Return Synchronicity in the Bond Market*

Haoyu GAO[†], Junbo WANG[‡], Junchao XIAO[§]

*Junbo WANG acknowledges financial support from the City University Strategic Research Grant (Project 7004258 and 7004525) and from the Research Grants Council (RGC) research grant [Project 9041965, equivalent to CityU 194913] of Hong Kong Special Administration Region, China. Haoyu Gao acknowledges financial support from the National Natural Science Foundation of China (Project 71702207). We thank the participants in 29th Australasian Finance and Banking Conference and Brown Bag Seminar of City University of Hong Kong for the helpful comments.

[†]Central University of Finance and Economics, Beijing, China, Email: gaohaoyu@cufe.edu.cn.

[‡]City University of Hong Kong, Email: jwang2@cityu.edu.hk.

[§]The Hong Kong Polytechnic University, Email: junchao.xiao@polyu.edu.hk

Return Synchronicity in the Bond Market

Abstract

This paper studies the information interpretation of return synchronicity in the corporate bond market. We find that bonds rated at investment grade, bonds with no rating splits and bonds issued by publicly listed firms are associated with higher levels of bond return synchronicity. Bond-years with credit rating change announcement exhibit lower return synchronicity and this effect is more pronounced for rating downgrades. Our findings verify the event intensity rationale and remain robust after a variety of sensitivity tests.
Keywords: Corporate bond market, Information event intensity, Price informativeness, Rating changes, Return synchronicity.

JEL: G10, G14, G24.

1 Introduction

Return synchronicity measures the amount of a security's return variation that can be attributed to the market variation. After first proposed by Roll (1988), synchronicity, especially its linkage with information, has drawn great attention from numerous scholars and been extensively studied in the stock market.[1] In this paper, we introduce the return synchronicity in the context of the corporate bond market and empirically examine whether and how information is interpreted. Moreover, we further explore the impact of credit rating change announcements to verify the specific-event intensity rationale.

Prior studies on the information interpretation of return synchronicity generally develop along two strands. The first strand of literature mirrors the idiosyncratic variation as firm-specific information capitalized in the stock prices and explores the factors that facilitate or hinder the incorporation of firm-specific information. For example, Morck, Yeung, and Yu (2000) document a negative relationship between the level of a country's property rights protection and the average stock return synchronicity. Piostriski and Roulston (2004) point out that the larger the institutional holdings and the analysts following, the lower the return synchronicity. The second strand, however, predicts that the security under a better information environment is associated with less idiosyncratic variation and a higher level of return synchronicity since better information environment will decrease the dispersions among investors. These intuitions are empirically supported in Chan and Chan (2014), where they find a negative relationship between stock return synchronicity and information asymmetry proxied by SEO discount. Chan, Hammed, and Kang (2013) find a positive relationship between stock liquidity and return synchronicity. Kelly (2014) also reveals that low R^2 stocks tend to be small, young, and of more opaque fundamentals.[2]

With these somewhat mixed interpretations, we may wonder, what exactly does return synchronicity implies? French and Roll (1986) have stated that *"in an efficient market, firm-specific volatility reflects the specific information event intensity that has been capitalized in the stock price"*. This means, that the greater information event intensity (or unanticipated

[1]See Roll (1988); Morck, Yeung, and Yu (2000); Piotroski and Roulstone (2004); Jin and Myers (2006); Chan and Hameed (2006); Dasgupta, Gan, and Gao (2010); Gul, Kim, and Qiu (2010); Xing and Anderson (2011); Chan and Chan (2014); Devos, Hao, Prevost, and Wongchoti (2015), Hameed, Morck, Shen, and Yeung (2015).

[2]Some other synchronicity studies on the role of investors can be found in Hou, Peng, and Xiong (2013) and Eun, Wang, and Xiao (2015).

event surprise), the larger the idiosyncratic variation, and the lower the return synchronicity. This is later called as "event intensity rationale" in Morck, Yeung, and Yu (2013) for exploring the cross-country differences in stock return synchronicity. Another study conducted by Dasgupta, Gan, and Gao (2010) develops an investor learning mechanism building upon this rationale. They show that improved information transparency not only helps the incorporation of information into prices but at the same time, facilitates investors' predictions of future events. Under a better information environment, information surprises that released by the specific events become smaller, which results in a decreased idiosyncratic variation and an increased return synchronicity. The event intensity rationale is helpful to re-interpret the information messages that conveyed via different synchronicity levels. However, little direct empirical evidence is provided in literature since event intensity is unobservable and difficult to be properly measured. [3]

In this paper, we utilize bond rating change announcement, a prevalent and security specific event in the corporate bond market, to gauge the specific event intensity. With this measure, we can directly test the event intensity rationale and provide innovative evidence on the information interpretation of bond return synchronicity. More specifically, we first introduce bond return synchronicity using the standard one-factor market model following prior literature (Morck, Yeung, and Yu, 2000; Chan and Hameed, 2006; Jin and Myers, 2006; Dasgupta, Gan, and Gao, 2010; etc.). Two proxies for information event intensity are constructed. One is the occurrence of rating change announcements and the other is the frequency of rating change announcements over a calendar year. As emphasized in Odders-White and Ready (2006) as well as Livingston, Naranjo, and Zhou (2008), a firm within a more transparent information environment, is associated with a lower likelihood of going through private information events. In line with this logic, the bonds under better information environment are less likely to encounter rating change event and thus exhibit higher return synchronicity. Our first hypothesis points out that bond return synchronicity is positively correlated to bond-level information environment. Following prior literature, three bond information proxies, i.e. investment-grade dummy, a dummy for no split ratings (rating difference between Moody's and S&P's), and a dummy variable reflecting

[3] One attempt is made by Roll (1988) that uses news release to directly capture such event intensity. He disentangles return synchronicity between the days reported as having news disclosure and those that do not.However, no significant difference is found. There remains an unresolved empirical challenge to accurately interpret return synchronicity by directly applying the rationale of specific information event intensity.

the issuer's listing status in the stock market, are employed for analyses.[4]

Our first hypothesis builds upon the prerequisite that rating change announcement captures the heterogeneity in information event intensity and that the event intensity indeed characterizes bond idiosyncratic variation. To verify this premise, we develop our second hypothesis that bond rating change intensity (or surprise) is negatively correlated with bond return synchronicity. Particularly, this effect varies across different rating change characteristics. This is because that information surprises brought by rating upgrades and rating downgrades significantly differ. Managers usually have discretions for information disclosure (He, Wang, and Wei, 2011) wherein good news is released immediately while bad news is always hoarded. It is easier for investors to predict rating upgrades from several information sources prior, but it is relatively harder to forecast rating downgrades as managers are reluctant to disseminate bad news. Once rating change announcements are eventually disclosed by rating agencies, rating downgrades deliver more information surprises, which enlarges the idiosyncratic variations of the returns of the downgraded bonds. Therefore, the levels of return synchronicity for downgraded bonds are expected to decrease severer than those upgraded bonds. If a bond is assigned with both rating upgrades and downgrades within a given year, it should be embedded with the most fluctuated fundamentals and is associated with even more information event surprises. Thus, the negative impact of rating changes on bond return synchronicity should be even more pronounced for the bond-years when both rating upgrades and downgrades occur.

Our empirical results strongly support these two hypotheses. The average bond return R^2 and the corresponding bond return synchronicity during the sample period are 5.70% and -4.03, respectively. The numbers are smaller than those calculated in the stock market (11.80% and -2.51 in Chan and Chan, 2014). The pooled regressions with industry-fixed and year-fixed effects reveal that the values of return synchronicity for investment-grade bonds are on average 0.70 larger than the synchronicity of speculative-grade bonds, and the difference is statistically significant at the 1% level. This incremental value is economically significant as it accounts for 17.37% of the absolute mean of bond return synchronicity. Bonds that are rated identically

[4]Unlike the stock market, the corporate bond market is over-the-counter and is mixed with both private and public issuers. The accounting information and the managerial quality of the issuers are not fully accessed. As a result, the costs of information collection would be rather large, especially for the individual investors, as the bond market is dominated by the institutional traders. Under these conditions, conventional information proxies in the stock market may not be used broadly in the bond market.

from Moody's and S&P's exhibit higher levels of synchronicity compared with those that ratings split. Besides, bonds issued by public firms, in general, own higher return synchronicity than those issued by private firms. These results are consistent with the findings in Dasgupta, Gan, and Gao (2010) about the impact of information environment on return synchronicity in stock market. The positive relationship between bond information environment proxies and bond return comovement keeps stable after controlling for bond characteristics (i.e. issue size, rating, age, time to maturity, embedded options, etc.). Altogether, our results confirm that better-informed bonds are associated with higher bond return synchronicity. This type of bonds is also less likely to encounter rating change announcement as shown in the Probit model estimations.

For the impact of rating changes on bond return synchronicity, we find that the concurrent bond return synchronicity on average decreases by 0.26 if the bonds' ratings have been changed. The result is significant at the 1% level and keeps robust after controlling for bond characteristics. We also consider the potential impact of rating change momentum and information leakage due to rating outlook watchlist arrangement[5]. The negative relationship between rating changes and return synchronicity remains intact. This indicates that bond return synchronicity declines when bond rating gets changed and when rating change intensity is high. This finding is in accordance with the event intensity rationale that firstly highlighted in Roll (1988). The empirical results for investigating the impact of different rating change directions reveal that bond return synchronicity decreases by 0.16, 0.40, and 0.63 for bond-years encountered with rating upgrades, downgrades, and multiple rating changes with mixed directions[6], respectively. These results altogether reinforce the explanation with respect to

[5]Supported by the prior literature as well as suggested in our Probit model, the likelihood of a bond having rating change announcement increases if its rating has been changed in the past. Because of this, we posit that during the observation period of a single bond, the year that bond rating is firstly reported to get changed, is associated with the strongest information surprises. This initial rating change announcement, if any, should impose the cleanest impact on bond return synchronicity relative to the second, third, ..., rating change for an individual bond. Moreover, the magnitude of the event shock to bond return synchronicity should sequentially decrease, as it is less surprising to forecast a rating change announcement if it has occurred prior. Another concern is the outlook watchlist arrangement made by rating agencies. If a bond has been outlooked on the watchlist by a rating agency, it may indicate that there exist potential variations upon the default risk of the bond. This may be served as one possible way of information leakage before a true rating change announcement happens. Therefore, we take into account of the potential endogeneity involved in the rating change event and construct two variables to control for the rating change momentum as well as one variable for controlling the outlook watchlist in our empirical tests. See Section 4.3 for more details.

[6]We call the situation when both rating upgrades and downgrades occur within a bond-year as being associated with a mixed rating change direction.

specific event intensity rationale.

To strengthen the validity of our findings, we conduct a battery of robustness checks. Particularly, we replace the value weighted market returns by the returns of Merrill Lynch Corporate Bond Master Index, run standard bond market model and re-estimate the relationship between bond rating changes and its return synchronicity. Even if we are still concerned that the return synchronicity is related to some unobserved time-invariant firm characteristics, which can create an omitted variable bias, those channels can be further controlled with inclusion of firm fixed effects. Moreover, to preclude the estimation bias caused by lower liquidity of bonds, our sample is further restricted to those bond-years that have at least 100 days of valid trading during the calendar year. Besides, the relationship between credit rating changes and return synchronicity is robust to alternative market models, in which bond synchronicity is estimated from government bond decomposed market model and Fama-French five-factor model (Fama and French, 1993), respectively. The government bond decomposed market model includes issue size value-weighted market returns as well as 10-year government bond returns and Fama-French five-factor model includes Fama-French three factors, default risk factor, and term structure factor. Most findings remain quantitatively unchanged and are consistent with our hypotheses.

