds fell and their prices recovered. These patterns are consistent with the prediction that the Lehman announcement caused selling pressure to abate. With a reduced likelihood of these bonds being downgraded to high yield, rating-sensitive investors curtailed their selling, which in turn reduced the excess supply of these bonds in the market, and prices recovered quickly.[31]

had an index rating of BBB–, and a one notch downgrade by S&P would have forced them out of the IG market segment. Fitch rated the GM/GMAC bonds BBB, and the Ford/FMCC bonds BBB+. Hence, under the new index rating rule, the GM/GMAC bonds would have an index rating of BBB, and the Ford/FMCC bonds would have an index rating of BBB or BBB+, depending on the Moody's rating but independent of any S&P downgrade.

[31] As a formal statistical test, we estimated a cross-sectional regression of cumulative returns for the GM and Ford bonds to verify that the differences in returns across portfolios with different Moody's rating categories are not due to other characteristics that systematically vary across these bonds. The precise methodology and control variables are detailed in Appendix B. The estimation results, reported in Table IA.3 in the Internet Appendix, are consistent with the trends observed in Figure 6.

4.3 Rating-based segmentation or indexation?

A large literature studies the effects of passive indexation by equity investors when stocks are added or dropped from a major stock index.[32] While indexation is one way in which investors use index ratings (and, thus, credit ratings) and may, itself, be one possible channel for rating-based market segmentation, we argue that rating-based segmentation is not just indexation, and that the abnormal returns on the 57 upgraded bonds in Section 3.1 are not driven solely by bond indexers.[33] To do this, we divide the upgraded bonds into a subsample of 34 upgraded bonds—which we call *IG index-eligible bonds*—which met the additional bond characteristic requirements to enter the IG index itself and a subsample of the remaining 23 upgraded bonds—which we call *orphan bonds*—which were ineligible to enter the IG index because they did not satisfy the IG par size requirement.[34] We further distinguish between 10 orphan bonds which were dropped from the HY index and 13 orphan bonds which were never in either index.

Table 13 compares returns on the orphan bonds and the bonds eligible to enter the IG index. The CARs reported here use our baseline matched sample methodology matching on old index rating, maturity, and size as described in Section 2.3. The announcement returns on the orphaned bonds are significantly positive (in the "All orphans" column) and exhibit a similar trajectory as the index-eligible bonds (in the "IG index-eligible bonds" columns). Abnormal returns on the orphan bonds reached 5.4% around year-end. While the 34 IG index-eligible bonds outperformed the 23 orphan bonds on the announcement day 0 itself, once we allow for slow-moving capital price lags, the returns on the IG index-eligible and orphan bonds by day +10 are very similar and continue to be similar for the rest of the year.

We do not claim that there is no indexation effect, but the size of the orphan bond CARs is consistent with the hypothesis that IG status itself matters for bond prices, not just IG index

[32] See, e.g., Vijh (1994), Barberis, Shleifer, and Wurgler (2005), Hendershott and Seasholes (2009), Shleifer (1986), Harris and Gurel (1986), Dhillon and Johnson (1991), Kaul, Mehrotra, and Morck (2000), Wurgler and Zhuravskaya (2002), Denis *et al.* (2003), Chen, Noronha, and Singhal (2004), Mitchell, Pulvino, and Stafford (2004), Greenwood (2005), Barberis, Shleifer, and Wurgler (2005), and Hendershott and Seasholes (2009).

[33] This is consistent with anecdotal indications that mechanical security-by-security index replication is less common for large bond indices than for smaller stock indices like the S&P 500.

[34] Lehman's IG index rules require bonds to have a par outstanding of at least $250 MM, while the HY index rules require only $150 MM of par outstanding.

membership and, thus, that passive indexation alone cannot explain the upgraded bond returns. In fact, on some days, the 10 orphan bonds exiting from the HY index—for which indexation effects should be most negative—actually outperformed the 34 index-eligible bonds. Thus, the abnormal returns on the upgraded bonds appear to be due to broader rating-based industry policies and procedures than just simple indexation alone.

Trading volume and indexation: Rating-based segmentation and indexation-based segmentation also have different predictions for volume following the Lehman announcement. Rating-based segmentation predicts abnormal volume due to buying by the IG clientele of both the index-eligible and orphan bonds, whereas indexation-based segmentation predicts buying by passive indexers only of the index-eligible bonds. Panel C in Table 11 shows that index-eligible upgraded bonds do appear to have post-announcement abnormal volume, but Panel D shows that, as a group, orphan bonds do not have statistically signification abnormal volume. However, the subsample of former HY index orphan bonds in Panel E does have statistically significant post-announcement abnormal volume. This supports rating-based market segmentation. The fact that volume does not seem to have increased for the non-index orphan subsample in Panel F is not surprising. By definition, these are very small bond issues and, thus, may be difficult to locate. Their abnormal returns appear to be due to anticipation of future demand rather than an immediate increase in buying. The weaker post-announcement demand for these bonds is also consistent with their weaker post-announcement abnormal returns.

4.4 Rating-based segmentation or liquidity improvement?

Another possible explanation for the price response of the immediately upgraded bonds in Section 3 is that increased turnover improved market liquidity for these bonds which, in turn, was priced. To investigate this possibility, we use two measures of liquidity. Roll's (1984) measure estimates the effective spread based on the serial covariance between price changes. Following Goyenko *et al.* (2009), we compute the Roll measure as

$$Roll = 2\sqrt{-cov(\Delta P_t, \Delta P_{t-1})}, \tag{2}$$

if $cov(\Delta P_t, \Delta P_{t-1}) < 0$, and zero otherwise. We compute the Roll measure for each bond separately and report the cross-sectional average, dropping bonds with insufficient data to compute the Roll measure.[35] As a robustness check, we also use the Amihud (2002) measure of price sensitivity to trading volume,

$$Amihud = \frac{|\Delta P_t / P_{t-1}|}{Volume_t}. \tag{3}$$

Table 14 gives the average changes in liquidity in the post-announcement and the post-effective windows relative to the pre-announcement window. A formal Diff-in-Diff test indicates that the changes in liquidity for the 57 upgraded bonds are not statistically significantly different from the control bonds. This result is true for both the Roll and Amihud measures. The absence of abnormal changes in liquidity is evidence against the alternative hypothesis that the positive and persistent abnormal returns on the upgraded bonds were caused by changes in priced liquidity.

5 Conclusion

The Lehman Brothers index rating redefinition in 2005 is a quasi-natural experiment which we use to test whether bonds trade in segmented markets with different inelastic demand curves, and whether credit ratings affect bond prices beyond whatever information they provide about credit risk. Our results are largely consistent with rating-based market segmentation and are evidence against the frictionless market paradigm. Split-rated bonds whose index ratings were immediately upgraded to investment grade exhibit significant positive short- and long-run abnormal returns, increased turnover, and increased institutional demand. We also find evidence of rating-based segmentation in bonds where the future transition probability of being investment-grade improved. Prices appreciated after the Lehman announcement for Fitch-favorable BB+ and BB rated bonds (which had an increased probability of becoming investment-grade in the future) and for GM and Ford bonds (which had an increased likelihood of remaining investment-grade). Our findings suggest, more generally, that market frictions may help in explaining other bond pricing puzzles (e.g.,

[35]The Roll and Amihud measures are both constructed only using actual daily prices. Since imputed prices are not used, the calendar time between prices can be more than one day if there is non-trading.

see Collin-Dufresne, Goldstein, and Martin (2001)). Since the Lehman redefinition did not change official rating-based regulations, our results indicate rating-based market segmentation via informal industry practices. The Dodd-Frank Act of 2010 and ensuant SEC regulations have reduced regulatory reliance on ratings issued by NRSROs and introduced softer criteria for determining capital requirements. As a consequence, industry conventions and informal rules, rating-based or otherwise, are likely to become even more important in the future.

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Appendix A. Bootstrap Procedure

Our bootstrap procedure for computing empirical p-values is implemented as follows:

- Form a matched sample for our portfolio of treatment bonds by randomly picking one control for each treatment bond. Calculate the cumulative abnormal return (CAR) for this long-short portfolio on each event day. Denote the CAR in round i at date t by $CAR_{t,i}$.
- Repeat the matched sample formation procedure, using another random draw of control bonds and calculate the corresponding CAR for the long-short portfolio. We draw a total of $1,000$ times to form an empirical distribution for the CAR at each event day. We then take the average CAR over the $I = 1,000$ simulations as the representative CAR value for the treatment bonds. That is, $CAR_t = \frac{1}{I}\sum_{i=1}^{I} CAR_{t,i}$.
- Construct the empirical distribution, F_{CAR}, for the CAR on each event day and use F_{CAR} to compute empirical p-values to test whether the abnormal returns are statistically significant relative to the null hypothesis $H_0 : CAR_t \leq 0$ by computing $p = 1 - F_{CAR}(CAR_t)$. Confidence bounds can be determined similarly as the values $[\underline{CAR}, \overline{CAR}]$ for which $F_{CAR}(\underline{CAR}) = .05$ and $F_{CAR}(\overline{CAR}) = .95$.

Appendix B. Cross-sectional Regression Approach and Control Variables

Cross-sectional regressions are used to verify that the differences in returns across the treated bonds and the control sample are not due to bond characteristics that vary systematically across these portfolios. The cross-sectional approach allows us to simultaneously estimate the abnormal returns on multiple sub-samples of interest. We run regressions of the following form:

$$CR_i = \alpha + \sum_k \beta_k I_{i,k} + \gamma' X_i + \varepsilon_i,$$

where the cumulative raw return CR_i for bond i is regressed on two types of explanatory variables. The first regressors are a set of indicator variables $I_{i,k}, k = 1, \ldots, K$ for a set of K subsamples, that take on a value of one if bond i is in sub-sample k, and zero otherwise. The coefficient β_k on $I_{i,k}$ yields an estimate for the mean CAR on sub-sample k. The second regressors are a set of control variables X_i that have been used in the literature to explain bond returns:

- Credit risk: indicator variables for index ratings under the old rule: AAA, AA, A, $BBB/BBB+$, $BBB-$, $BB+$, $BB/BB-$, B, C - D and bonds unrated by Moody's and S&P, or a coarser definition (AAA - A, BBB, BB, B, etc.);
- Maturity: maturity of bond i in years.
- Age: age of bond i, measured in years since offering date;
- Coupon: measured in percent;

- Market risk: return beta of bond i on Lehman IG bond index, computed using Dimson's method with one lead and lag;
- Liquidity: percent of days with trades in bond i over pre-event control window;
- Issue size: indicator variables for the par amount of the bond outstanding, split into five categories: < 50, $[50, 150)$, $[150, 250)$, $[250, 1,000)$, $\geq 1,000$ \$MM;
- Industry: indicator variables for the industry group: Industrial, Financial, Utility.

To address measurement problems due to infrequent trading, we compute returns by averaging transaction prices over consecutive days. We use the volume-weighted average clean price over $[t_0 - L, t_0]$ as the pre-event price and the volume-weighted clean price over $[t_1 - L, t_1]$ as the post-event price when computing the cumulative return over the time period $[t_0, t_1]$. For most of the analysis, we choose $L = 5$. Cumulative returns are then computed as the percentage difference between post-event and pre-event bond prices: $CR_{[t_0,t_1]} = \overline{P}_{t_1-L,t_1}/\overline{P}_{t_0-L,t_0} - 1$.

Appendix C. Abnormal Stock Return Computation

Step 1 Compute the return for firm i at date t: $R_{i,t} = \ln(P_{i,t+1}) - \ln(P_{i,t})$, where $P_{i,t}$ is the stock price of firm i at date t. If either price is missing, $R_{i,t}$ is set to missing.

Step 2 Estimate a model for expected stock returns by regressing $R_{i,t}$ for each firm on the Fama-French factors over the six-month period from June 1, 2004 to December 24, 2004 (one month prior to the Lehman announcement).

$$R_{i,t} - R_{f,t} = \alpha_i + \beta_i MKT_t + s_i SMB_t + h_i HML_t + \epsilon_t.$$

Step 3 Compute daily ARs for firm i over the event window using the fitted Fama-French model and aggregate ARs at portfolio level. Then compute CARs as follows:

$$\begin{aligned} AR_{i,t} &= (R_{i,t} - R_{f,t}) - \widehat{\alpha}_i - \widehat{\beta}_i MKT_t - \widehat{s}_i SMB_t - \widehat{h}_i HML_t, \\ AR_t &= \frac{1}{n}\sum_{i=1}^{n} AR_{it}, \\ CAR_\tau &= \sum_{t=-20}^{\tau} AR_t, \end{aligned}$$

where n is the number of firms in the portfolio and $\tau = -20, -19, ..., 0, ..., 19, 20$.

Table 1: Timeline of Events

Date	Event	Description
01/01/73	Lehman bond index inception	Lehman Brothers bond indices are established. The initial rule defines a bond's index rating as the average of its credit ratings from Moody's and S&P.
Aug 88	Lehman index rule change 1	Lehman changes a bond's index rating to be its Moody's rating or, if not rated by Moody's, its S&P rating.
07/01/02	TRACE Phase I	NASD requires all over-the-counter bond transactions to be reported through the TRACE system. The rule affects investment-grade bonds having an original issue size of $1 billion or more (a total of 500 bond issues) as well as 50 high-yield bonds which were carried over from NASD's Fixed Income Pricing System (FIPS). Initially, NASD members were required to report transactions within 75 minutes of the trade's occurrence.
03/03/03	TRACE Phase II	The TRACE system includes all bonds with an original issue size of at least $100 million and an index rating of A or better. An additional 120 BBB rated bonds with issue sizes less than $1 billion are added as part of Phase II in April 2003. The number of disseminated bonds increases to approximately 4,200 bonds. In addition, the NASD shortens the time required to report a trade's occurrence to 45 minutes.
Oct 03	Lehman index rule change 2	Lehman makes another change and defines a bond's index rating as the lower of its ratings from Moody's and S&P in an effort to reduce the dependence on one rating agency and to align its methodology with industry practice.
10/01/04	TRACE Phase III, Stage One	All "liquid" bond issues (i.e., TRACE-eligible securities transactions that were subject to immediate dissemination under the Phase III rule amendments) become subject to dissemination. As a result, the number of bonds in the TRACE universe jumps to 17,000 bonds. In addition, the required reporting time is reduced to 30 minutes.
01/14/05	GM rating review	S&P affirms the rating and outlook on General Motors (GM), but announces it will review them within the next six months.
01/24/05	Lehman index rule change 3	Lehman Brothers announces that Fitch ratings will be incorporated in computing index ratings. Under this new rule, a bond's index rating is to be the middle of its Moody's, S&P, and Fitch ratings. If rated by only two agencies, a bond's index rating will continue to be the lower of the two. The change is to go into effect on July 1, 2005.
02/07/05	TRACE Phase III, Stage Two	All TRACE-eligible bond issues become subject to dissemination. NASD begins full dissemination of transaction and price data on the entire universe of corporate bonds, a total of approximately 29,000 issues. The required reporting time is scheduled to reach the final goal of 15 minutes by July 1, 2005.
03/16/05	GM profit warning	GM issues a profit warning. Fitch downgrades GM and GMAC by one notch to BBB– with negative outlook. S&P changes its GM and GMAC outlook from stable to negative.
04/05/05	GM downgrade	Moody's downgrades GM and GMAC by one notch to BBB– and BBB, respectively, with negative outlook.
04/20/05	GM announces $1.1 bn loss	GM posts record $1.1 bn loss. Rating agencies signal they could drop GM's bonds one notch to junk status, and they put rival Ford on notice.
05/05/05	GM and Ford downgrade	S&P downgrades GM and GMAC to BB with a negative outlook, and it downgrades Ford and FMCC to BB+ with negative outlook.
05/24/05	GM downgrade	Fitch downgrades GM and GMAC to BB+ with negative outlook.
07/01/05	Lehman index rule change	The index rating rule change announced by Lehman on January 24, 2005 goes into effect.

Table 2: Summary of bond characteristics

This table summarizes the characteristics of the bonds in our sample as of the Lehman announcement date.

	Mean	S.D.	Min	Max
Panel A: IG index members – 2,336 bonds				
Amount outstanding ($ MM)	580.43	481.72	250.00	5,000.00
Maturity (years)	9.82	10.63	1.00	93.30
Coupon (%)	6.12	1.51	0.00	10.63
Age (years)	4.04	3.13	0.21	23.19
Fraction of days with trades over [-10,+10]	0.56	0.33	0.00	1.00
Panel B: HY index members – 722 bonds				
Amount outstanding ($ MM)	426.49	301.40	150.00	2,750.00
Maturity (years)	8.35	7.66	1.06	91.69
Coupon (%)	8.15	1.79	0.00	14.25
Age (years)	3.60	2.87	0.21	15.48
Fraction of days with trades over [-10,+10]	0.67	0.29	0.00	1.00
Panel C: Index non-members – 5,709 bonds				
Amount outstanding ($ MM)	54.58	87.31	0.01	3,250.00
Maturity (years)	10.19	8.98	1.02	93.10
Coupon (%)	5.59	1.78	0.00	13.50
Age (years)	3.70	4.13	0.17	67.65
Fraction of days with trades over [-10,+10]	0.17	0.21	0.00	1.00
Panel D: IG index-eligible upgraded bonds – 34 bonds				
Amount outstanding ($ MM)	582.30	324.13	250.00	1,500.00
Maturity (years)	11.03	9.83	1.39	29.68
Coupon (%)	6.88	0.91	4.63	8.50
Age (years)	3.82	2.34	0.34	9.65
Fraction of days with trades over [-10,+10]	0.66	0.29	0.00	1.00
Panel E: Orphaned upgraded bonds – 23 bonds				
Amount outstanding ($ MM)	112.14	78.39	3.18	200.00
Maturity (years)	15.10	18.18	2.72	91.69
Coupon (%)	7.05	1.29	4.50	9.63
Age (years)	6.35	4.07	1.14	12.51
Fraction of days with trades over [-10,+10]	0.32	0.35	0.00	1.00
Panel F: HY bonds not rated favorably by Fitch (control sample) – 337 bonds				
Amount outstanding ($ MM)	364.48	307.45	1.00	3,250.00
Maturity (years)	7.54	5.13	1.06	28.98
Coupon (%)	8.19	1.62	0.00	13.50
Age (years)	3.62	3.81	0.25	37.04
Fraction of days with trades over [-10,+10]	0.55	0.32	0.00	1.00

Table 3: Index ratings and rating comparison across agencies

This table summarizes the index ratings of all bonds in our sample as of the Lehman announcement date based on the old and new index rating rules (Panel A). The old index rating is the more conservative of the Moody's and S&P rating, and the new index rating is the middle of the Moody's, S&P, and Fitch rating. Panel B compares bond ratings issued by Fitch to the lower of the ratings by Moody's and S&P.