Our work for reinvestigating the information interpretation of return synchronicity in the corporate bond market is mainly inspired by the three unique features of corporate bond market. First and foremost, bond market trading is dominated by institutional participants.[7] When information flows in, these informed and sophisticated institutions in bond markets are less likely to exhibit over-optimistic or over-pessimistic interpretations of information as well as future variations compared with that in the stock market. Such bias can amplify the systematic risks when firm-specific events come across and further distort the concurrent information incorporated in the synchronicity (Hou, Peng, and Xiong, 2013). This means that price fluctuations exhibited in the bond market are more likely to be triggered by true events rather than investment sentiments. Therefore, the setting of corporate bond market, can to some

[7] As reported in 2016 Federal Reserve Board's Statistical Release of Z.1 about the ownership structure of corporate and foreign bond market, the majority of the bonds are held by insurance companies, pension funds, mutual funds and official institutions (with the holding percentage of 21%, 12%, 17%, and 6% respectively) in 2015. This proportion is even bigger during the beginning of our sample period. Detailed statistics data can be accessed through https://www.federalreserve.gov/releases/z1/Current/z1.pdf.

extent, help mitigate the trading noises, and provides us a relatively reasonable setting to explore the true idiosyncratic information component conveyed by the synchronicity measure. Second, unlike the stock market, corporate bond market is over-the-counter and mixed with both private and public issuers. Securities issued by private firms are less informational transparent (Gao, Harford, and Li, 2014), which makes the information difficult and costly to collect (Saunders and Steffen, 2011). Being private may slow down the information incorporation process when specific events occur. Hence, this mixed composition of security issuers in the market broadens our investigation spectrum, particularly provides us with more insights into how private firms comove with the market, which is unavailable in the stock market. Third, corporate bond market involves the participation of intermediaries like rating agencies. These agencies can evaluate, monitor, and collect private information that is unavailable to public domain. As An and Chan (2008) and May (2010) suggest, rating change announcements disclosed by the agencies comprise idiosyncratic information, contain unexpected surprises, and are given by the outside parties rather than the companies *per se*. Manipulation of timing of event is less possible to be arranged by managers. Therefore, rating change announcement, as a relative exogenous event from the perspective of manager's decision, enables us to capture the specific event intensity and empirically testify the information event intensity rationale for synchronicity interpretation.

This paper complements the synchronicity studies by investigating the relationship between return synchronicity and information environment under a new and relatively clean setting. There is a large literature on the stock market synchronicity and in contrast the literature on corporate bond market is surprisingly sparse. Some scholars realized that more efforts should be paid on development of corporate bond market research, for example, Lin, Wang and Wu (2011) firstly introduce the liquidity risk factor to cross-sectional corporate bond returns, Bai, Bali and Wen (2018) propose that specific bond-implied risk factors relying on the prominent features of corporate bonds are crucial to improve the empirical performance of cross-sectional predictive power, Cai, Han, Li and Li (2017) examine the herding behavior in corporate bond market and a recent paper by Robertson and Spiegel (2017) is the first to propose a better bond market index constructed solely from the public data. To the best of our knowledge, our study is the first to shed light upon return synchronicity in the corporate bond market. Moreover, as Roll (1988) predicted, the higher specific-event intensity provides a theoretical explanation on the lower level of return comovement. we innovatively exploit the rating change announcements as the observable indicator for these event intensities and offer a straightforward methodology to verify the rationale proposed by Roll (1988). This attempt for measuring event intensity also extends the implication of credit rating change in the financial market. Additionaly, the findings for how individual bond return comoves with the bond market returns, and how such comovement varies across different bond characteristics, are conducive to figure out the information transmission procedure and price variations in the bond market.

The rest of the paper is organized as follows. Section 2 demonstrates how we develop the hypotheses. Section 3 describes the sample construction, variables and summary statistics. Section 4 reports the main empirical results. Section 5 further provides robustness tests with alternative synchronicity constructions and model specifications. Section 6 concludes.

2 Hypotheses Development

Analogous to the stock market, when new information flows into the bond market, bond prices react accordingly.[8] The return volatility generated during this process can, in the same spirit, be decomposed into two parts: the market-wide and the idiosyncratic volatility. Following prior studies (Roll, 1988; Morck, Yeung, and Yu, 2000; Chan and Hameed, 2006; Jin and Myers, etc.), R-square derived from the market model or its logit transformation as synchronicity[9] across certain time period can be used to represent the proportion that market-wide volatility takes, or equivalently used to inversely indicate the proportion of idiosyncratic variation. As documented in French and Roll (1986), idiosyncratic volatility reflects the unpredicted specific events. If more specific events occur and the information with which more incorporated in the bond prices *ceteris paribus*, idiosyncratic volatility rises, thereby the individual bond will be less synchronous with the market. Consequently, the interpretation of bond return synchronicity with respect to information context involves two aspects: how synchronicity varies across different information classes, and what is the underlying rationale that information environment

[8]Corporate bond market is sporadically traded compared with the stock market, it may take longer time to absorb the equivalent amount of information, and reflect in the price fluctuations.

[9]More precisely, synchronicity= $log(R^2/(1-R^2))$. This logit transformation is developed as R-square is bounded to 0 and 1. See section 3 for detailed explanations.

alters the bond return synchronicity.

As emphasized in Roll(1988) and Morck, Yeung, and Yu (2013), firm-specific event intensity characterize the idiosyncratic variation. Market conditions that intensify the specific events would lead to less synchronous stock returns, which is also reinforced by Kelly (2014) wherein days with private information arrival present higher idiosyncratic volatility. This specific informational event has to be "true" event unanticipated as to trigger the price fluctuations. Since security price comprises of investors' expectations about the probability of future events occurrence (Dasgupta, Gan, and Gao, 2010), fundamental environment that enables investors to better acquire information and update more precise predictions, should impose less "true" events surprise if the future events subsequently occur. Therefore, bonds under more transparent information contexts earn more information disclosure, which facilitate investors to analyze, interpret and further update expectations for future events, consequently have lower likelihood of events occurrence (smaller event intensity) and present higher levels of synchronicity afterward.

To make our predictions testable in corporate bond market, we introduce three proxies to disentangle between information classes, namely, the investment-grade dummy indicating whether the bond is investment-graded or not, the split ratings dummy that denotes whether the ratings acquired from Moody's and Standard and Poor's differ, and the public issuer dummy representing whether the bond issuer is a public listed firm or not. These three proxies can effectively distinguish across different bond information environment as shown in the prior literature and are also accessible for uninformed investors.

Firstly, rating agencies claim to have great expertise and competitive advantages in information gathering, evaluation, and production with low cost. They can get access to firm-specific information unapproachable to the public domain (Holthausen and Leftwich, 1986; Liu and Malatesta, 2006). It is verified in Kliger, and Sarig (2000) that bond rating comprises of price-relevant information, and in Boot, Milbourn, and Schmeits (2006) about the prevalence of rating used in the financial markets. By disseminating private information to the market, credit rating helps mitigate the information asymmetry between the borrowers and the lenders, and also other types of market participants (Sufi, 2007; An and Chan, 2008; Boot, Milbourn, and Schmeits, 2006). The impact of rating scales on information asymmetry has also been extensively emphasized. Usually, securities or firms under poorer credit ratings are linked with larger asymmetric information, while with better bond ratings they are in general accompanied with lower degree of uncertainty, better corporate governance, greater institutional ownership, and higher accounting disclosure scores (Sengupta, 1998; Bhojraj and Sengupta, 2003; Yu, 2005; Mansi, Maxwell, and Miller, 2011). Odder-White and Ready (2006) as well confirm that bonds with better credit ratings are associated with lower uncertainty of bond value and less opaque fundamentals of the issuer. Hence, the classification of bond ratings between investment-grade and speculative-grade substantially differentiates the information environment surrounding various bonds.

Secondly, as figured out by Morgan (2002) and Livingston, Naranjo, and Zhou (2007), firms with less transparency and suffering from asset opaqueness problems are more likely to have split ratings. Split scale also matters in that larger split ratings corresponds to severer firm's uncertainty. Similarly, the existence of split ratings, together with the split scales for the bond reveal relatively opaque information context.

Thirdly, public firms own better information environment rather than private firms. Considerable amount of business and financial information needs to be released to SEC once the firm files for IPO (Hale and Santo, 2009). The regulation agencies require these materials to be updated periodically, which enables investors, with high visibility, to constantly obtain information and learn about the firms (Saunders and Steffen, 2011; Bernstein, 2015). Thus, the public companies are more liquid (Asker, Farre-Mensa, and Ljungqvist, 2014), informational transparent with respect to media and analyst coverage. Additionally, price fluctuations and trading patterns in the secondary market offer important channels for investors to access information (Gao, Harford, and Li, 2014). Bonds issued by public firms, therefore, should obtain better information environment regarding to firms' riskiness than bonds issued by private firms.

Moreover, our primary explanation for the positive relationship between information environment and return synchronicity is based on the premise that bond with more transparent information environment responses to a declining likelihood of bond-specific event occurrence. To make such mechanism testable, we utilize a common and well-disseminated information event, credit rating change announcement, as a portrait of the bond-specific event characterization.[10] Extensive studies have addressed the economically informational role that

[10]After providing the initial rating, analysts keep watching on the issuer, continue gathering private information, and modify the pre-assigned rating level if the bond's risk alters when necessary. This procedure reinforces the

rating change plays in the bond and the equity market (Holthausen and Leftwich, 1986; Dichev and Piotroski, 2001; Jorion, Liu, and Shi, 2005; Odders-White and Ready, 2006; May, 2010; He, Wang, and Wei, 2011; et al.). Significant market reaction is observed surrounding the rating change announcement, which at least partially implies that there is additional new and security specific information delivered via change announcement, and such announcement is a plausible event revealing unexpected surprise. [11] Moreover, rating change announcement is made by the outside agencies rather than issuer itself, in that little timing manipulation can be arranged by the issuer's managers. Therefore, we suggest that credit rating change can be served as an ideal and reasonable measure of the bond-specific event. Odder-White and Ready (2006) argue that firms under opaque fundamentals are more likely to have rating changes. Accordingly, we posit that the bonds with poorer information environment are associated with higher likelihood of having rating change announcements. Considering the eligibility of the three proxies for the bond information environment, it's reasonable to propose our first hypothesis.

Hypothesis 1: *Bonds under better information environment are associated with higher bond return synchronicity and lower likelihood of having rating changes. Specifically, investment-grade bonds, bonds without split ratings, and bonds issued by public firms are associated with higher bond return synchronicity and lower likelihood of having rating changes.*

As aforementioned logic foundation, bond-specific event intensity echoes the amount of idiosyncratic volatility incorporated in the bond prices opposed to that from market-wide. Recalling that rating changes are triggered by significant corporate events (Kliger and Sarig, 2000) and reflect fundamental shifts in firms prospects, such as earnings and profitability (Dichev and Piostroski, 2001), we strongly believe that the frequency measure of rating change announcements per year offers a valid and powerful proxy for the bond-specific event intensity.

validity about the informational content of rating change announcement.

[11] May (2010) concerns about the possibility that rating change event can be contaminated by contemporaneous fundamental events. Since we are not focusing on event study of rating change, but instead, using this announcement to capture the intensity of bond-specific events, and figuring out the cross-sectional intensity differences. Any other information event taking place during the concurrent period that may alter the firm's variation is unnecessary to be influential to the bond return, even if so, should be to some extend, be reflected in the rating change announcement as the rating change incorporates factors that can possibly affect the fundamentals of the bond.

Both Dasgupta, Gan, and Gao (2010) and Morck, Yeung, and Yu (2013) predict that stocks with more unanticipated events occurrence have lower return synchronicity. When the new information conveyed by rating change capitalizes into bond prices, the contemporaneous bond return synchronicity will decline accordingly in comparison with the level when no such information event occurs.

Prior studies claim that market responses of rating upgrades and rating downgrades may differ in both magnitudes and statistical significance. As argued in He, Wang, and Wei (2011), good news may be beforehand expected by investors from signals somewhere else, and gradually release to the market, whereas bad news, which issuers are reluctant to disclose, are more likely to be disseminated with greater surprise, and flow into the market in a harsh way. If both upgrades and downgrades are announced during the same year, the bond's fundamentals should be greatly fluctuated that discordance raises about the bond risk interpretation given by the rating agencies. It will be even more difficult for investors to make predictions, and should be enclosed with larger events surprise.