Panel A: Anticipated index rating transitions

	New index rating								
Old index rating	AAA	AA	A	BBB	BB	B	C - D	Unrated	Total
AAA	671	0	5	0	0	0	0	0	676
AA	4	560	4	0	0	0	0	0	568
A	3	433	3,961	3	0	0	0	0	4,400
BBB	2	0	170	2,092	0	0	0	0	2,264
BB	3	0	0	44	262	0	0	0	309
B	0	0	0	7	33	270	1	0	311
C - D	0	0	0	0	0	21	180	0	201
Unrated	0	3	0	0	0	1	5	29	38
Total	683	996	4,140	2,146	295	292	186	29	8,767

Panel B: Comparison of Fitch ratings with Moody's and S&P

	All	rated by Fitch	Fitch rates better	Index rating upgraded	Fitch rates worse	Index rating downgraded
All bonds	8,767	6,169	4,149	3,108	240	26
By old index rating:						
AAA	676	104	0	0	18	5
AA	568	376	247	242	19	8
A	4,400	3,526	2,727	1,960	42	4
BBB	2,264	1,724	882	677	121	3
BB	309	219	148	111	20	3
B	311	132	79	63	19	2
C - D	201	79	57	46	1	1
Unrated	38	9	9	9	0	0
By industry:						
Industrial	3,217	2,129	1,171	690	105	12
Financial	4,813	3,432	2,616	2,151	112	12
Utility	737	608	362	267	23	2

Table 4: Abnormal returns for bonds upgraded to investment grade

This table reports cumulative abnormal returns for the sample of 57 upgraded bonds expected to obtain a Lehman investment-grade rating because of the Lehman index rating redefinition. Abnormal returns are calculated using the matched-sample methodology described in Section 2.3 (columns A to D) and using cross-sectional regression (column E). The control group consists of all bonds, matched on index rating, maturity and additional characteristics, that are either not rated by Fitch or have a Fitch rating below Moody's and S&P. In our baseline sample of matches for each upgraded bond, we pair bonds based on their old Lehman index rating up to the notch (i.e., BB+, BB, BB–, B+, etc.) and match on being in the same maturity bin (short=1-5 years or long=5 years or longer) and size bin (<\$250 MM or ≥\$250 MM par value of bond issue outstanding). In the alternative control sample we match bonds on rating, maturity, size, and, in addition, based on index betas, liquidity, coupon, and industry. Index betas for the IG index are estimated using Dimson's method with one lead and lag and are then used to define high-low bins (less or greater than 0.255). Liquidity is measured by the frequency of non-trading days and then high-low bins are defined (less or more than 13%). Coupons are grouped into high-low bins (less or more than 5.9%). The industry-matching is based on three broad sectors (utility, financial, and industrial). The specification for the cross-sectional regression is described in Appendix B, and the coefficient estimates on the control variables are reported in Table IA.1 in the Internet Appendix. The control window abnormal returns are cumulated over the pre-announcement window $(-50, -10]$. The event window abnormal returns are cumulated starting at date $t = -10$, and the horizons in the first column are in terms of trading days. The marker † indicates the effective date for the Lehman rule change (July 1, 2005), and $t = 0$ refers to the announcement date (Jan. 24, 2005). For the matching methods in columns A to D, empirical p-values are one-sided for the null hypothesis $H_0 : CAR_t \leq 0$ and calculated using the bootstrap procedure described in Section 2.3. For the regression in column E, the one-sided p-values are adjusted for heteroskedasticity and clustering at the issuer level.

	(A)		(B)		(C)		(D)		(E)	
	Method 1				*Method 2*					
	Baseline match		Alternative match		Baseline match		Alternative match		OLS	
Time	CAR	p	CAR	p	CAR	p	CAR	p	CAR	p
Control window:	0.34	[0.10]	0.12	[0.33]	0.09	[0.35]	-0.14	[0.69]	0.23	[0.59]
Event window:										
-5	0.54	[0.00]	0.49	[0.00]	0.31	[0.05]	0.40	[0.00]	0.40	[0.00]
0	1.09	[0.00]	1.06	[0.00]	1.07	[0.00]	1.31	[0.00]	1.12	[0.00]
10	1.37	[0.00]	1.19	[0.00]	1.32	[0.00]	1.47	[0.00]	0.99	[0.00]
20	0.66	[0.02]	0.45	[0.08]	0.73	[0.02]	0.92	[0.01]	0.78	[0.05]
30	0.60	[0.04]	0.47	[0.12]	0.58	[0.07]	0.60	[0.07]	0.27	[0.46]
50	1.31	[0.00]	1.33	[0.00]	1.04	[0.01]	1.29	[0.00]	1.58	[0.00]
80	3.37	[0.00]	3.23	[0.00]	3.12	[0.00]	3.30	[0.00]	3.76	[0.00]
114†	3.16	[0.00]	2.75	[0.00]	2.91	[0.00]	2.79	[0.00]	3.04	[0.00]
150	2.58	[0.00]	2.28	[0.00]	2.56	[0.00]	2.62	[0.00]	2.46	[0.00]
200	2.22	[0.00]	2.10	[0.00]	1.84	[0.01]	1.97	[0.00]	2.29	[0.00]
245	3.18	[0.00]	3.09	[0.00]	2.79	[0.00]	2.98	[0.00]	1.87	[0.02]

Table 5: Cross-sectional evidence on abnormal returns for bonds upgraded to investment grade

This table reports cumulative abnormal returns for the sample of 57 upgraded bonds expected to obtain a Lehman investment-grade index rating because of the Lehman index rating redefinition. Across columns, we split the sample into short maturity (1-5 years), long maturity (5 years or longer), low announcement turnover, and high announcement turnover. Announcement turnover is measured as TRACE volume over the 30 days after the Lehman announcement divided by FISD par outstanding. Abnormal returns are calculated using the baseline matched-sample methodology described in Section 2.3. The control group consists of all bonds, matched on index rating, maturity, and size, that are either not rated by Fitch or have a Fitch rating below Moody's and S&P. The control window abnormal returns are cumulated over the pre-announcement window $(-50, -10]$. The event window abnormal returns are cumulated starting at date $t = -10$, and the horizons in the first column are in terms of trading days. The marker † indicates the effective date for the Lehman rule change (July 1, 2005), and $t = 0$ refers to the announcement date (Jan. 24, 2005). Empirical p-values are one-sided for the null hypothesis $H_0 : CAR_t \leq 0$ and calculated using the bootstrap procedure described in Section 2.3. The number of treated bonds in each column is reported in parenthesis.

	Upgraded bonds (57)							
	Short maturity (20)		Long maturity (37)		Low turnover (16)		High turnover (39)	
Time	CAR	p	CAR	p	CAR	p	CAR	p
Control window:	0.48	[0.02]	0.35	[0.17]	-0.04	[0.44]	0.54	[0.03]
Event window:								
-5	-0.06	[0.58]	0.91	[0.00]	0.25	[0.19]	0.69	[0.00]
0	0.11	[0.31]	1.70	[0.00]	0.25	[0.25]	1.49	[0.00]
10	-0.13	[0.68]	2.31	[0.00]	0.21	[0.27]	1.90	[0.00]
20	-0.44	[0.96]	1.37	[0.00]	-0.58	[0.92]	1.26	[0.00]
30	-0.53	[0.99]	1.37	[0.00]	-0.61	[0.89]	1.18	[0.00]
50	0.54	[0.06]	1.76	[0.00]	0.87	[0.09]	1.54	[0.00]
80	2.13	[0.01]	4.07	[0.00]	2.71	[0.00]	3.67	[0.00]
114†	0.53	[0.11]	4.74	[0.00]	1.30	[0.08]	4.05	[0.00]
150	0.53	[0.13]	3.83	[0.00]	1.63	[0.06]	3.07	[0.00]
200	0.66	[0.13]	3.21	[0.00]	1.93	[0.04]	2.40	[0.00]
245	0.85	[0.05]	4.65	[0.00]	1.76	[0.04]	3.91	[0.00]

Table 6: Decomposition of abnormal bond returns

The table reports estimates for the 57 upgraded bonds of the following decomposition of abnormal returns into a permanent component PC_t and a transitory component TC_t:

$$\begin{aligned} CAR_t &= PC_t + TC_t, \\ PC_t &= PC_{t-1} + \alpha \frac{\mathbf{1}_{t_0 < t \leq t_1}}{t_1 - t_0} + \beta_0\, IMH_t\, \mathbf{1}_{t > t_1} + \ldots + \beta_K\, IMH_{t-K} \mathbf{1}_{t > t_1 + K} + \eta_t, \\ TC_t &= \delta_1 TC_{t-1} + \ldots + \delta_L TC_{t-L} + \epsilon_t, \end{aligned}$$

where CAR_t is the cumulative abnormal return on the upgraded bond portfolio computed using the baseline matched-sample approach described in Section 2.3, PC_t is a unit root process, TC_t is a mean-reverting process with zero long-run mean, IMH_t is the return on date t of a portfolio that is long the IG index and short the HY index, and $\mathbf{1}$ is an indicator that takes value one during the time period indicated by the subscript, and zero otherwise where $t_0 = -10$ and $t_1 = 10$. The error terms (η_t, ϵ_t) are independent Gaussian random variables. We use the Kalman filter to estimate α, β, δ, and PC_t and TC_t for $t = 1, ..., T$.

	(A)	(B)	(C)	(D)	(E)
α	1.23	1.23	1.22	1.24	1.25
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
β_0	0.22	0.21	0.21	0.17	0.17
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
β_1				0.09	0.08
				[0.01]	[0.04]
β_2					0.02
					[0.48]
δ_1	0.53	0.51	0.51	0.50	0.51
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
δ_2		0.16	0.17	0.20	0.20
		[0.03]	[0.03]	[0.01]	[0.01]
δ_3			-0.03		
			[0.70]		
σ_η	0.07	0.06	0.06	0.06	0.06
	[0.05]	[0.04]	[0.04]	[0.05]	[0.06]
σ_ϵ	0.14	0.14	0.14	0.14	0.14
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Log-likelihood	112.65	115.02	115.09	118.97	118.87
AIC	-215.31	-218.04	-216.19	-223.93	-221.73
BIC	-197.08	-196.17	-190.67	-198.44	-192.63
Observations	283	283	283	282	281

Table 7: Impact on bond trading activity

The table reports statistics on equally-weighted average daily turnover for the 57 upgraded bonds expected to obtain a Lehman investment-grade index rating because of the Lehman index rating redefinition. There are three different event windows: the pre-announcement window $(-50, -10]$, the post-announcement window $(-10, +114]$, and the post-effective window $(+114, +245]$. The control sample comprises high-yield bonds with unfavorable or no Fitch rating. p-values are reported in brackets. The Diff-in-Diff p-values are for Wald tests based on seemingly unrelated regressions (SUR) where the errors are assumed to be serially independent but may have contemporaneous cross-equation correlations.

	Event window			Difference		Diff-in-Diff	
	Pre-announce	Post-announce	Post-effective	Post-ann. – Pre-ann.	Post-eff. – Pre-ann.	Post-ann. – Pre-ann.	Post-eff. – Pre-ann.
Panel A: HY-to-IG upgraded bonds							
Turnover (%)	0.19	0.39	0.27	0.20	0.08	0.15	0.13
	[0.00]	[0.00]	[0.00]	[0.00]	[0.02]	[0.00]	[0.00]
Panel B: High-yield bonds not rated favorably by Fitch (control sample)							
Turnover (%)	0.27	0.32	0.23	0.05	-0.04	–	–
	[0.00]	[0.00]	[0.00]	[0.12]	[0.17]		

Table 8: Bond returns and order flow imbalances

This table gives results from regressions of daily returns on order flow imbalances for the 57 upgraded bonds expected to obtain a Lehman investment-grade index rating because of the Lehman index rating redefinition. The dependent variable is the daily return. In Panel A the time period is the post-announcement window starting two weeks before the announcement date (day -10 before January 24, 2005) and ending on the effective date (July 1, 2005). In Panel B the time period is the post-effective window starting from the effective date and ending at year-end (December 31, 2005). We show estimation results for both pooled OLS and average coefficients from time-series OLS on each individual bond. To compute order flow imbalances, we compare the transaction price of each trade with the closing price on the most recent prior day with trading. If the transaction price is higher, we classify the transaction as a buy, otherwise as a sell. The buy/sell indicators are then used to compute the trade direction and then applied to log volume to compute order flow imbalances. p-values are shown in brackets.

	Pooled	TS	Pooled	TS	Pooled	TS
Panel A: Post-announcement window (-10, +114] – 3,244 observations						
Order flow imbalance ($ MM)	4.89	7.55				
	[0.00]	[0.00]				
Order flow imbalance (no. trades)			45.35	78.81		
			[0.00]	[0.00]		
Order flow imbalance (no. trades $\geq$ $1 MM)					40.41	46.82
					[0.00]	[0.00]
Volume	2.25	7.86	3.47	9.17	3.82	11.89
	[0.05]	[0.20]	[0.00]	[0.14]	[0.00]	[0.06]
R^2	0.21	0.22	0.45	0.20	0.42	0.07
Panel B: Post-effective window (+114, +245] – 3,240 observations						
Order flow imbalance ($ MM)	4.79	8.29				
	[0.00]	[0.00]				
Order flow imbalance (no. trades)			50.98	90.20		
			[0.00]	[0.00]		
Order flow imbalance (no. trades $\geq$ $1 MM)					39.12	59.37
					[0.00]	[0.00]
Volume	2.06	-0.25	2.55	-1.14	3.09	7.68
	[0.05]	[0.93]	[0.02]	[0.72]	[0.01]	[0.09]
R^2	0.20	0.45	0.19	0.43	0.05	0.18

Table 9: Insurance company bond trading

The table reports the equal-weighted average net purchases by insurance companies of different types of bonds over two time periods. The treatment sample is the 57 upgraded bonds expected to obtain a Lehman investment-grade index rating because of the Lehman index rating redefinition. The control sample comprises high-yield bonds with unfavorable or no Fitch rating. In Panel A the time period is the post-announcement window starting two weeks before the announcement date (January 24, 2005) and ending on the effective date (July 1, 2005). In Panel B the time period is the post-effective window starting from the effective date and ending at year-end (December 31, 2005). The two sets of columns measure insurance company purchases in dollar terms or, respectively, as fraction of issue size. The first pair of columns in each set reports the aggregate change in insurance company holdings by rating category, and the second pair reports a Diff-in-Diff test of the hypothesis that purchases of upgraded bonds (treatment sample) are not larger than those of bonds in the corresponding control sample. The *p*-values are for Wald tests based on seemingly unrelated regressions (SUR) where the errors are assumed to be serially independent but may have contemporaneous cross-equation correlations. The *p*-values are two-sided for the difference tests and one-sided for the Diff-in-Diff tests.

	Δ Inventory ($ MM)				Δ Inventory (% of issue)			
	Difference [p]		Diff-in-Diff [p]		Difference [p]		Diff-in-Diff [p]	
Panel A: Post-announcement window (-10, +114]								
HY-to-IG bonds	3.89	[0.10]	6.48	[0.01]	2.03	[0.00]	2.73	[0.02]
Control sample	-2.59	[0.00]	–	–	-0.70	[0.02]	–	–
Panel B: Post-effective window (+114, +245]								
HY-to-IG bonds	11.51	[0.00]	12.81	[0.00]	2.67	[0.00]	3.13	[0.00]
Control sample	-1.31	[0.12]	–	–	-0.45	[0.13]	–	–

Table 10: Rating-based segmentation vs. Fitch reputation

The table reports cumulative abnormal returns for all bonds rated favorably by Fitch excluding the 57 upgraded bonds and excluding GM and Ford bonds. The sample is then split by the index rating under the old rule. Abnormal returns are calculated using the baseline matched-sample methodology described in Section 2.3. In the columns under heading A, the control group consists of all bonds, matched on index rating, maturity and size, that are either not rated by Fitch or have a Fitch rating below Moody's and S&P. We require the treated and matched bonds to be rated by both Moody's and S&P. The number of treated bonds in each column is reported in parenthesis. In the column under heading B, modified CARs are computed for the Fitch-favorable BB+ bonds using all Fitch-favorable BBB– bonds, matched on maturity and size, as control bonds. Empirical p-values are one-sided for the null hypothesis $H_0 : CAR_t \leq 0$ and calculated using the bootstrap procedure described in Section 2.3. The control window abnormal returns are cumulated over the pre-announcement window $(-50, -10]$. The event window abnormal returns are cumulated starting at date $t = -10$, and the horizons in the first column are in terms of trading days. The marker † indicates the effective date for the rule change, and $t = 0$ refers to the announcement date.

	(A) Long Fitch-favorable bonds, short matched sample												(B) Long Fitch-favorable BB+, short matched Fitch-favorable BBB– bonds	
	Investment-grade bonds						High-yield bonds							
	AAA - A (2,927)		BBB+ - BBB (599)		BBB– (270)		BB+ (12)		BB (40)		BB– - B (118)			
Time	CAR	p	CAR	p	CAR	p	CAR	p	CAR	p	CAR	p	CAR	p
Control window:	0.01	[0.28]	-0.24	[1.00]	0.05	[0.33]	0.27	[0.29]	-0.42	[0.99]	-0.36	[0.92]	0.23	[0.27]
Event window:														
-5	0.04	[0.02]	-0.34	[1.00]	0.02	[0.41]	0.66	[0.00]	0.95	[0.00]	-0.07	[0.68]	0.57	[0.04]
0	0.17	[0.00]	-0.14	[0.99]	0.04	[0.35]	1.33	[0.00]	0.87	[0.00]	-0.15	[0.82]	1.06	[0.00]
10	0.11	[0.00]	-0.26	[1.00]	0.22	[0.04]	1.98	[0.00]	1.06	[0.00]	0.24	[0.12]	1.68	[0.01]
20	-0.23	[1.00]	-0.19	[0.98]	-0.16	[0.89]	3.06	[0.00]	1.14	[0.00]	0.53	[0.01]	2.83	[0.00]
30	-0.26	[1.00]	-0.27	[1.00]	-0.17	[0.83]	2.67	[0.00]	0.95	[0.00]	0.62	[0.01]	2.76	[0.00]
50	-0.12	[1.00]	0.34	[0.01]	-0.50	[1.00]	1.51	[0.00]	0.41	[0.23]	0.22	[0.20]	1.10	[0.03]
80	0.11	[0.01]	0.74	[0.00]	0.45	[0.02]	1.50	[0.14]	2.90	[0.00]	1.85	[0.00]	0.23	[0.42]
114†	-0.15	[0.99]	0.54	[0.00]	0.39	[0.05]	2.47	[0.00]	2.67	[0.00]	2.36	[0.00]	1.60	[0.05]
150	-0.15	[0.99]	0.46	[0.00]	0.29	[0.13]	1.81	[0.03]	1.88	[0.00]	2.05	[0.00]	1.64	[0.06]
200	-0.38	[1.00]	0.04	[0.41]	0.04	[0.44]	2.49	[0.05]	2.38	[0.00]	1.58	[0.00]	2.19	[0.04]
245	-0.30	[1.00]	0.55	[0.00]	-0.05	[0.55]	3.24	[0.01]	2.69	[0.00]	1.13	[0.03]	3.65	[0.01]

Table 11: Impact on bond trading activity

The table reports statistics on equally-weighted average daily turnover for the 12 BB+ bonds rated favorably by Fitch (Panel A), their control sample comprising BB+ bonds not rated favorably by Fitch (Panel B), the 34 upgraded bonds which were eligible to enter the IG index (Panel C), the 23 orphaned bonds which were upgraded to an IG index rating but which were not eligible for IG index inclusion (Panel D) and, respectively, the 10 HY index member orphans (Panel E) and 13 index non-member orphans (Panel F). The control sample for the bonds in Panels C through F comprises high-yield bonds with unfavorable or no Fitch rating (their turnover is reported in Panel B of Table 7). There are three different event windows: the pre-announcement window $(-50, -10]$, the post-announcement window $(-10, +114]$, and the post-effective window $(+114, +245]$. p-values are reported in brackets. The Diff-in-Diff p-values are for Wald tests based on seemingly unrelated regressions (SUR) where the errors are assumed to be serially independent but may have contemporaneous cross-equation correlations.