Hypothesis 2: *Bond-years when rating changes occur are associated with lower bond return synchronicity than those non-rating change bond-years. This negative impact is strongest for years when upgrade and downgrade announcements coexist. Compared with rating upgrades, rating downgrades induce more reductions in bond return synchronicity.*

3 Data and Variables

3.1 Sample

To construct our sample, we use TRACE for U.S. corporate bond transaction data, and Mergent FISD to collect information of bond credit rating and other characteristics such as issue date, maturity date, coupon rate, as well as callable identification, and bond covenants, etc. Our sample period starts from July, 1, 2002[12] to December 31, 2015. We first follow

[12]It's the date when TRACE dataset becomes publicly available. The dataset contains all reported OTC trades of eligible corporate bonds. Released information includes price quote, execution time and trade size (truncated at $5 million for investment-grade bonds and $1 million for speculative-grade bonds). The dissemination of TRACE gradually develops upon three phases. Phase I starts from July 1, 2002, when the disclosure of transaction information is only required for investment-grade bonds with no less than $1 billion issue size and 50 selected non-investment-grade bonds, while the maximum reporting time delay is 75 minutes. Phase II, which begins on

Bessembinder, Kahle, Maxwell, and Xu (2009) to deal with the reported trades in TRACE. Duplicated, canceled, corrected, commission trades, and trades with negative bond prices are eliminated.[13] Trade size weighted average daily price is adopted[14] to calculate the daily bond return. We then merge the data with Mergent FISD, requiring all bonds to have information for issue date, maturity date, coupon, issue size, principal amount, and SIC industry identification. We exclude bonds with odd interest payment frequency, and constraint our sample within US dollars denominated fixed coupon bonds. In the meantime, bond trades with time to maturity less than one year are removed for the liquidity concern.[15] We first employ Moody's rating, if not available, then use Standard and Poor's.[16] Rating differences between Moody's and S&P's at notch basis are adopted to measure the split ratings. If the bond does not have Moody's or S&P's rating for the specific year, we report a missing value for the split ratings.

3.2 Variables

Similar to Lin, Wang, and Wu (2011), we calculate the daily return for each individual bond at date t using the following formula.

$$R_t = \frac{(P_t + AI_t) + Coupon_t - (P_{t-1} + AI_{t-1})}{P_{t-1} + AI_{t-1}} \quad (1)$$

P_t is the daily bond price, AI_t denotes accrued interest, and $Coupon_t$ is the coupon payment, if any, on day t. P_{t-1} and AI_{t-1} are the price and accrued interest for the previous trading day $t-1$. Following Edwards, Harris, and Piwowar (2007) and Bessembinder, Kahle, Maxwell, and

April 14, 2003, broadens the released bonds spectrum and includes approximately 4650 bonds with a smaller issue size demand and a lower credit rating requirement. Phase III is implemented on February 7, 2005, and collects almost 99% of all public transactions and 95% of par value in the TRACE-eligible securities market. On July 9, 2006, all transactions in TRACE have been disseminated immediately upon receipts (Bao, Pan, and Wang, 2011; FINRA TRACE Fact Book, 2015).

[13]We also conduct the filtering methodology introduced in Dick-Nielsen (2009). Sample statistics and empirical results remain qualitatively the same. Hence we do not report the results in this paper for brevity.

[14]Bessembinder, Kahle, Maxwell, and Xu (2009) point out that trade size weighted average daily price owns a higher empirical test power compared with last trading daily price. For robustness, we also calculate the return using last trading daily price and find no statistically significant difference between the two.

[15]To maintain the generality of the conclusion for corporate bond market, we do not require the bonds to be stringent straight without any options. Robustness checks for straight bonds are conducted (results are not reported for brevity) and all the conclusions remain qualitatively unchanged.

[16]Mergent FISD reports detailed rating actions (upgrade, downgrade, confirmation, etc.) assigned by each rating agencies and incorporates information like reporting date, rating scale, credit watch status and the reason for the action. Based on this database, we are able to generate time series of bonds ratings reported by different rating agencies. We eliminate those non-rated bonds (neither available in Moody's nor in S&P's), which account for less than 0.1% of our total observations.

Xu (2009), we remove observations with absolute return value larger than 20% to avoid any outlier effect, then construct the issue size weighted average bond market index return including all the daily return observations in our sample (Acharya, Amihud, and Bharath, 2013). [17]

Bond return R-square is estimated annually based on standard market model, where individual bond's daily return is regressed on the bond market daily return.

$$R_{i,t,j} = \alpha_{i,j} + \beta_{i,j} RM_{t,j} + \varepsilon_{i,t,j} \tag{2}$$

$R_{i,t,j}$ denotes the daily return of bond i on day t in year j, $RM_{t,j}$ represents the market return on day t for the year j, $\varepsilon_{i,t,j}$ is the unspecified factors. $R^2_{i,j}$ refers to the R-square estimated from the model regression, and the corresponding synchronicity $Synch_{i,j}$ is defined as the logit transform of R-square: $Synch_{i,j} = log(\frac{R^2_{i,j}}{1-R^2_{i,j}})$, for bond i in year j.[18] To ensure the statistical validity of the OLS estimation, we demand at least 30 available daily return observations for each bond-year.[19] After this step, our sample counts to 88,570 bond-year observations, wherein contains 21,143 bonds issued by 4,088 firms in total.

We introduce here three measures of information environment classes with respect to our first hypothesis: investment-grade dummy variable (*IVgrade*) indicating whether the bond is investment-grade or speculative-grade, split ratings dummy variable (*Split*) indicating whether the bond's rating is assigned differently by Moody's and S&P's, and the public issuer dummy variable (*PublicIssuer*) indicating whether the bond issuer is a public listed firm or not. We choose the very first non-missing rating at the year beginning to identify if the bond is investment-graded or not.[20] Differences between annual ratings assigned by Moody's and S&P's are defined as the split ratings, and the issuers' listing information is acquired from CRSP.

[17]Albeit mainly focus on synchronicity using issue size weighted market index in the empirical analyses, we carry out robustness tests using Merrill Lynch US Corporate Master Bond Index for the synchronicity calculation within investment-grade bonds subsample as to guarantee the generality of our conclusion (See section 4). All the results are both economically and statistically indistinguishable.

[18]The average value of alphas estimated from the bond market model regression owns only around 1/3 of the mean value of bond return, albeit significant different from zero. This relatively small magnitude of alpha indicates that large proportion of bond returns are attributed to the correlation with market return and unexplained idiosyncratic components, which to some extent affirms the implication of standard bond market model.

[19]To avoid criteria selecting that might bring in endogeneity issue, we floor-bound the number to 100 (approximately the sample median) for robustness check. The results remain qualitatively the same.

[20]Following Xia (2014), we convert the alphabetic rating to the numerical value on a notch basis: Aaa/AAA for 1, Aa1/AA+ for 2, Aa2/AA for 3, ..., Caa3/CCC for 19, Ca/CC for 20, C for 21, and D for 22 (Unlike S&P's, Moody's rating does not indicate the status for bond default). We assign each bond with the rating be equal to the level in the previous date if no change takes place. When the rating is less than or equal to 10, we designate the bond as investment-grade, otherwise, speculative-grade.

Chan and Hameed (2006) state that stock return synchronicity relates to firm size and trading volume; Dasgupta, Gan, and Gao (2010) suggest that firm age should be informative of return synchronicity. Chan, Hameed, and Kang (2013) claim a positive linkage between the liquidity and the synchronicity. Therefore, we add a number of bond controls such as issue size (*Size*), age (*Age*), time to maturity (*TTM*), and turnover (*Turnover*)[21] to capture the liquidity condition in the bond market. We also consider other bond characteristics like coupon rate (*Coupon*) and options embedded dummies whether it's callable or has covenants restrictions (*Callable*, *Covenant*) that are known to affect the price formation.

Regarding our second hypothesis, we utilize the rating change announcement to measure the bond-specific event intensity. To be precise, we first pick up rating actions reported by Moody's or S&P's and drop those marked as "Initial", "Withdraw", and "Affirmation" or "Confirmation" that keep maintaining the identical rating scales with the prior actions as we believe they are unable to reveal much event surprise.[22] In this way, the remaining actions are either upgrades or downgrades, and the total number of change actions across the year is defined as the rating change intensity (*Intensity*). The rating change dummy (*Change*) equals one if the bond is assigned with at least one upgrade or downgrade action during the year, otherwise zero.

For some specific actions, rating agencies would put them on the credit watch list if considered as having any possible bond risk variation in the near future. Prior literature address mixed conclusions about the information impact of this credit watch list arrangement. Holthausen and Leftwich (1986) believe that most entries in the watch list are resolved subsequently. May (2010) however, acknowledges that watch list action actually reveals information in the market. To avoid any potential information contamination caused by this watch list decision, we construct the watch list dummy (*OnWatch*) that equals one if at least one action of the bond is on the credit watch list within the year, otherwise zero. Since bonds, if the rating has been changed prior, are known to have a higher likelihood to encounter changes in the future, investors thus may anticipate more rating changes subsequently, and lower the market surprise if changes did happen later. If this is the case, synchronicity shocks due to rating changes may gradually (even monotonically) decrease for changes that ranked behind in

[21]Turnover is defined as the total trading volume across the year over the bond's issue size.

[22]Most of the rating actions, especially for the decision of change directions, released by Moody's every year is akin to S&P's, although some actions may vary contemporarily because of different judgments. To keep the consistency, we choose the history of Moody's rating change actions if available, otherwise, we use S&P's.

our sample. In other words, the initial rating change for the bond during our sample period may exert the cleanest impact if our second hypothesis holds. To account for this momentum effect, we identify an after initial change dummy variable (*AfterInitial*) that is equals to one if the bonds have already been encountered with rating change announcements previously, otherwise zero. We also consider another discrete variable, defined as *Rank*, that represents the cumulative number of the years that rating changes occur.[23] If the impact of change events on return synchronicity would be contaminated by the change momentum phenomenon, then we should be able to observe an opposite impact of this ranking variable.

3.3 Summary Statistics

We summarize the R-square and the synchronicity distributions in Table 1, Panel A. Synchronicity (R-squares) are all comparably higher during TRACE pre-Phase III period. Consistent with the phase development of TRACE, the total number of bonds in our sample increases from 396 in 2002 to a stable value of 6,000-8,500 from 2005 and later on. We also report two alternative synchronicity measures constructed using the equally weighted market index or constraining sample within more liquid bonds as robustness checks. [24] The distributional patterns using other approaches do not altered qualitatively. The industrial distribution of bond return synchronicity analogous to what the prior literature have done about the industry analysis in the stock market is shown in Table 1, Panel B. Synchronicity varies across different industries. Bonds issued by firms from Public Administrative and Mining industry co-move as the highest, whereas bonds issued by firms from Agriculture, Forestry and Fishing and Construction industry are lowest synchronous with the market index. When comparing Industry bonds with Utilities bonds, the latter present a higher average synchronicity value of -3.960, which is consistent with prior findings in the stock market (Hameed, Morck, Shen, and Yeung, 2015).

[Insert Table 1 here]

[23] For example, the bond is assigned with rating changes in 2005, 2007 and 2009 in our sample period, then the *Rank* regarding to rating change is 1, 2, and 3 for the three years respectively, and 0 for the rest of the years for the bond.

[24] Floor-bound of 100 available daily return observations per year is adopted, which is nearly half of the business days in a year, and very close to the median size of the daily observations over one year in our full sample. With this liquidity requirement, we still get in total 47,485 bond-year observations that comprise of 7,275 bonds issued by 1,137 firms. See section 5 for more detailed robustness checks analyses.

Table 2 reports descriptive statistics of variables for the whole sample. The absolute mean value of bond R-square and synchronicity[25] are around 5.696% and -4.029 respectively, which is smaller than that observed in the stock market (Dasgupta, Gan, and Gao, 2010; Chan and Chan, 2014). Comparing the mean value and standard deviation for R-square or synchronicity, we find a large cross-sectional variance in the pooled bond-year observations. Around three-quarters of the observations belong to investment-grade category, and about 57% have split ratings, and about 41% are issued by public listed firms. Other bond characteristics are comparable to the numbers documented in the prior studies. For example, bond age and time to maturity are on average 4.051 and 9.889 years respectively, consistent with the value described in Wang and Wu (2015).

[Insert Table 2 here]

Table 3 presents the pairwise Pearson correlation coefficients among the main variables. As shown in the correlation matrix, Synchronicity is significantly positive correlated with R-square. In line with our hypotheses developed in section 2, we find that the investment-grade bonds, bonds with identical ratings from Moody's and S&P's, and those issued by public listed firms exhibit more co-movement with the bond market index. Correlations among other key explanatory variables are generally moderate. The variance inflation factor (VIF) tests suggest that multicollinearity is not a serious concern in the multivariate regressions.