	Event window			Difference		Diff-in-Diff	
	Pre-announce	Post-announce	Post-effective	Post-ann. – Pre-ann.	Post-eff. – Pre-ann.	Post-ann. – Pre-ann.	Post-eff. – Pre-ann.
Panel A: BB+ bonds rated favorably by Fitch							
Turnover (%)	0.26	0.26	0.24	0.00	-0.03	0.01	0.01
	[0.00]	[0.00]	[0.00]	[0.96]	[0.71]	[0.81]	[0.93]
Panel B: BB+ bonds not rated favorably by Fitch (control sample)							
Turnover (%)	0.15	0.14	0.12	-0.01	-0.03	–	–
	[0.00]	[0.00]	[0.00]	[0.49]	[0.25]		
Panel C: Index-eligible upgraded bonds							
Turnover (%)	0.21	0.49	0.34	0.27	0.12	0.23	0.17
	[0.00]	[0.00]	[0.00]	[0.00]	[0.01]	[0.00]	[0.00]
Panel D: All orphans							
Turnover (%)	0.16	0.25	0.18	0.09	0.02	0.04	0.07
	[0.00]	[0.00]	[0.00]	[0.02]	[0.60]	[0.36]	[0.21]
Panel E: HY index member orphans							
Turnover (%)	0.26	0.46	0.34	0.20	0.08	0.15	0.12
	[0.00]	[0.00]	[0.00]	[0.00]	[0.43]	[0.02]	[0.22]
Panel F: Index non-member orphans							
Turnover (%)	0.08	0.08	0.06	0.00	-0.02	-0.04	0.02
	[0.00]	[0.00]	[0.00]	[0.89]	[0.59]	[0.24]	[0.58]

Table 12: Abnormal stock returns and the Lehman announcement

The table reports estimation results on the cross-sectional variation in equity CARs around the Lehman announcement date on stocks that are matched to bonds in our universe of 8,767 bonds. The regressors of interest are dummy variables indicating the old Lehman rating category interacted with an indicator for a favorable Fitch rating. In addition, the regression includes the old index rating dummy variables by themselves as controls for overall credit risk, dummies for the company's industry segment, firm size measured as log value of sales and book-to-market ratio. p-values are shown in brackets.

	(-10,+10]		(-10,+30]	
	Coef.	p	Coef.	p
AA × Fitch favorable	2.29	[0.15]	2.22	[0.29]
A × Fitch favorable	-0.31	[0.64]	-0.57	[0.52]
BBB+ - BBB × Fitch favorable	-0.09	[0.91]	-1.18	[0.25]
BBB– × Fitch favorable	1.06	[0.25]	-0.41	[0.76]
BB+ × Fitch favorable	-0.21	[0.86]	-0.42	[0.84]
BB - BB– × Fitch favorable	-0.54	[0.66]	-1.65	[0.36]
B × Fitch favorable	-1.59	[0.26]	-3.71	[0.04]
C - D × Fitch favorable	1.48	[0.42]	1.33	[0.57]
AAA	-3.36	[0.06]	-4.18	[0.13]
AA	-3.12	[0.07]	-3.91	[0.11]
A	-1.17	[0.35]	-2.17	[0.26]
BBB+ - BBB	-1.10	[0.34]	-1.39	[0.44]
BBB–	-1.14	[0.31]	-1.29	[0.45]
BB+	-1.05	[0.43]	-2.08	[0.29]
BB - BB–	-0.38	[0.77]	-0.64	[0.74]
B	-0.32	[0.76]	-0.86	[0.59]
C - D	-1.03	[0.45]	-1.47	[0.44]
Financial	-2.58	[0.00]	-2.79	[0.00]
Industrial	-0.96	[0.09]	0.52	[0.54]
Size	0.27	[0.03]	0.21	[0.28]
Book-to-market	0.01	[0.00]	0.02	[0.00]
Observations	734		734	
$R2$	0.06		0.09	

Table 13: Rating-based segmentation vs. indexation

The table reports cumulative abnormal returns for the 57 upgraded bonds, split into the 23 orphaned bonds which were upgraded to an IG index rating but which were not eligible for IG index inclusion and, respectively, the 34 bonds which were eligible to enter the IG index. Abnormal returns are calculated using the baseline matched-sample methodology described in Section 2.3. The control group consists of all bonds, matched on index rating, maturity, and size, that are either not rated by Fitch or have a Fitch rating below Moody's and S&P. The number of treated bonds in each column is reported in parenthesis. Empirical p-values are one-sided for the null hypothesis $H_0 : CAR_t \leq 0$ and calculated using the bootstrap procedure described in Section 2.3. The control window abnormal returns are cumulated over the pre-announcement window $(-50, -10]$. The event window abnormal returns are cumulated starting at date $t = -10$, and the horizons in the first column are in terms of trading days. The marker † indicates the effective date for the rule change, and $t = 0$ refers to the announcement date.

	Orphaned bonds							
	HY index members (10)		Index non-members (13)		All orphans (23)		Index-eligible bonds (34)	
Time	CAR	p	CAR	p	CAR	p	CAR	p
Control window:	0.95	[0.01]	-0.39	[0.82]	0.46	[0.07]	0.30	[0.16]
Event window:								
-5	0.95	[0.01]	0.43	[0.13]	0.71	[0.01]	0.53	[0.00]
0	0.64	[0.06]	0.16	[0.33]	0.38	[0.11]	1.22	[0.00]
10	1.89	[0.00]	1.13	[0.05]	1.53	[0.00]	1.34	[0.00]
20	1.84	[0.00]	0.54	[0.22]	1.25	[0.00]	0.61	[0.04]
30	1.49	[0.01]	0.83	[0.08]	1.14	[0.01]	0.57	[0.06]
50	0.82	[0.15]	1.78	[0.01]	1.06	[0.05]	1.40	[0.00]
80	2.86	[0.00]	4.97	[0.00]	3.58	[0.00]	3.36	[0.00]
114†	4.35	[0.00]	3.28	[0.00]	4.12	[0.00]	3.01	[0.00]
150	4.22	[0.00]	2.93	[0.02]	3.92	[0.00]	2.35	[0.00]
200	4.05	[0.01]	4.19	[0.01]	3.97	[0.00]	1.92	[0.00]
245	5.98	[0.00]	3.98	[0.01]	5.40	[0.00]	2.82	[0.00]

Table 14: Impact on liquidity

The table reports statistics on changes in liquidity over three different event windows: the pre-announcement window $(-50, -10]$, the post-announcement window $(-10, +114]$, and the post-effective window $(+114, +245]$. We compute Roll and Amihud liquidity measures for each bond separately and report the cross-sectional average. See the main text for additional details. The treatment sample are the 57 upgraded bonds expected to move to IG status. The control sample comprises high-yield bonds with unfavorable or no Fitch rating. p-values are reported in brackets. The Diff-in-Diff p-values are for Wald tests based on seemingly unrelated regressions (SUR) where the errors are assumed to be serially independent but may have contemporaneous cross-equation correlations.

	Liquidity (*Roll*)				Liquidity (*Amihud*)			
	Difference [p]		Diff-in-Diff [p]		Difference [p]		Diff-in-Diff [p]	
Panel A: Post-announcement window (-10, +114]								
HY-to-IG bonds	0.02	[0.83]	0.00	[0.82]	0.16	[0.43]	0.03	[0.79]
Control sample	0.02	[0.63]	–	–	0.13	[0.02]	–	–
Panel B: Post-effective window (+114, +245]								
HY-to-IG bonds	0.06	[0.53]	-0.01	[0.69]	0.26	[0.22]	0.09	[0.91]
Control sample	0.07	[0.04]	–	–	0.17	[0.01]	–	–

Figure 1: Index performance and timeline of events

The figure plots the cumulative return over time for the Lehman indices for investment-grade (IG) and high-yield (HY) bonds normalized relative to the index level on November 15, 2004 ($t = -50$). The solid line plots the IG index and the dashed line plots the HY index. The vertical dotted lines refer to important events in the corporate bond market as described in Table 1. On the horizontal axis, 0 marks the announcement date (January 24, 2005) and 114 the effective date (July 1, 2005).

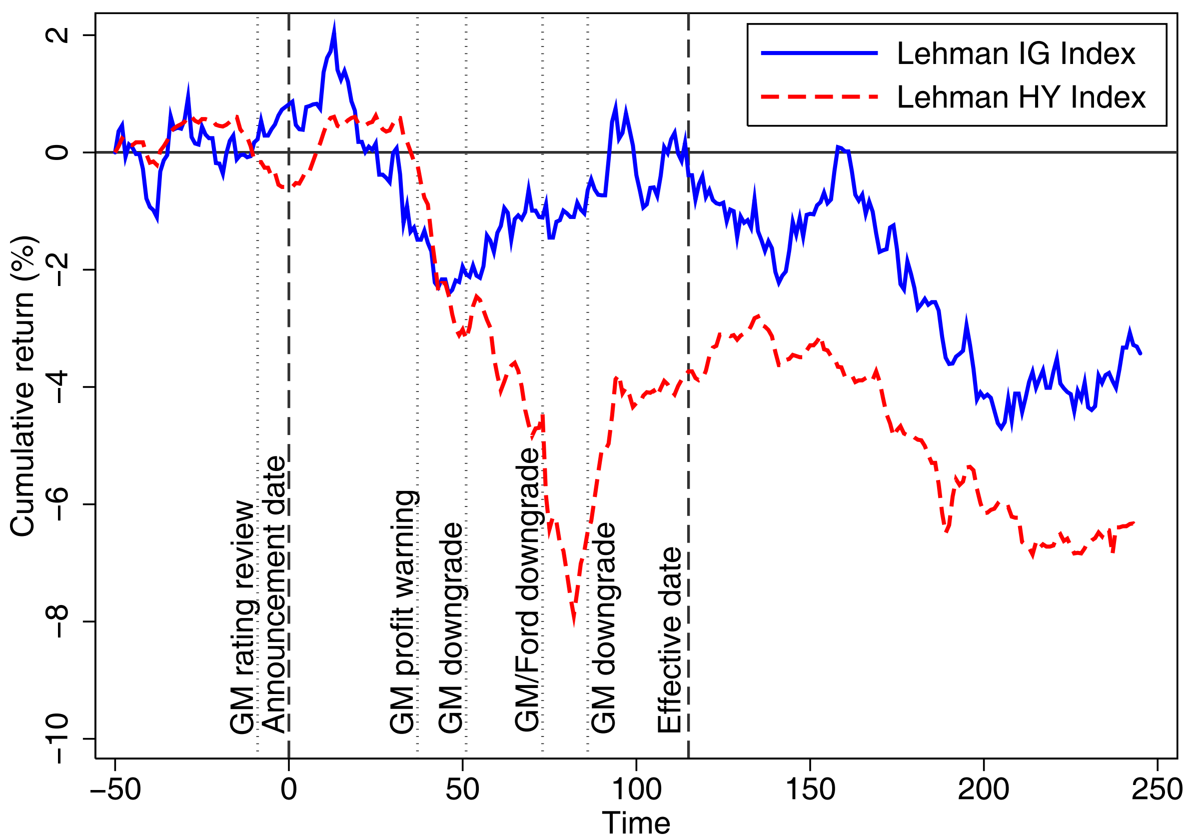


Figure 2: Announcement returns in bonds upgraded to investment grade

The figure plots value-weighted average cumulative abnormal returns for the 57 upgraded bonds expected to obtain a Lehman investment-grade index rating because of the Lehman index rating redefinition. Abnormal returns are calculated using the matched-sample approach described in Section 2.3. The control group consists of all bonds, matched on index rating, maturity and size, that are either not rated by Fitch or have a Fitch rating below Moody's and S&P. Specifically, we pair bonds based on their credit risk by matching on the index rating category up to the notch under Lehman's old split-rating rule (i.e., BB+, BB, BB–, B+, etc.). In addition, we match on being in the same maturity bin (short=1-5 years or long=5 years or longer) and size bin (<\$250 MM or ≥\$250 MM par value of bond issue outstanding). The dotted lines are the confidence interval at 95 percent significance level estimated using empirical p-values obtained using a bootstrap simulation procedure. On the horizontal axis, 0 marks the announcement date (January 24, 2005) and 114 the effective date (July 1, 2005).

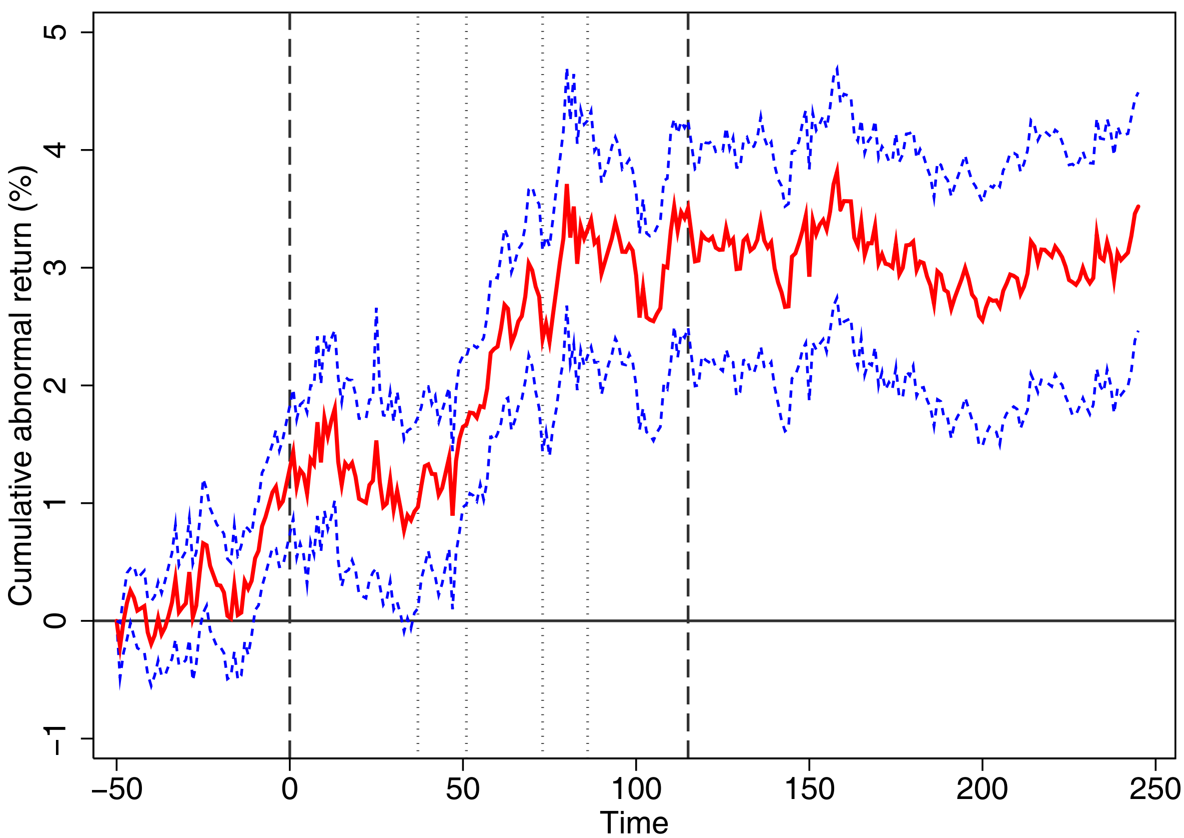


Figure 3: Return decomposition for bonds upgraded to investment grade

The figure plots value-weighted average cumulative abnormal returns on the 57 upgraded bonds expected to obtain a Lehman investment-grade index rating (dotted line) and their estimated permanent and transitory components. Abnormal returns are calculated using the matched-sample approach described in Section 2.3. CARs are decomposed into estimated permanent and transitory components, $\widehat{PC}_t$ and $\widehat{TC}_t$, based on the Kalman Filter estimation of specification (D) in Table 6. The estimated permanent component is then further decomposed into an uncontingent component, $\widehat{PC}_t^U = \widehat{PC}_t - \widehat{PC}_t^C$ and a contingent permanent component that is conditional on the differential return in the IG index relative to the HY index, $PC_t^C = \sum_{s=t_1+1}^{t}(\widehat{\beta}_0\, IMH_s\, \mathbf{1}_{s>t_1} + \ldots + \widehat{\beta}_K\, IMH_{s-K}\mathbf{1}_{s>t_1+K})$ where IMH_t is the return on date t of a portfolio that is long the IG index and short the HY index, and $\mathbf{1}$ is an indicator that takes value one during the time period indicated by the subscript, and zero otherwise where t_1 is event day +10. On the horizontal axis, 0 marks the announcement date (January 24, 2005) and 114 the effective date (July 1, 2005).

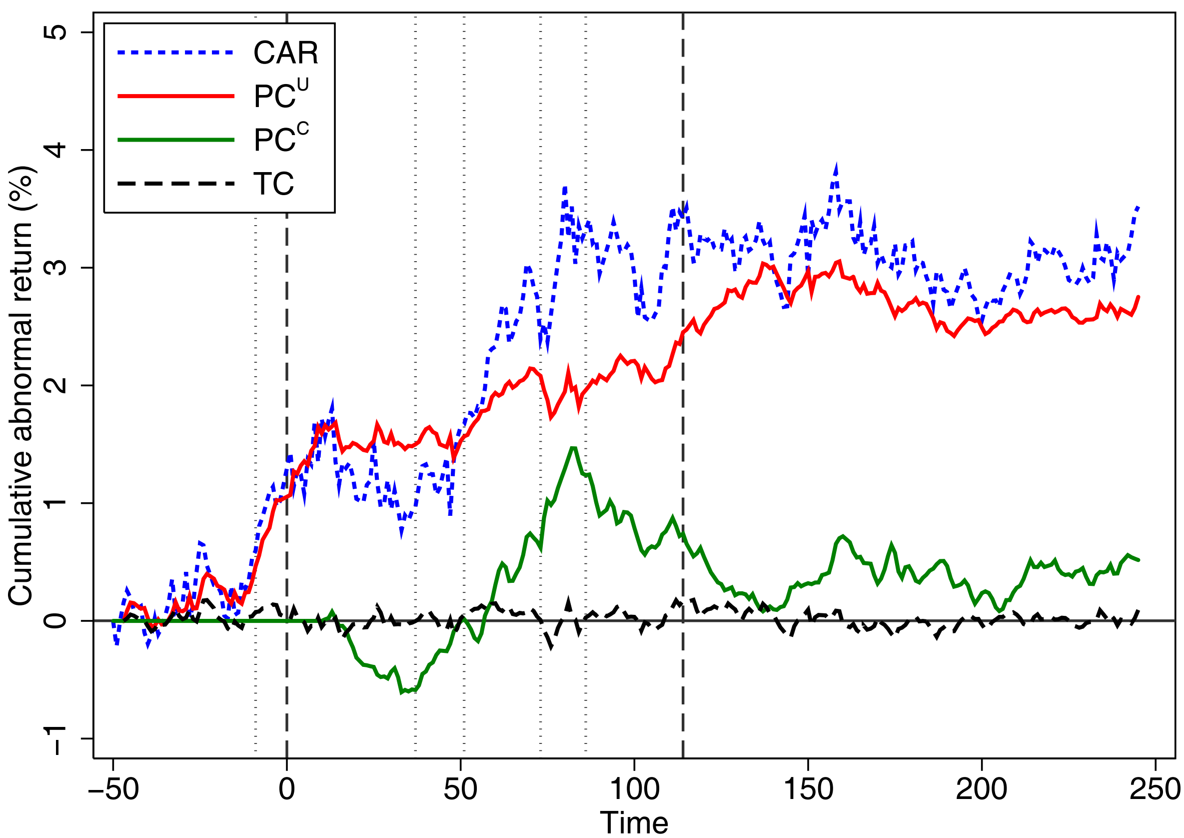


Figure 4: Post-announcement turnover in bonds upgraded to investment grade

The figure reports the average daily turnover for the 57 upgraded bonds expected to obtain a Lehman investment-grade index rating because of the Lehman index rating redefinition (solid line). Turnover is calculated as the dollar volume of all transactions reported in TRACE and normalized by the outstanding par value. The control sample (dashed line) comprises the control bonds with unfavorable or no Fitch rating. On the horizontal axis, 0 marks the announcement date (January 24, 2005) and 114 the effective date (July 1, 2005).