[Insert Table 3 here]

4 Empirical Analysis

4.1 Information Environment and Return Synchronicity

To figure out the relation between bond information environment and bond return synchronicity, we first conduct three univariate tests by grouping our bond-year observations according to the three information environment proxies. More specifically, we divide our sample

[25]Except for robustness tests in section 5, all the synchronicity measures are estimated using the standard bond market model using daily return data, with value weighted market index that includes all the sample bonds requiring at least 30 available return observations per year.

into four rating subgroups as of "AAA/AA", "A", "BBB", "BB and below" in panel A[26], and directly compare the mean/median/standard deviation of bond return synchronicity for the four rating categories. Similarly, we divide the sample into four subgroups based on split ratings and mark them as "No Split", "Split=1 notch", "Split=2 notches", and "Split=3 notches and above" in panel B. For Panel C, we use "Public Issuer" and "Private Issuer" to identify the subgroups regarding to issuer's listing statuses.

Return synchronicity for each panel in general decreases with respect to more transparent information environment (poorer rating, larger split ratings, and issued by private firms), albeit marginal. For investment-grade bonds (first three subgroups together), return synchronicity values are larger than -4.000 and very close, most importantly, all greater than -4.579 for the fourth speculative-grade bonds subgroup. Synchronicity of the bonds that ratings split (the latter three subgroups together) keep below -4.000 and are smaller than the number (-3.895) of the subgroup whose ratings do not split. t-statistics of mean difference T-tests and z-statistics of median difference Wilcoxon rank sum tests are reported for the investment-grade bonds versus speculative-grade bonds in panel A, bonds with rating splits versus bonds identically rated by Moody's and S&P's in panel B, and bonds issued by public firms versus bonds with private issuers in panel C, respectively. All the differences are positive and statistically significant at 1% level, which primarily support the positive relation between bond-level information environment and bond return synchronicity.

[Insert Table 4 here]

We then set up the following multivariate regression model as to estimate how the three information environment measures affect bond return synchronicity with bond characteristics controls and industry-year fixed effects.

$$\begin{aligned} Synch_{i,j} = \alpha + \beta \times Information_{i,j} + \delta_1 \times Rating_{i,j} + \delta_2 \times Age_{i,j} + \delta_3 \times TTM_{i,j} \\ + \delta_4 \times Turnover_{i,j} + \delta_5 \times log(Size_i) + \delta_6 \times Coupon_i + \delta_7 \times Callable_i \\ + \delta_8 \times Covenant_i + \sum \eta_k \times Industry_k + \sum \theta_m \times Year_m + \varepsilon_{i,j} \end{aligned} \quad (3)$$

The dependent variable $Synch_{i,j}$ is the return synchronicity for bond i in year j.

[26] For simplicity, we use the alphabet symbolism of S&P's to represent the subgroups, but the grouping procedure is adopted for all the ratings acquired either from Moody's or S&P's.

$Information_{i,j}$ refers to the three information environment proxies of bond i for the year j, namely, Investment-grade dummy (*IVgrade*), split ratings dummy (*Split*), and public issuer dummy (*PublicIssuer*), respectively. We also control for the commonly-used bond characteristics shown to be relevant to the bond return variation. $Age_{i,j}$ denotes the continuous number of years since the issue date for bond i in year j, $TTM_{i,j}$ measures the continuous number of years left till the maturity date for bond i in year j, $Turnover_{i,j}$ is the total trading volume over the issue size of bond i during year j, $log(Size_i)$ is the natural logarithm of issue size (offering amount) of bond i, $Coupon_i$ is the coupon rate of bond i, $Callable_i$ is a dummy variable that equals one if bond i can be redeemed by the issuer, otherwise zero. $Covenant_i$ is defined as a dummy that equals one if bond i is embedded with covenants restrictions, otherwise zero. To avoid the potential time or industry effect, we control for year fixed effects and two-digit SIC industry fixed effects throughout the analyses. The regression sample in total contains 88,570 observations. Coefficients estimates and robust t-statistics with clustered standard errors by issuer-level are reported in Table 5.

[Insert Table 5 here]

Inspired by Hypothesis 1, we expect a positive relation between bond return synchronicity and bond information environment. As shown in the first two columns of Table 5, the coefficients for *IVgrade* are positive and significant at 1% level (i.e. t-statistic is 5.633 for multivariate model specifications), which implies that investment-grade bonds indeed have higher return synchronicity compared with speculative-grade bonds. In the meantime, *Split* is significantly negatively correlated with bond return synchronicity, indicates that bonds with split ratings are less synchronous with the market. Supported by the significantly positive coefficients for *PublicIssuer*, return synchronicity are statistically and economically higher for the bonds issued by public listed firms than those issued by private firms. This is because bond investors are exposed to more available information for the public firms, therefore may more accurately anticipate the occurrence of specific events, and release less event surprise than that for the private firms (Dasgupta, Gan, and Gao, 2010; Chan and Chan, 2014). In a horserace regression shown in the last column of Table 5, where synchronicity is regressed on all the three information proxies and a set of bond-level characteristics, our proposed predictors still maintain persistent directions and the magnitudes keep quantitatively unchanged.

In addtion, the relationships for synchronicity and the bond characteristics revealed by the regression coefficients are consistent with the conventional logic expectation as well. For example, the coefficients associated with *Rating* are all negative and significant across different model specifications, which reinforces the finding based on Investment-grade Dummy *IVgrade*. The cross-section variation of bond return synchronicity respect to bond rating does not cluster at investment-grade/junk boundary but also is pervasive across the whole rating categories. Chan, Hameed, and Kang (2013) investigate the relation between stock return synchronicity and stock liquidity concluding that an improvement of stock liquidity help increase the return comovement. Accordingly, we follow the prior literature (Bao, Pan, and Wang, 2011), and use bond age, time to maturity, bond issue size, and turnover to reflect bond liquidity condition, and test whether more liquid bonds bear larger return synchronicity. Confirmed in our regression results, we consistently find that recently issued bonds are more likely to co-move with the market than bonds issued some times ago, and the bonds with larger size or turnover rate have higher return synchronicity.

4.2 Probability of Rating Change Occurrence

One explanation we propose in the paper for why information environment is positively linked with bond return synchronicity is because that the bond underlying better information environment responses to a declining event surprise, and owns a lower probability of bond-specific events occurrence, in other words, is less likely to have rating change. To verify if this mechanism works, we perform the Probit model using maximum-likelihood estimation methodology to estimate the potential factors that may influence the likelihood of bond rating change announcement.

$$\begin{aligned} Prob\ [Change_{i,j}\ ] = \Phi(&\alpha + \beta \times Information_{i,j} + \gamma_1 \times Change_{i,j-1} + \gamma_2 \times Crisis_j \\ &+ \delta_1 \times Rating_{i,j} + \delta_2 \times Age_{i,j} + \delta_3 \times TTM_{i,j} + \delta_4 \times Turnover_{i,j} \\ &+ \delta_5 \times log(Size_i) + \delta_6 \times Coupon_i + \delta_7 \times Callable_i \\ &+ \delta_8 \times Covenant_i + \varepsilon_{i,j}) \end{aligned} \tag{4}$$

The dependent variable, *Change*, is a dummy variable equals one if any credit rating change (either upgrade or downgrade) has been announced by the rating agency for the bond i in the given year j. Prior studies on the determinants of credit rating change probability show that past bond rating changes can predict future changes (Dichev and Piotroski, 2001). To involve this potential factor in our model, we require bonds to have at least two years of observations in order to get the change information for the previous year $j-1$. This filtering constitutes a subsample of 75,342 observations. Besides, recession has been addressed to be predictive for the likelihood of rating change occurrence (Kliger and Sarig, 2000; Jorion, Liu, and Shi, 2005; Livingston, Naranjo, and Zhou, 2008), we then define a dummy variable, *Crisis* that equals one if the observation is in the most recent crisis period from the year 2007 to 2009 based on NBER's definition, and zero otherwise (Beber and Pagano, 2013). Our main explanatory variables about the information environment and the other controls are defined in Section 4.1. Coefficients estimates and z-statistics are displayed in Table 6.

[**Insert Table 6 here**]

As shown in Table 6, investment-grade bonds, bonds rated identically by Moody's and S&P's, and bonds issued by public listed firms, have lower likelihood of rating change assignment. Corporate bonds under more transparent information environment are verified to have smaller bond-specific event intensity. In Table 6, the coefficients of *IVgrade* are all negative and significant at 1% level, consistent with the conventional wisdom that better bond ratings are accompanied by lower degrees of uncertainty (Sengupta, 1998). We confirm that bonds with split ratings are more likely to be confronted with rating change announcements, which has been emphasized by Livingston, Naranjo, and Zhou (2008). Moreover, bonds issued by public listed firms are less likely to experience credit rating changes. The coefficients associated with *Rating* are all positive and significant across different model specifications, parallel to the findings for the Investment-grade dummy. In addition, we notice that the coefficients for the lag of rating change dummy are significantly positive, which means the rating change announcement *per se* exhibits a time series autocorrelation. There may exist a momentum effect for the rating change occurrence that once rating agencies begin to modify the bonds' rating levels, they are more likely to assign change actions for the bonds in the future comparing to the bonds whose ratings haven't been adjusted by the rating agencies yet.

4.3 Impact of Rating Change Intensity on Return Synchronicity

In this subsection, we examine Hypothesis 2 that when the rating gets changed, bond return synchronicity declines. To do so, we conduct the pooled OLS multivariate regression as below.

$$\begin{aligned} Synch_{i,j} = \alpha &+ \beta \times log(1 + Intensity_{i,j})(Change_{i,j}) + \gamma_1 \times AfterInitial_{i,j} \\ &+ \gamma_2 \times Rank_{i,j} + \gamma_3 \times OnWatch_{i,j} + \delta_1 \times Rating_{i,j} + \delta_2 \times Age_{i,j} \\ &+ \delta_3 \times TTM_{i,j} + \delta_4 \times Turnover_{i,j} + \delta_5 \times log(Size_i) \\ &+ \delta_6 \times Coupon_i + \delta_7 \times Callable_i + \delta_8 \times Covenant_i \\ &+ \sum \eta_k \times Industry_k + \sum \theta_m \times Year_m + \varepsilon_{i,j} \end{aligned} \tag{5}$$

$AfterInitial_{i,j}$ is the dummy that equals one if bond i's rating already been initially changed before year j, otherwise zero. $Rank_{i,j}$ is the cumulative number of years when bond j's rating gets changed till year j. $OnWatch_{i,j}$ is the dummy variable that equals one if bond i has been put on the watch list by the rating agencies in year j, and zero otherwise. These variables are employed here as to control for any confounding effect caused by rating change momentum and the potential information disclosure from watch list arrangement. The rest of the control variables are defined in Section 4.1. With this model specification, we investigate the relationship between rating change event intensity (or the dummy variable of change occurrence) and bond return synchronicity. We use the logarithm transformation of rating change intensity ($log(1 + Intensity_{i,j})$) here is because this intensity measure, which is defined as the frequency of rating change announcements throughout the bond-year, is a discrete integer. Year fixed effects and two-digit SIC industry fixed effects are included throughout the analyses. Coefficients estimates and robust t-statistics with clustered standard errors by issuer-level are reported in Table 7.

[Insert Table 7 here]

From the estimations in Table 7, we are able to observe that credit rating change occurrence is negatively related to bond return synchronicity and significant at 1% level. Our direct measure of change event intensity-total number of change announcements within a given year is also negatively correlated with bond return synchronicity. These two findings strongly support our Hypothesis 2, and verify the argument documented in Roll (1988) and Morck, Yeung, and Yu (2013) that specific event intensity is a valid reflection of return synchronicity. The larger specific event intensity, the smaller bond return synchronicity. Besides, the coefficients for *AfterInitial* is negative and statistically significant, which implies that the impact of rating change event to synchronicity does not only exist, but also is prolong and persistent. The coefficients for *Rank* is positive and significant at 1% level, revealing that the synchronicity shock imposed by rating change decreases with respect to the subsequent change event. The positive and significant coefficients of *OnWatch* affirm our argument that rating watch list arrangement facilitates investors' expectation for future rating changes, thus may lower the surprise embedded in the event.

4.4 Impact of Change Direction on Return Synchronicity

Rating change announcement reflect the bond-specific information event, to some extent, capture the unpredictable idiosyncratic information, and reduce the bond return synchronicity. Event surprise triggered by different rating change directions however varies. Such event surprise difference has not been fully discussed in the synchronicity measure yet in the prior studies. We thereby separately test if different rating change directions affect diversely on bond return synchronicity using pooled OLS multivariate regression specified as below.

$$\begin{aligned} Synch_{i,j} = \alpha &+ \beta \times Up_{i,j}(Down_{i,j})(Mix_{i,j}) + \gamma_1 \times InitialAfter_{i,j} + \gamma_2 \times Rank_{i,j} \\ &+ \gamma_3 \times OnWatch_{i,j} + \delta_1 \times Rating_{i,j} + \delta_2 \times Age_{i,j} + \delta_3 \times TTM_{i,j} \\ &+ \delta_4 \times Turnover_{i,j} + \delta_5 \times log(Size)_i + \delta_6 \times Coupon_i + \delta_7 \times Callable_i \\ &+ \delta_8 \times Covenant_i + \sum \eta_k \times Industry_k + \sum \theta_m \times Year_m + \varepsilon_{i,j} \end{aligned} \tag{6}$$

$Up_{i,j}$ is the Upgrade Dummy that equals one if all rating changes observed are upgrades for bond i in year j, otherwise zero. $Down_{i,j}$ denotes Downgrade Dummy that equals one when only downgrades take place for bond i during year j, otherwise zero. $Mix_{i,j}$ indicates the Mix Change Dummy that equals one if both upgrades and downgrades announcements occur for bond i of year j, otherwise zero. The rest of the variables are defined as section 4.3. To distinguish the separate impact of various rating change directions on bond return synchronicity, we use the 65,309 bond-year observations that ratings do not change as the benchmark, and construct three subsamples comprising of rating change observations under the specified directions together with the non-change observations. Subsample for testing the upgrades impact includes 8,943 bond-year observations when only upgrades take place, subsample concentrating on downgrades effect owns 13,888 bond-year observations with only downgrades, and subsample examining mixed change direction shock contains of 430 bond-year observations when upgrades and downgrades coexist. We repeat the model specifications introduced in section 4.3 separately for the three subgroups and compare the magnitude and significance of the coefficients for different directions. Year fixed effects and two-digit SIC industry fixed effects are controlled. Coefficients estimates and robust t-statistics with clustered standard errors by issuer-level are reported in Table 8.

[Insert Table 8 here]

As depicted in Table 8, we find that both *Up*, *Down*, and *Mix* are negatively associated with the bond return synchronicity and significant at 1% level, which reinforces our findings in Table 7. Particularly, the absolute value of the coefficient estimation for *Down* (-0.402) is much larger than that of *Up* (-0.168). This strongly supports our expectation that downgrade rating changes are more likely to reveal unanticipated events surprise. Moreover, bond-year observations with multiple rating changes in opposite directions should be involved with higher event intensity, more volatile fundamental fluctuations, and more surprises that investors are the least likely to anticipate, therefore exhibit the lowest synchronicity level, which is also verified in the last column of Table 8. Our findings based on this identification of different rating change types in turn strengthen the relationship between information event intensity and return synchronicity.

5 Robustness Check

5.1 Control for Possible Endogeneity

We adopt the measure of rating change announcement and its frequency throughout the year to capture the specific information event intensity. When the bond comoves tightly with the market, it might be easier for rating agencies to collect information and assess the default risk as the bond is more exposed to the market conditions, thus may affect agencies' decisions on assigning rating change actions. Whether this channel works or not remains a question, nevertheless we control for the possibility that rating change announcement might be endogenous determined, and apply a two-stage regression estimation procedure as to figure out the impact of rating change on bond return synchronicity in section 4.3.

In the first stage, we estimate a probit model for the rating change occurrence dummy (or multivariate model for the rating change event intensity) with explanatory variables. We include financial crisis dummy variable, $Afterinitial$ for the change momentum effect, and bond characteristics like age, time to maturity, issue size, turnover, coupon rate, dummy for callable feature, and dummy for covenants restrictions as the determinants of the rating change occurrence (change intensity). Year and two-digit SIC code industry dummies are also included. In the second stage, we use the predicted value for rating change occurrence (change intensity) in the first stage as the instrument variable and estimate how rating change affect bond return synchronicity. Since the dummy variable $AfterInitial$ has been applied to capture the change momentum pattern in the first stage for change probability (change intensity) estimation, we exclude this initial rating change indicator in the second stage, and control for watch list arrangement and bond characteristics. Year fixed effects and two-digit SIC industry fixed effects are controlled in the second stage. Coefficients estimates and z-statistics for two stages regressions are reported in Table 9.

[**Insert Table 9 here**]

After the 2SLS methodology, the coefficient for rating change dummy is consistently negative and significant at 1% level. Similar negative coefficient for rating change intensity is also presented, all of which confirm a robust negative relationship between rating change events surprise and bond return synchronicity.

5.2 Impact of Issuer Characteristics

So far, we are using the pooling OLS regression to exam the relation between the information environment and the bond return synchronicity. To control for the potential unobservable time-invariant issuer characteristics or omitted variables that contemporarily comove with the variation of information environment and synchronicity, we re-estimate the models specified in section 4 by adding firm fixed effects. Coefficients estimates and robust t-statistics with clustered standard errors by issuer-level for section 4.1 (or Table 5) and section 4.3 (or Table

7) are reported in Table 10. The sign directions of all independent variables that proxy for the information environment levels are statistically significant and in line with our prior expectations.

[Insert Table 10 here]

As shown in panel A of Table 10, investment-grade dummy and public issuer dummy are all positively correlated with return synchronicity, while the coefficients for split ratings dummy are negative. All these impacts are economically significant. Panel B of Table 10 confirms the role of rating change announcements' frequency as a reasonable proxy for specific event intensity that played in cross-sectional variations of bond return synchronicity and consolidates our hypothesis that bond-years purely encountered with downgrades show less comovement with the market return than those purely with rating upgrades. Particularly, if the ratings are upgraded but subsequently downgraded (*vice versa*) during the same year, which is defined as mixed changes, the bonds' returns are shown to be lowest synchronous with the market. Because bonds with mixed changes bear the most volatile fundamentals and rating agencies even have to render inconsistent or even contradict evaluations in short period of time. The strongest negative impact of such rating change direction on bond return synchronicity therefore reinforces our argument that it's the event intensity surprise that matters for the synchronicity cross-sectional variations.

5.3 Multi-Issuance within Firm

There is large cross-section variation for the number of bonds issued within the firm. In our sample, while some type of issuers only maintain one unique available bond, some firms earn as many as hundreds of bonds outstanding. For issuers with multiple bonds coexist in the market, because being exposed to the exact same firm's information flows, risk and investment opportunities, these bonds sharing the one issuer are more likely to comove with each other. Since the market index is mechanically calculated based on all the available bonds, such multi-issuance phenomenon may contaminate the message conveyed by the bond return synchronicity.

Therefore, we take into account this multi-issuance concern, and conduct robustness tests for sample aggregated at firm-year level under which each observation is exposed to distinct firm's fundamentals in a given year. This firm-year level sample in total contains 24,095 observations. More specifically, we recompute the bond return synchronicity using firm's value weighted average bond return, where issue size (offering amount) of the outstanding bonds serve as the weights. Characteristics as *Rating*, *Age*, *TTM*, *Size*, *Coupon* and *Turnover*, etc. are defined as the issue size value weighted average value of the number reported by all the outstanding bonds within the firm-year. Information proxies of investment-grade dummy, split ratings dummy are acquired based on the aggregated characteristics. Since rating change announcements are generally clustered for bonds under the same issuer (May, 2010), we calculate the total number of the rating change announcement dates for the issuer within the year as the rating change intensity measure, based on which we also define the change dummy aggregated at firm level. We then repeat OLS multivariate regression tests designed in section 4. Coefficients estimates and robust t-statistics with clustered standard errors by issuer-level are reported in Table 11.

[**Insert Table 11 here**]

As the results in Panel A of Table 11 revealed, The coefficient for investment-grade dummy is positive and significant at 1% level, and the results for split ratings dummy keep negative and significant at 10% level for multivariate regression. For information proxy of public listing status, univariate regression strongly supports the positive relation between information environment and bond return synchronicity. The coefficients in multivariate regression and horserace model remain positive, albeit insignificant. In general, that bonds under better information environment are more synchronous with the market return remains qualitatively unchanged. Besides, rating change (change intensity) is negatively associated with bond return synchronicity and significant at 1% level. Results in Panel B of Table 11 weakly support the negative impact of rating upgrades on bond return synchroncity, which is reasonable as the event surprise embedded in upgrade announcement is smallest and sometimes may be fully anticipated. The magnitude of change effect is strongest for mixed change direction years (-0.673), and rating downgrades impose significantly negative and stronger impact than rating upgrades, all of which are consistent with our expectations.

5.4 Bond Market Liquidity

To guarantee the implication of synchronicity/R-square in the corporate bond market using standard market model is statistically reliable as corporate bonds are in general less liquid than securities in the stock market, we constraint our sample to have at least 100 available daily return observations per year, of which contains more liquid bonds and still leaves us with 47,485 bond-year observations. With this requirement, cases such as daily returns are calculated with time range spanning in a week or longer, or returns are clustered in specific periods of the year are extremely rare. We then compute the robust bond return synchronicity/R-square and repeat the OLS multivariate regression tests designed in section 4. Coefficients estimates and robust t-statistics with clustered standard errors by issuer-level are reported in Table 12.

[**Insert Table 12 here**]

The table explicitly addresses a robust and statistically significant positive relationship between return synchronicity and the information environment proxies. The impact of rating change occurrence (rating change intensity) exert on bond return synchronicity is also in the coherent direction as we expect and is statistically significant. This negative linkage becomes most pronounced for the years that blended with both downgraded rating announcements and upgraded news. While for the years when ratings are only downgraded, the magnitude of the direction effect (-0.419) is more than doubled in comparison with the number for the rating upgraded years (-0.178).

5.5 Market Return Index

Similar to the stock market synchronicity calculation, we compute the R-square estimates and its transformation for bond return synchronicity based on standard market pricing model where the bond market index is the issue size (value) weighted bond index comprises of all available bonds in our sample. To ensure the generality of our conclusion, we alternatively choose Merrill Lynch US Corporate Master Bond Index[27] as the market index to track for the return comovement. Because this commonly-used index only constitutes with investment-grade bonds, we have to re-specify the robustness tests for subsample of bonds that are investment-grade

[27]With this commonly-used market index both for academics and practitioners, we may at most preclude the misconstruction issue, if any, for our value weighted bond market index.

accordingly, which in total remains 66,059 bond-year observations. We conduct the OLS multivariate regression tests designed in section 4, except that the information environment proxies only consist of split ratings dummy and public issuer dummy. Coefficients estimates and robust t-statistics with clustered standard errors by issuer-level are reported in Table 13.

[**Insert Table 13 here**]

The coefficients of the robustness tests about the main hypotheses keep persistently in the same directions with those in section 4. Moreover, the positive relationship between two information environment proxies (split dummy and public issuer dummy) is more pronounced when restricting our sample into investment-grade bonds. Similarly, a stronger negative impact of rating change intensity on the synchronicity is observed. And the absolute value of synchronicity is on average 0.768 lower for the bond-years associated with rating downgrades only.

6 Conclusion

In this paper, we explore the information interpretation of return synchronicity in the corporate bond market and the possible channel through which different information environment affects the return co-movement. The market features that participants are dominated by institutional investors, and both public and private bonds issuers coexist in, together provide us a newly and relatively exogenous setting to disentangle the synchronicity among different information environment classes both cross-sectional and along the time dimension. We test, in particular, whether transparent information context enhances the level of synchronicity. We find that bonds under better information environment are associated with higher bond return synchronicity. This is because such type of bonds owns lower likelihood of informational event occurrence or less specific event surprise, therefore should be incorporated with less idiosyncratic information in the total return variation.