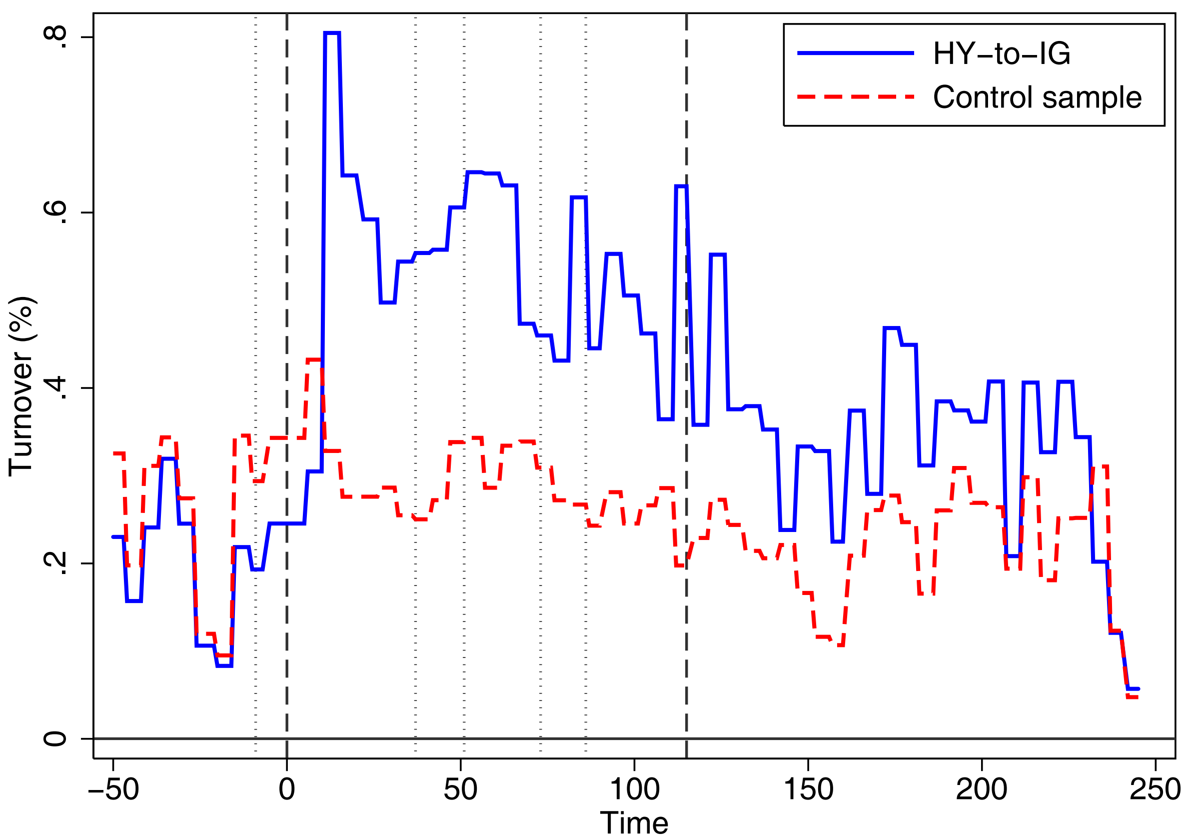


Figure 5: Insurance company trading in bonds switching from HY to IG segment

The figure plots the average cumulative change in the aggregate insurance company holdings of the 57 upgraded bonds expected to obtain a Lehman investment-grade index rating because of the Lehman index rating redefinition (in units of $ MM per bond). The dashed line plots the corresponding average change in inventory for bonds in the control sample of matched bonds. On the horizontal axis, 0 marks the announcement date (January 24, 2005) and 114 the effective date (July 1, 2005).

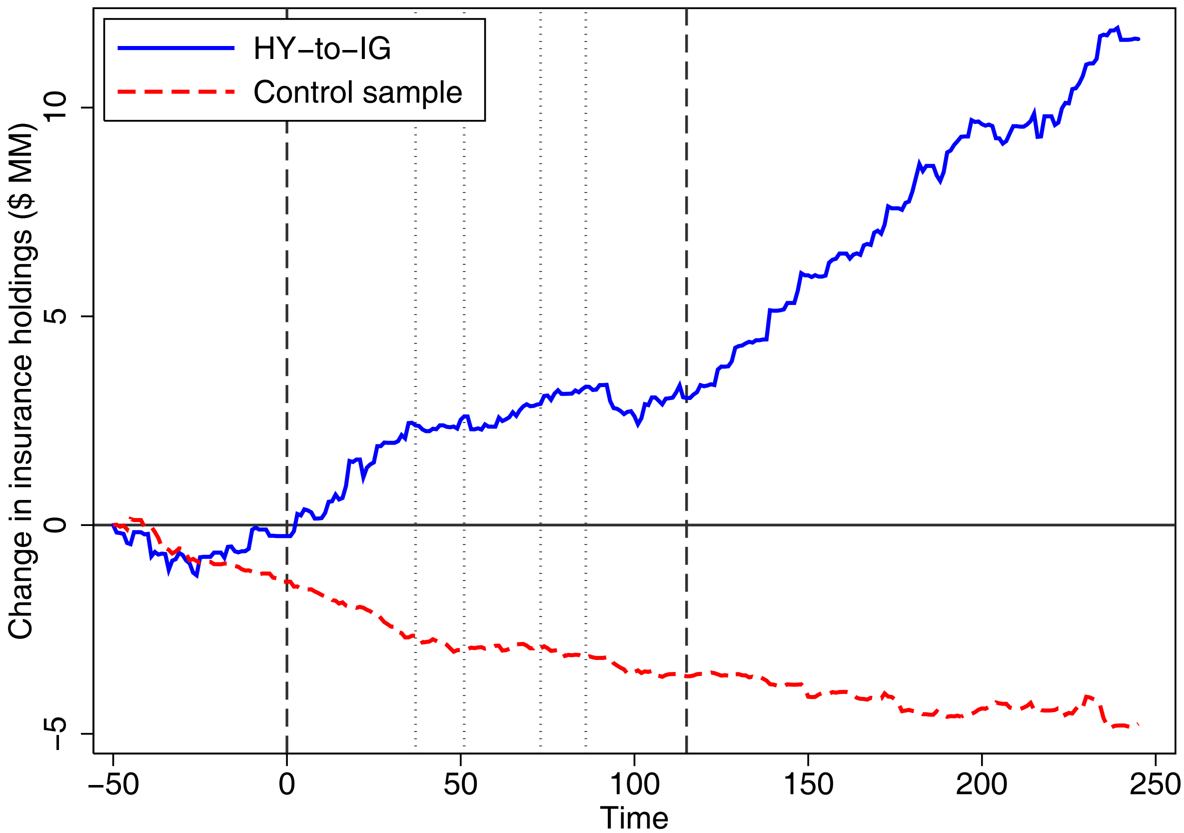
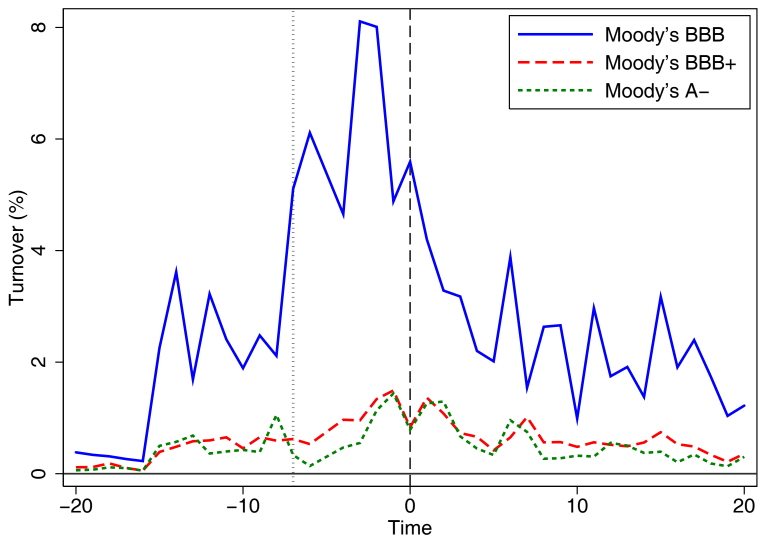
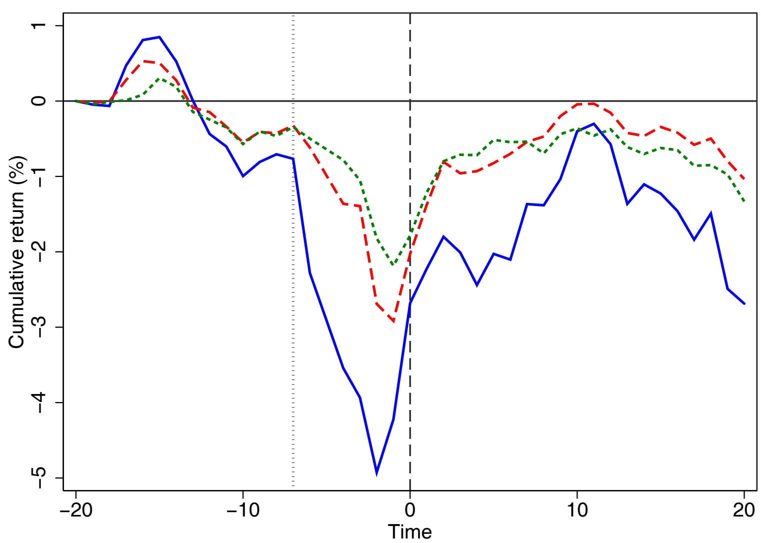


Figure 6: GM and Ford bonds around Lehman announcement date

Panel (a) plots the average daily turnover in GM, GMAC, Ford, and FMCC bonds around the announcement date. Turnover is measured using TRACE transactions volume data and normalized by the FISD par amount outstanding. Panel (b) plots the cumulative returns of bonds issued by GM, GMAC, Ford, and FMCC around the announcement date. All of these bonds have a BBB– rating issued from Standard and Poor's and a rating of BBB or BBB+ from Fitch. The sample consists of 984 bonds and is split according to the credit rating issued by Moody's into A– (farthest from HY), BBB+, and BBB (closest to HY). On the horizontal axis, 0 marks the announcement date (January 24, 2005) and −7 marks the GM rating review by S&P (January 14, 2005).