Using rating dummy (investment-grade bonds versus speculative-grade bonds), split ratings dummy (bonds that are identically rated versus those with split ratings), and public issuer dummy (bonds issued by public firms versus those issued by private firms) to proxy for information environment levels, we find that returns of investment-grade bonds, bonds assigned with identical ratings from Moody's and S&P's, and bonds issued by public firms are more synchronous with the market index return than speculative-grade bonds, bonds having split ratings, and that issued by private firms, respectively. We employ the prevalent specific event-credit rating change announcement in the bond market and measure the number of credit rating changes per year to capture the magnitude of information event intensity. More directly, we construct the dummy variable of change intensity, which indicates whether the bond rating has been changed during the year, as a representative measure of the event surprise. Probit model estimations for the probability of bonds having rating change announcement further support that the bonds embedded with the aforementioned three types of good information environment are less likely to be assigned with rating changes by the rating agencies. In addition, we establish a negative relationship between rating change occurrence (change intensity) and contemporaneous synchronicity level. Our findings showing the significant reduction of return synchronicity for bond-years with more rating change announcements to some extent strengthens the eligibility of using rating change to represent the specific event intensity. Furthermore, we also discover that the negative impact of rating change on the bond return synchronicity is more pronounced when the rating is downgraded compared with being upgraded. When both downgrades and upgrades coexist, bond return synchronicity becomes lowest, which supports the viewpoint that it is the unanticipated specific event surprise rather than the whole event that matters for the return synchronicity.

References

Acharya, V. V., Amihud, Y., Bharath, S. T., 2013. Liquidity risk of corporate bond returns: conditional approach. *Journal of Financial Economics* 110, 358-386.

An, H.H., Chan, K.C., 2008. Credit ratings and IPO pricing. *Journal of Corporate Finance* 14, 584-595.

Asker, J., Farre-Mensa, J., Ljungqvist, A., 2014. Corporate investment and stock market listing: a puzzle? *Review of Financial Studies* 28, 342-390.

Bai, J., Bali, T. G., Wen, Q., 2018. Common risk factors in the cross-section of corporate bond returns *Journal of Financial Economics, forthcoming.*

Baker, H. K., Mansi, S. A., 2002. Assessing credit rating agencies by bond issuers and institutional investors. *Journal of Business Finance & Accounting* 29, 1367-1398.

Bao, J., Pan, J., Wang, J., 2011. The illiquidity of corporate bonds. *The Journal of Finance* 66, 911-946.

Beber, A., Pagano, M., 2013. Short-selling bans around the world: Evidence from the 2007-09 crisis. *The Journal of Finance* 68, 343-381.

Bernstein, S., 2015. Does going public affect innovation? *The Journal of Finance* 70, 1365-1403.

Bessembinder, H., Kahle, K. M., Maxwell, W. F., Xu, D., 2009. Measuring abnormal bond performance. *Review of Financial Studies* 22, 4219-4258.

Bhojraj, S., Sengupta, P., 2003. Effect of corporate governance on bond ratings and yields: The role of institutional investors and outside directors. *Journal of Business* 76, 455-475.

Boot, A. W., Milbourn, T. T., Schmeits, A., 2006. Credit ratings as coordination mechanisms. *Review of Financial Studies* 19, 81-118.

Cai, F., Han, S., Li, D., Li, Y., 2017. Institutional herding and its price impact: Evidence from the corporate bond market. *Journal of Financial Economics, forthcoming.*

Chan, K., Chan, Y. C., 2014. Price informativeness and stock return synchronicity: Evidence from the pricing of seasoned equity offerings. *Journal of Financial Economics* 114, 36-53.

Chan, K., Hameed, A., 2006. Stock price synchronicity and analyst coverage in emerging markets, *Journal of Financial Economics* 80, 115-147.

Chan, K., Hameed, A., Kang, W., 2013. Stock price synchronicity and liquidity, *Journal of Financial Markets* 16, 414-438.

Dasgupta, S., Gan, J., Gao, N., 2010. Transparency, price informativeness, and stock return synchronicity: theory and Evidence. *Journal of Financial and Quantitative Analysis* 45, 1189-1220.

Devos, E., Hao, W., Prevost, A.K., Wongchoti, U., 2015. Stock return synchronicity and the market response to analyst recommendation revisions. *Journal of Banking & Finance* 58, 376-389.

Dichev, I.D., Piotroski, J.D., 2001. The long-run stock returns following bond ratings changes. *The Journal of Finance* 56, 173-203.

Dick-Nielsen, J., 2009. Liquidity biases in TRACE. *Journal of Fixed Income* 19, 43-55.

Dick-Nielsen, J., 2014. How to clean enhanced TRACE data. *Available at SSRN 2337908.*

Edwards, A.K., Harris, L.E., Piwowar, M.S., 2007. Corporate bond market transaction costs and transparency. *The Journal of Finance* 62, 1421-1451.

Eun, C. S., Wang, L., Xiao, S. C., 2015. Culture and R2. *Journal of Financial Economics*, 115, 283-303.

French, K.R., Roll, R., 1986. Stock return variances: The arrival of information and the reaction of traders, *Journal of Financial Economics* 17, 5-26.

Gao, H., Harford, J., Li, K., 2015. CEO turnover-performance sensitivities in private firms. *Journal of Financial and Quantitative Analysis*, Forthcoming.

Gul, F. A., Kim, J. B., Qiu, A. A., 2010. Ownership concentration, foreign shareholding, audit quality, and stock price synchronicity: Evidence from China. *Journal of Financial Economics* 95, 425-442.

Haggard, K.S., Martin, X., Pereira, R., 2008. Does voluntary disclosure improve stock price informativeness? *Financial Management* 37, 747-768.

Hale, G., Santos, J.A., 2009. Do banks price their informational monopoly? *Journal of Financial Economics* 93, 185-206.

Hameed, A., Morck, R., Shen, J., Yeung, B., 2015. Information, analysts, and stock return comovement. *Review of Financial Studies* 28, 3153-3187.

He, Y., Wang, J., Wei, K. J., 2011. Do bond rating changes affect the information asymmetry of stock trading? *Journal of Empirical Finance* 18, 103-116.

Holthausen, R. W., Leftwich, R. W., 1986. The effect of bond rating changes on common stock prices. *Journal of Financial Economics* 17, 57-89.

Hou, K., Peng, L., Xiong, W., 2013. Is R2 a measure of market inefficiency. *National Bureau of Economic Research Working paper.*

Houston, J., James, C., 1996. Bank information monopolies and the mix of private and public debt claims. *The Journal of Finance* 51, 1863-1889.

Jin, L., Myers, S. C., 2006. R2 around the world: New theory and new tests. *Journal of Financial Economics* 79, 257-292.

Jorion, P., Liu, Z., Shi, C., 2005. Informational effects of regulation FD: Evidence from rating agencies. *Journal of Financial Economics* 76, 309-330.

Kelly, P. J., 2014. Information efficiency and firm-specific return variation. *Quarterly Journal of Finance* 4, 1-44.

Kliger, D., Sarig, O., 2000. The information value of bond ratings, *The Journal of Finance* 55, 2879-2902.

Li, K., Morck, R., Yang, F., Yeung, B., 2004. Firm-specific variation and openness in emerging markets. *Review of Economics and Statistics* 86, 658-669.

Lin, H., Wang, J., Wu, C., 2011, Liquidity risk and expected corporate bond returns. *Journal of Financial Economics* 99, 628-650.

Livingston, M., Naranjo, A., Zhou, L., 2007. Asset opaqueness and split bond ratings. *Financial Management* 5, 49-62.

Livingston, M., Naranjo, A., Zhou, L., 2008. Split bond ratings and rating migration. *Journal of Banking & Finance* 32, 1613-1624.

Liu, Y., Malatesta, P. H., 2006. Credit ratings and the pricing of seasoned equity offerings. *University of Washington Working paper.*

May, Anthony D., 2010. The impact of bond rating changes on corporate bond prices: New evidence from the over-the-counter market. *Journal of Banking & Finance* 34, 2822-2836.

Morgan, S. A., Maxwell, W. F., Miller, D. P., 2011. Analyst forecast characteristics and the cost of debt. *Review of Accounting Studies* 16, 116-142.

Morck, R., Yeung, B., Yu, W., 2000. The information content of stock markets: why do emerging markets have synchronous stock price movements? *Journal of Financial Economics* 58, 215-260.

Morck, R., Yeung, B., Yu, W., 2013. R2 and the Economy. *Annual Review of Financial Economics* 5,143-166.

Morgan, D.P., 2002. Rating banks: risk and uncertainty in an opaque industry. *American Economic Review* 92, 874-888.

Odders-White, E. R., Ready, M. J., 2006. Credit ratings and stock liquidity. *Review of Financial Studies* 19, 119-157.

Piotroski, J. D., Roulstone, D. T., 2004. The influence of analysts, institutional investors, and insiders on the incorporation of market, industry, and firm-specific information into stock prices. *The Accounting Review* 79, 1119-1151.

Robertson, A. Z., Spiegel, M. I., 2017. Better bond indices and liquidity gaming the rest. *Available at SSRN 3059824* .

Roll, R., 1988. R2. *The Journal of Finance* 43, 541-566.

Saunders, A., Steffen, S., 2011. The costs of being private: Evidence from the loan market. *Review of Financial Studies* 24, 4091-4122.

Sengupta, P., 1998. Corporate disclosure quality and the cost of debt. *The Accounting Review* 3, 459-474.

Sufi, A., 2007. Information asymmetry and financing arrangements: Evidence from syndicated loans. *The Journal of Finance* 62, 629-668.

Wang, J., Wu, C., 2015. Liquidity, credit quality, and the relation between volatility and trading activity: Evidence from the corporate bond market. *Journal of Banking & Finance* 50, 183-203.

Xia, H., 2014. Can investor-paid credit rating agencies improve the information quality of issuer-paid rating agencies? *Journal of Financial Economics* 111, 450-468.

Xing, X., Anderson, R., 2011. Stock price synchronicity and public firm-specific information. *Journal of Financial Markets* 14, 259-276.

Yu, F., 2005. Accounting transparency and the term structure of credit spreads. *Journal of Financial Economics* 75, 53-84.

Table 1. Sample Distributions of Bond R-square & Synchronicity

This table describes the bond return synchronicity distribution at the bond-year level over the period of 2002-2015. Panel A shows the temporal distribution, where the overall sample is grouped annually and the mean values of bond return synchronicity and R-square are reported for each year. Panel B shows the industrial distribution, where the observations are categorized by industries (using two-digit SIC) and the average values of bond return synchronicity and R-square are reported for each industry. *# Bonds* denotes the number of bonds, *# Firms* denotes the number of issuers, *Synch VW* and *R-square VW* are estimates from the standard bond market model, wherein we use issue size weighted average market index including all the available bonds in the sample as the market-wide bond return. *Synch EW* and *R-square EW* are estimates from the standard market model, where the market-wide bond return is calculated based on the equally weighted bond index using all the available bonds in our sample.

Panel A: Temporal Distribution

	# Observations of Daily Return > 30						# Observations of Daily Return > 100					
Year	# Bonds	# Firms	Synch VW	Synch EW	R-square VW (%)	R-square EW (%)	# Bonds	# Firms	Synch VW	Synch EW	R-square VW (%)	R-square EW (%)
2002	396	182	-3.440	-3.506	8.205	7.878	330	137	-3.320	-3.382	8.319	7.898
2003	2295	784	-3.566	-3.419	7.857	8.475	1311	334	-3.310	-3.167	8.862	9.393
2004	3556	1227	-3.647	-3.529	7.444	7.838	1449	337	-2.917	-2.817	10.139	10.383
2005	7047	2182	-4.304	-4.278	4.226	4.157	3172	823	-4.092	-4.203	4.609	4.228
2006	7011	2170	-4.404	-4.295	4.305	4.226	3173	894	-4.385	-4.298	4.296	3.642
2007	6455	1953	-4.559	-4.474	3.333	3.536	2749	765	-4.595	-4.544	2.947	2.990
2008	6017	1776	-3.825	-3.605	6.106	6.407	2752	752	-3.563	-3.480	6.780	6.198
2009	7375	1955	-4.356	-4.250	3.952	4.224	3853	993	-4.314	-4.433	3.694	3.192
2010	7931	2074	-4.356	-4.238	4.762	4.605	4456	1110	-4.114	-4.022	5.113	4.710
2011	7831	2097	-4.036	-3.967	5.185	5.194	4465	1115	-3.717	-3.678	6.096	5.886
2012	7938	2155	-4.421	-4.353	4.039	4.138	4551	1130	-4.276	-4.245	4.548	4.487
2013	8109	2175	-3.168	-3.104	11.033	11.056	4931	1181	-2.807	-2.791	12.893	12.425
2014	8253	2149	-3.828	-3.704	6.110	6.551	4989	1147	-3.634	-3.542	6.760	7.031
2015	8356	2087	-3.589	-3.454	7.070	7.852	5304	1145	-3.345	-3.289	7.779	8.380
ALL	21143	4088	-4.029	-3.927	5.696	5.885	7275	1137	-3.785	-3.749	6.477	6.339

Panel B: Industrial Distribution

Industry	# Obs	# Firms	Synch VW	Synch EW	R-square VW (%)	R-square EW (%)
Agriculture, Forestry and Fishing: (01-09)	16	6	-5.592	-5.219	2.618	3.954
Mining: (10-14)	5101	288	-3.598	-3.554	7.522	7.439
Construction: (15-17)	969	42	-4.515	-4.233	3.631	4.202
Manufacturing: (20-39)	19865	1095	-3.931	-3.868	5.848	6.014
Transportation, Communications: (40-48)	8795	468	-3.805	-3.762	6.565	6.425
Utilities: (49)	9112	388	-3.960	-3.845	5.799	6.293
Wholesale & Retail Trade: (50-59)	5023	274	-3.964	-3.900	5.842	5.855
Finance, Insurance and Real Estate: (60-67)	34092	1105	-4.219	-4.077	5.149	5.410
Services: (70-89)	5495	413	-4.068	-3.951	5.383	5.572
Public Administration: (91-97)	102	9	-2.448	-2.511	13.500	13.792

Table 2. Descriptive Statistics

This table reports the summary statistics of the main variables used in this study. The sample covers 88,570 bond-year observations, spanning from 2002 to 2015. For each variable, we report the sample means, medians, standard deviations, 25th percentiles, and 75th percentiles. Synchronicity and R-square are estimates from the standard market model, where the market-wide bond index return is the issue size value weighted bond return including all the sample bonds. *Synch VW* denotes the bond synchronicity and derives from the logit transformation of *R-square VW*. *Rating* is the numerical rating for a bond, ranging from 1 to 22 (AAA–D) based on Moody's, if not accessible, then use S&P's. *IVgrade* is the investment-grade dummy variable indicating whether the bond belongs to investment-grade category. *Split* is the dummy variable indicating whether there is rating difference between Moody's and S&P's. *PublicIssuer* is the public issuer dummy which takes the value of one if the issuer is a public listed firm and zero otherwise. *Size* is the bond issue size in billion dollars. *Age* is the number of years since the bond issuance. *TTM* is the bond's time to maturity in years. *Coupon* denotes bond interest payment, in percentage of the par value. *Turnover* is the ratio of bond's total trading volume in a year over the issue size scaled by 100. *Volume* measures the annual total trading volume in billion dollars. *# Trades* is the total number of trades across the year in thousand. *Callable* is a dummy variable that takes the value of one if the bond is callable, and zero otherwise. *Covenant* is a dummy variable that equals one when the bond has any covenant constraints.

Variable	Mean	Median	Std. Dev.	Q1	Q3
Synch VW	-4.029	-3.603	2.240	-5.059	-2.512
R-square VW (%)	5.696	2.653	7.805	0.631	7.499
Rating	8.692	8.000	4.169	6.000	11.000
IVgrade	0.746	1.000	0.435	0.000	1.000
Split	0.570	1.000	0.495	0.000	1.000
PublicIssuer	0.401	0.000	0.490	0.000	1.000
Size	0.574	0.350	3.264	0.183	0.600
Age	4.051	2.819	4.249	1.031	5.783
TTM	9.889	6.997	8.761	4.058	12.008
Coupon	5.949	6.000	1.923	4.900	7.000
Turnover	0.006	0.003	0.079	0.002	0.006
Volume	0.299	0.113	0.621	0.028	0.318
# Trades	0.865	0.325	1.724	0.147	0.832
Callable	0.700	1.000	0.458	0.000	1.000
Covenant	0.704	1.000	0.457	0.000	1.000

Table 3. Correlation Matrix

This table shows the pairwise Pearson correlation coefficients among the main variables. The sample covers 88,570 bond-year observations, spanning from 2002 to 2015. Synchronicity and R-square are estimates from the standard market model, where the market-wide bond index return is the issue size value weighted bond return including all the sample bonds. *Synch VW* denotes the bond synchronicity and derives from the logit transformation of *R-square VW*. *Rating* is the numerical rating for a bond, ranging from 1 to 22 (AAA–D) based on Moody's, if not accessible, then use S&P's. *IVgrade* is the investment-grade dummy variable indicating whether the bond belongs to investment-grade category. *SplitRatings* is the rating difference between Moody's and S&P's on notch basis. *PublicIssuer* is the public issuer dummy variable which takes the value of one if the issuer is a public listed firm and zero otherwise. *Size* is the bond issue size in billion dollars. *Age* is the number of years since the bond issuance. *TTM* is the bond's time to maturity in years. *Coupon* denotes bond interest payment, in percentage of the par value. *Turnover* is the ratio of bond's total trading volume in a year over the issue size scaled by 100. *Volume* measures the annual total trading volume in billion dollars. *# Trades* is the total number of trades across the year in thousand. *Callable* is a dummy variable that takes the value of one if the bond is callable, and zero otherwise. *Covenant* is a dummy variable that equals one when the bond has any covenant constraints.

	1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Synch VW	2	1.000														
R-square VW (%)	3	0.672	1.000													
Rating	4	-0.123	-0.138	1.000												
IVgrade	5	0.144	0.163	-0.814	1.000											
SplitRatings	6	-0.084	-0.076	0.108	-0.112	1.000										
PublicIssuer	7	0.112	0.117	0.090	-0.025	-0.143	1.000									
Size	8	0.072	0.108	-0.033	0.023	-0.006	0.020	1.000								
Age	9	-0.178	-0.210	0.018	0.014	0.030	-0.100	-0.028	1.000							
TTM	10	0.145	0.204	-0.096	0.122	0.001	0.029	-0.008	0.073	1.000						
Coupon	11	-0.128	-0.150	0.442	-0.410	0.031	-0.079	-0.025	0.333	0.077	1.000					
Turnover	12	0.002	0.009	0.026	-0.023	0.006	0.018	-0.002	-0.027	-0.006	0.013	1.000				
Volume	13	0.256	0.381	-0.058	0.072	-0.027	0.124	0.118	-0.208	0.026	-0.089	0.056	1.000			
# Trades	14	0.161	0.214	-0.030	0.019	-0.005	0.116	0.088	-0.075	-0.066	-0.042	0.069	0.656	1.000		
Callable	15	0.056	0.056	0.256	-0.153	-0.102	0.156	-0.023	-0.234	0.166	0.070	0.008	-0.042	-0.080	1.000	
Covenant	16	0.115	0.105	0.273	-0.157	-0.142	0.441	0.026	0.056	0.047	0.185	0.007	0.116	0.087	0.278	1.000

Table 4. Univariate Analyses

This table reports the univariate statistics of the bond return synchronicity for bond-year observations grouped by different levels of information environment. The sample has 88,570 bond-year observations, spanning from 2002 to 2015. Synchronicity estimates derives from the logit transformation of R-square of the standard market model, where the market-wide bond index return is the issue size value weighted bond return including all sample bonds. For simplicity, we use symbolic ratings from S&P to represent different rating groups. Split ratings subgroups are marked with different split ratings' notches. We report the number of observations, means, medians, standard deviations for synchronicity for each group. Significances of the mean differences are based on t-tests while significances of the median differences are based on Wilcoxon rank sum tests. We report t-statistics and z-statistics of differences between Investment-grade bonds subgroups and Junk bonds subgroup (group I+II+III vs. group IV) for panel A, bonds with no split ratings and bonds that ratings split (group I vs. group II+III+IV) for panel B, bonds with public issuers and bonds with private issuers (group I vs. group II) for panel C respectively, in the last two rows of each panel. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Group	Nobs	Mean	Median	Std. Dev
Panel A: Bond Rating				
(I): AAA/AA	12060	-3.952	-3.509	2.250
(II): A	26360	-3.786	-3.346	2.195
(III): BBB	27639	-3.845	-3.423	2.195
(IV): BB and below	22511	-4.579	-4.128	2.248
Investment-grade vs. Junk		43.157***		
(I+II+III)-IV			49.994***	
Panel B: Split Ratings				
(I): No Split	35327	-3.895	-3.477	2.180
(II): Split=1 notch	31036	-4.129	-3.691	2.251
(III): Split=2 notches	11175	-4.102	-3.671	2.256
(IV): Split=3 notches and above	4583	-4.743	-4.341	2.324
No Split vs. With Split		18.317***		
I-(II+III+IV)			20.509***	
Panel C: Issuer Listing Status				
(I): Public	35532	-3.722	-3.302	2.157
(II): Private	53038	-4.234	-3.803	2.270
Public vs. Private		33.545***		
I-II			38.269***	

Table 5. Determinants of Bond Return Synchronicity

This table reports results from OLS regressions of bond return synchronicity on information environment and bond characteristics. The sample covers 88,570 bond-year observations, spanning from 2002 to 2015. The dependent variable is the bond return synchronicity estimated from the standard market model, where the market-wide bond index return is the issue size value weighted bond return including all the sample bonds. *Rating* is the numerical rating for a bond, ranging from 1 to 22 (AAA–D) based on Moody's, if not accessible, then use S&P's. *IVgrade* is the investment-grade dummy variable indicating whether the bond belongs to investment-grade category. *Split* is the dummy variable indicating whether there is rating difference between Moody's and S&P's. *PublicIssuer* is the public issuer dummy variable which takes the value of one if the issuer is a public listed firm and zero otherwise. *log(Size)* is the logarithm transformation of the bond issue size in billion dollars. *Age* is the number of years since the bond issuance. *TTM* is the bond's time to maturity in years. *Coupon* denotes bond interest payment, in percentage of the par value. *Turnover* is the ratio of bond's total trading volume in a year over the issue size scaled by 100. *Callable* is a dummy variable that takes the value of one if the bond is callable, and zero otherwise. *Covenant* is a dummy variable that equals one when the bond has any covenant constraints. Industry and year fixed effects are included in all regressions. Robust t-statistics with clustered standard errors by issuer-level are reported in parentheses. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

	Dependent Variable: Bond Return Synchronicity						
Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Intercept	-4.395***	-6.405***	-3.917***	-5.711***	-4.098***	-5.881***	-6.143***
	(-7.818)	(-8.764)	(-5.770)	(-7.676)	(-5.851)	(-7.932)	(-8.234)
IVgrade	0.704***	0.339***		0.425***			0.287***
	(12.512)	(5.633)		(7.631)			(4.451)
Split			-0.222***	-0.104***			-0.092**
			(-5.395)	(-2.953)			(-2.534)
PublicIssuer					0.425***	0.057*	0.074**
					(7.631)	(1.733)	(2.294)
Rating		-0.029***		-0.048***		-0.057***	-0.025***
		(-3.573)		(-5.734)		(-7.385)	(-2.906)
Age		-0.087***		-0.087***		-0.086***	-0.088***
		(-12.839)		(-15.581)		(-12.733)	(-15.598)
TTM		0.038***		0.040***		0.038***	0.039***
		(15.479)		(15.395)		(15.471)	(15.305)
log(Size)		0.370***		0.349***		0.368***	0.347***
		(15.042)		(13.692)		(14.989)	(13.484)
Turnover		0.326*		2.008		0.320*	1.932
		(1.915)		(1.378)		(1.931)	(1.368)
Coupon		-0.015		-0.029**		-0.019	-0.020
		(-1.227)		(-2.280)		(-1.510)	(-1.548)
Callable		0.033		-0.013		0.039	-0.019
		(0.589)		(-0.228)		(0.700)	(-0.328)
Covenant		-0.036		-0.023		-0.056	-0.047
		(-0.793)		(-0.501)		(-1.224)	(-1.040)
Year FE	YES	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES	YES
N	88,570	88,570	82,121	82,121	88,570	88,570	82,121
Adj R^2	0.070	0.168	0.060	0.164	0.062	0.167	0.165