(a) Turnover



(b) Announcement returns

Internet Appendix

Table IA.1: Cross-sectional determinants of announcement returns

The table reports determinants of cumulative returns, CR, over different announcement windows. As described in Appendix B, we estimate the following regression in the cross section:

$$CR_i = \alpha + \beta I_{\text{HY-to-IG}} + \gamma' X_i + \varepsilon_i,$$

where CR_i is the cumulative return for bond i, I is an indicator variables used to identify the bonds in the treated sample, and X_i is a set of control variables. The sample consists of the 57 upgraded bonds expected to move to the IG segment and all control bonds without favorable Fitch ratings. The observations are value weighted. Standard errors are clustered at the issuer level. In brackets we report p-values for the null hypothesis $H_0 : CR = 0$. The marker † indicates the effective date for the rule change, and $t = 0$ refers to the announcement date. The control window returns are cumulated starting at date $t = -50$, the event window returns are cumulated starting at date $t = -10$, and the horizons in the first row are in terms of trading days.

	(-50,-10]	(-10,-5]	(-10,0]	(-10,+10]	(-10,+20]	(-10,+30]	(-10,+50]	(-10,+80]	(-10,+114]†	(-10,+150]	(-10,+200]	(-10,+245]
HY-to-IG	0.23	0.40	1.12	0.99	0.78	0.27	1.58	3.76	3.04	2.46	2.29	1.87
	[0.59]	[0.00]	[0.00]	[0.00]	[0.05]	[0.46]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.02]
AAA	-5.40	2.77	2.68	2.63	2.56	0.98	2.93	5.23	4.49	6.45	12.26	18.14
	[0.00]	[0.03]	[0.00]	[0.07]	[0.20]	[0.66]	[0.14]	[0.02]	[0.00]	[0.00]	[0.01]	[0.02]
AA	-5.29	2.76	2.75	2.61	2.64	0.87	2.92	5.23	5.12	6.94	12.49	18.35
	[0.00]	[0.03]	[0.00]	[0.08]	[0.19]	[0.69]	[0.13]	[0.02]	[0.00]	[0.00]	[0.01]	[0.02]
A	-5.34	2.74	2.76	2.76	2.84	1.15	2.90	5.01	4.57	6.56	12.35	17.98
	[0.00]	[0.03]	[0.00]	[0.06]	[0.16]	[0.60]	[0.13]	[0.02]	[0.00]	[0.00]	[0.01]	[0.02]
BBB	-4.95	2.61	2.58	2.73	2.93	1.33	2.62	3.97	4.06	6.27	12.00	17.92
	[0.00]	[0.03]	[0.01]	[0.07]	[0.15]	[0.54]	[0.16]	[0.07]	[0.01]	[0.00]	[0.01]	[0.02]
BB	-4.89	2.26	1.68	2.15	2.69	1.68	1.48	0.73	1.89	5.09	11.12	17.64
	[0.00]	[0.06]	[0.08]	[0.15]	[0.18]	[0.42]	[0.42]	[0.74]	[0.20]	[0.02]	[0.02]	[0.03]
B	-4.64	2.13	1.32	1.81	2.47	1.84	1.97	0.87	1.29	5.54	11.46	17.27
	[0.00]	[0.06]	[0.17]	[0.23]	[0.22]	[0.37]	[0.28]	[0.69]	[0.41]	[0.01]	[0.02]	[0.03]
Maturity	0.07	0.01	0.05	0.10	0.12	0.11	0.04	0.06	0.20	0.16	0.08	0.17
	[0.00]	[0.25]	[0.00]	[0.00]	[0.00]	[0.00]	[0.03]	[0.03]	[0.00]	[0.00]	[0.00]	[0.00]
Age	0.03	-0.02	-0.01	-0.01	-0.03	0.02	0.08	0.01	-0.06	-0.05	0.06	0.05
	[0.28]	[0.17]	[0.60]	[0.50]	[0.25]	[0.47]	[0.09]	[0.93]	[0.33]	[0.41]	[0.31]	[0.47]
Coupon	-0.03	0.06	0.05	0.03	0.01	-0.09	-0.16	-0.12	-0.19	-0.24	-0.62	-0.86
	[0.58]	[0.12]	[0.30]	[0.50]	[0.82]	[0.26]	[0.13]	[0.38]	[0.09]	[0.03]	[0.00]	[0.00]
Index beta	0.19	0.04	0.18	0.40	0.51	0.19	-0.31	-0.02	0.44	-0.01	-0.38	-0.24
	[0.15]	[0.44]	[0.02]	[0.00]	[0.01]	[0.38]	[0.33]	[0.95]	[0.13]	[0.98]	[0.36]	[0.62]
Liquidity	-3.13	0.55	0.88	3.19	1.05	-0.69	1.68	6.28	6.60	5.58	4.65	6.58
	[0.04]	[0.41]	[0.38]	[0.09]	[0.53]	[0.61]	[0.37]	[0.02]	[0.01]	[0.04]	[0.08]	[0.03]
Amount outstanding:												
\$50-150 MM	0.10	-0.03	0.20	0.30	-0.02	0.15	0.46	0.37	0.74	0.45	0.05	0.76
	[0.71]	[0.84]	[0.44]	[0.30]	[0.95]	[0.66]	[0.26]	[0.53]	[0.21]	[0.34]	[0.93]	[0.24]
\$150-250 MM	0.16	-0.05	-0.04	0.18	0.18	0.17	0.15	0.07	0.65	0.52	0.63	1.29
	[0.52]	[0.67]	[0.89]	[0.50]	[0.54]	[0.68]	[0.72]	[0.90]	[0.27]	[0.37]	[0.29]	[0.24]
\$250-1,000 MM	-0.09	-0.17	0.03	0.29	0.15	0.09	-0.15	0.44	0.87	0.43	0.22	0.91
	[0.68]	[0.11]	[0.87]	[0.20]	[0.57]	[0.81]	[0.60]	[0.28]	[0.02]	[0.36]	[0.55]	[0.33]
$\geq$ \$1,000 MM	0.16	-0.21	-0.01	0.35	0.27	-0.07	0.02	0.80	1.23	0.66	0.68	1.31
	[0.46]	[0.14]	[0.96]	[0.15]	[0.36]	[0.87]	[0.94]	[0.06]	[0.00]	[0.17]	[0.11]	[0.18]
Industrial	0.07	0.16	0.30	0.44	0.27	0.01	-0.13	-0.46	-0.47	-0.19	-0.51	-0.83
	[0.70]	[0.04]	[0.06]	[0.05]	[0.31]	[0.96]	[0.63]	[0.17]	[0.37]	[0.67]	[0.25]	[0.11]
Financial	-0.08	0.05	0.14	0.25	0.23	-0.01	-0.37	-0.79	-0.37	-0.07	-0.22	-0.48
	[0.68]	[0.55]	[0.42]	[0.30]	[0.43]	[0.97]	[0.21]	[0.08]	[0.50]	[0.89]	[0.65]	[0.38]
Observations	1,223	1,439	1,145	1,245	1,225	1,210	1,145	1,120	1,148	1,115	1,152	927
R^2	0.315	0.261	0.312	0.390	0.369	0.222	0.128	0.296	0.400	0.347	0.307	0.368

Table IA.2: COMPARISON OF IMMEDIATE UPGRADE IMPACT AND PRICED TRANSITION PROBABILITY EFFECT

The table reports modified cumulative abnormal returns for all BB+ bonds rated favorably by Fitch against the 57 upgraded bonds expected to obtain a Lehman investment-grade rating because of the Lehman index rating redefinition. Abnormal returns are calculated using the matched-sample approach described in Section 2.3 modified so that the control group for the Fitch-favorable BB+ bonds consists of the 57 upgraded bonds, matched on maturity and size. We require the treated bonds to be rated by both Moody's and S&P (as in Table 10). Empirical p-values are one-sided for the null hypothesis $H_0 : CAR_t \leq 0$ and calculated using the bootstrap procedure described in Section 2.3. The control window abnormal returns are cumulated over the pre-announcement window $(-50, -10]$. The event window abnormal returns are cumulated starting at date $t = -10$, and the horizons in the first column are in terms of trading days. The marker † indicates the effective date for the rule change, and $t = 0$ refers to the announcement date.

	Long Fitch-favorable BB+ bonds, short matched HY-to-IG upgraded bonds	
	CAR	p
Control window:	-0.26	[0.67]
Event window:		
-5	0.32	[0.19]
0	0.41	[0.22]
10	0.55	[0.23]
20	1.97	[0.01]
30	1.57	[0.02]
50	0.27	[0.33]
80	-0.74	[0.86]
114†	-0.26	[0.54]
150	0.36	[0.43]
200	1.09	[0.23]
245	1.27	[0.20]

Table IA.3: Determinants of announcement returns on bonds issued by GM and Ford

The table reports estimates for the cross-sectional determinants of cumulative returns around the announcement date for bonds issued by GM and Ford. Estimation results are from a cross-sectional regression on cumulative returns over different horizons. p-values are shown in brackets.

	[-1,+10]		[-1,+20]	
	Coef.	p	Coef.	p
Moody's BBB	1.64	[0.02]	1.38	[0.01]
Moody's BBB+	0.83	[0.04]	1.03	[0.00]
Maturity	0.11	[0.06]	0.05	[0.16]
Age	0.05	[0.57]	0.06	[0.50]
Coupon	0.29	[0.30]	0.04	[0.85]
Amount outstanding \$50-150 MM	0.22	[0.47]	0.49	[0.12]
Amount outstanding \$150-250 MM	-1.07	[0.08]	-1.75	[0.02]
Amount outstanding \$250-1,000 MM	-0.23	[0.76]	-0.12	[0.81]
Amount outstanding $\geq$\$1,000 MM	1.43	[0.00]	1.18	[0.00]
Observations	868		916	
R^2	0.49		0.30	