Table 6. Bond-level Information and the Likelihood of Rating Change

This table reports Probit model estimates of the likelihood of having rating change announcement on bond-level information environment. The sample requires the bond to have at least two years of qualified trading as to acquire the lag value of rating change, which in total includes 75,342 bond-year observations, spanning from 2002 to 2015. The dependent variable, *Change*, is a dummy variable that equals one if the bond has been assigned with rating change announcements by the rating agency in the year, otherwise zero.*IVgrade* is the investment-grade dummy variable indicating whether the bond belongs to investment-grade category. *Split* is the dummy variable indicating whether there is rating difference between Moody's and S&P's. *PublicIssuer* is the public issuer dummy variable which takes the value of one if the issuer is a public listed firm and zero otherwise. *Lag_Change* is the value of *change* for the previous year. *Crisis* a dummy variable denoting whether during the most recent financial crisis period from 2007 to 2009. *Rating* is the numerical rating for a bond, ranging from 1 to 22 (AAA–D) based on Moody's, if not accessible, then use S&P's. *log(Size)* is the logarithm transformation of the bond issue size in billion dollars. *Turnover* is the ratio of bond's total trading volume in a year over the issue size scaled by 100. *Callable* is a dummy variable that takes the value of one if the bond is callable, and zero otherwise. *Covenant* is a dummy variable that equals one when the bond has any covenant constraints. Robust z-statistics with clustered standard errors by issuer-level are reported in parentheses. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

	Dependent Variable: *Change*			
Variable	**(1)**	**(2)**	**(3)**	**(4)**
Intercept	-0.333***	-0.802***	-0.693***	-0.462***
	(-9.200)	(-33.071)	(-30.187)	(-12.231)
IVgrade	-0.250***			-0.238***
	(-12.737)			(-11.791)
Split		0.165***		0.157***
		(15.471)		(14.674)
PublicIssuer			-0.042***	-0.030**
			(-3.610)	(-2.507)
lag_Change	0.131***	0.114***	0.134***	0.109***
	(11.266)	(9.554)	(11.528)	(9.116)
Crisis	0.462***	0.493***	0.476***	0.480***
	(40.620)	(42.501)	(42.085)	(41.069)
Rating	0.029***	0.050***	0.051***	0.029***
	(13.467)	(36.755)	(39.400)	(12.907)
log(Size)	-0.045***	-0.045***	-0.046***	-0.042***
	(-11.250)	(-11.009)	(-11.306)	(-10.190)
TTM	-0.000	-0.001	-0.001	-0.001
	(-0.730)	(-1.480)	(-1.386)	(-0.860)
Turnover	-0.070	2.911***	-0.062	2.997***
	(-1.139)	(7.650)	(-1.020)	(7.868)
Callable	-0.084***	-0.080***	-0.090***	-0.072***
	(-7.246)	(-6.669)	(-7.788)	(-5.982)
Covenant	-0.266***	-0.274***	-0.259***	-0.254***
	(-18.323)	(-18.397)	(-17.067)	(-16.321)
N	75,342	72,513	75,342	72,513
Pseudo R^2	0.0591	0.0624	0.0574	0.0641

Table 7. Impact of Rating Change on Bond Return Synchronicity

This table reports OLS estimates of bond return synchronicity on credit rating change. The sample is from 2002 to 2015 covering 88,570 bond-year observations. The dependent variable is bond return synchronicity estimated from the standard market model, where the market-wide bond index return is the issue size value weighted bond return including all the sample bonds. One main independent variable of interest, *Change*, is a dummy that equals one if the bond has been assigned with rating change announcements by the rating agency in the year, otherwise zero. Another is the logarithm transformation of *Intensity* which denotes the total number of credit rating change announcements for the bond in a given year. *AfterInitial* is a dummy that equals one if the bond has already went through the very first rating change in our sample, otherwise zero. *Rank* refers to the cumulative number of years when the bond's rating has been changed by the rating agency. *OnWatch* is a dummy that equals one if the bond has been put on the credit watch list by the rating agency during the year when rating changed. *Rating* is the numerical rating for a bond, ranging from 1 to 22 (AAA–D) based on Moody's, if not accessible, then use S&P's. *log(Size)* is the logarithm transformation of the bond issue size in billion dollars. *Age* is the number of years since the bond issuance. *TTM* is the bond's time to maturity in years. *Coupon* denotes bond interest payment, in percentage of the par value. *Turnover* is the ratio of bond's total trading volume in a year over the issue size scaled by 100. *Callable* is a dummy variable that takes the value of one if the bond is callable, and zero otherwise. *Covenant* is a dummy variable that equals one when the bond has any covenant constraints. Industry and year fixed effects are included in all regressions. Robust t-statistics with clustered standard errors by issuer-level are reported in parentheses. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

	Dependent Variable: Return Synchronicity			
Variable	**(1)**	**(2)**	**(3)**	**(4)**
Intercept	-3.986***	-5.946***	-3.989***	-5.970***
	(-5.830)	(-7.912)	(-5.811)	(-7.888)
Change	-0.136***	-0.259***		
	(-3.292)	(-4.603)		
log(1+Intensity)			-0.138**	-0.208***
			(-2.208)	(-3.277)
AfterInitial		-0.192***		-0.178***
		(-5.160)		(-4.714)
Rank		0.109***		0.077***
		(3.570)		(3.261)
OnWatch		0.416***		0.415***
		(7.516)		(8.346)
Rating		-0.058***		-0.057***
		(-8.202)		(-7.936)
Age		-0.081***		-0.080***
		(-11.380)		(-11.377)
TTM		0.037***		0.037***
		(15.045)		(15.135)
log(Size)		0.368***		0.369***
		(15.887)		(15.986)
Turnover		0.314*		0.314*
		(1.898)		(1.910)
Coupon		-0.013		-0.015
		(-1.105)		(-1.263)
Callable		0.023		0.029
		(0.445)		(0.569)
Covenant		-0.028		-0.029
		(-0.605)		(-0.628)
Year FE	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES
N	88,570	88,570	88,570	88,570
Adj R^2	0.056	0.171	0.056	0.171

Table 8. Impact of Rating Change Directions on Bond Return Synchronicity

This table reports the OLS estimates of bond return synchronicity on different credit rating change directions. Regressions are conducted separately for subsamples comprising of rating change years under specified directions and non-change bond-year observations. Column (1) examines the effect of upgraded credit change on bond return synchronicity, column (2) examines the effect of rating downgrades on bond return synchronicity, and column (3) investigates the effect of rating changes when upgrades and downgrades that coexist in the year. The dependent variable is bond return synchronicity estimated from the standard market model, where the market-wide bond index return is the issue size value weighted bond return including all the sample bonds. *Up* is a dummy variable that equals one if only rating upgrade announcements are observed the bond during the year, otherwise zero. *Down* is a dummy variable which takes the value of one if all rating announcements are downgrades for the bond in a year. *Mix* is a dummy variable representing both upgrades and downgrades changes take place within a given bond-year. The rest of the independent variables are defined in Table 7. Industry and year fixed effects are included in all regressions. Robust t-statistics with clustered standard errors by issuer-level are reported in parentheses. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

	Dependent Variable: Synchronicity		
Variable	**(1)**	**(2)**	**(3)**
Intercept	-6.181***	-5.647***	-5.899***
	(-6.390)	(-8.536)	(-9.006)
Up	-0.158***		
	(-2.879)		
Down		-0.402***	
		(-4.131)	
Mix			-0.627*
			(-1.797)
AfterInitial	-0.213***	-0.194***	-0.206***
	(-5.679)	(-5.226)	(-5.603)
Rank	0.069***	0.180***	0.184
	(2.583)	(3.426)	(0.897)
OnWatch	0.383***	0.453***	0.360***
	(8.181)	(7.010)	(8.392)
Rating	-0.055***	-0.060***	-0.058***
	(-7.454)	(-9.176)	(-8.699)
Age	-0.081***	-0.083***	-0.084***
	(-10.669)	(-12.597)	(-12.439)
TTM	0.040***	0.037***	0.040***
	(17.109)	(14.601)	(17.036)
log(Size)	0.403***	0.371***	0.412***
	(19.863)	(15.767)	(19.626)
Turnover	0.319*	0.302*	0.315*
	(1.956)	(1.741)	(1.820)
Coupon	-0.016	-0.006	-0.007
	(-1.317)	(-0.489)	(-0.639)
Callable	-0.002	0.011	-0.028
	(-0.037)	(0.220)	(-0.516)
Covenant	-0.026	-0.041	-0.042
	(-0.576)	(-0.859)	(-0.900)
Year FE	YES	YES	YES
Industry FE	YES	YES	YES
N	74,252	79,197	65,739
Adj R^2	0.186	0.176	0.193

Table 9: 2SLS for Impact of Rating Change on Bond Return Synchronicity

This table reports 2SLS estimates for the impact of credit rating change on bond return synchronicity. The sample is from 2002 to 2015, covering 88,570 bond-year observations. The dependent variable in the first stage for the probit model is *Change*, a dummy that equals one if the bond has been assigned with rating change announcements by the rating agency in the year, otherwise zero. Another dependent variable in the first stage of OLS model is the *Intensity* which denotes the total number of credit rating change announcements for the bond in a given year. The dependent variable in the second stage is bond return synchronicity estimated from the standard market model, where the market-wide bond index return is the issue size value weighted bond return including all the sample bonds. The rest of the independent variables are defined in Table 7. Industry and year fixed effects are included in all regressions. z-statistics are reported in parentheses. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

Variable	**Change Dummy**		**Change Intensity**	
	First Stage	Second Stage	First Stage	Second Stage
Intercept	-0.910**	-5.566***	0.296	-5.939***
	(-2.061)	(-8.383)	(1.455)	(-8.369)
Change		-1.498***		
		(-9.252)		
Intensity				-1.568***
				(-8.455)
AfterInitial	0.143***		0.114***	
	(12.776)		(22.258)	
Crisis	0.225***		0.202***	
	(3.230)		(6.091)	
Rank		0.471***		
		(9.414)		
OnWatch		0.710***		1.903***
		(16.022)		(10.420)
Rating	0.051***	-0.071***	0.027***	-0.016***
	(34.321)	(-26.895)	(40.078)	(-3.066)
Age	0.006***	-0.104***	0.001**	-0.071***
	(3.944)	(-36.554)	(2.064)	(-27.305)
TTM	-0.001	0.036***	-0.001**	0.034***
	(-1.061)	(42.915)	(-2.284)	(34.231)
log(Size)	-0.042***	0.354***	-0.020***	0.347***
	(-10.154)	(55.326)	(-10.589)	(48.848)
Turnover	-0.039	0.344***	-0.016	0.289***
	(-0.644)	(3.924)	(-0.597)	(3.070)
Coupon	0.030***	0.006	0.006***	-0.000
	(9.421)	(1.085)	(4.121)	(-0.025)
Callable	0.039***	-0.046**	0.055***	0.093***
	(3.003)	(-2.218)	(9.356)	(4.248)
Covenant	-0.148***	-0.002	-0.068***	-0.090***
	(-9.578)	(-0.105)	(-9.703)	(-3.465)
Year FE	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES
N	88,462	88,462	88,570	88,570
Adj (Pseudo) R^2	0.0814	0.150	0.146	0.025

Table 10. Robustness for the Model Specifications Adding Firm Fixed Effects

This table reports robustness tests considering firm fixed effects. The sample covers 88,570 bond-year observations, spanning from 2002 to 2015. The dependent variable is bond return synchronicity estimated from the standard market model, where the market-wide bond index return is the issue size value weighted bond return including all the sample bonds. *IVgrade* is the investment-grade dummy variable indicating whether the bond belongs to investment-grade category. *Split* is the dummy variable indicating whether there is rating difference between Moody's and S&P's. *PublicIssuer* is the public issuer dummy variable which takes the value of one if the issuer is a public listed firm and zero otherwise.*Change*, is a dummy that equals one if the bond has been assigned with rating change announcements by the rating agency in the year, otherwise zero. *log(Intensity)* is the logarithm transformation of the total number of credit rating change announcements for the bond in a given year. *Up* is a dummy variable that equals one if only rating upgrade announcements are observed the bond during the year, otherwise zero. *Down* is a dummy variable which takes the value of one if all rating announcements are downgrades for the bond in a year. *Mix* is a dummy variable representing both upgrades and downgrades changes take place within a given bond-year. The rest of the variables are defined as in Table 7. Firm and year fixed effects are included in all regressions. Robust t-statistics with clustered standard errors by issuer-level are reported in parentheses. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

Panel A: Robustness for Determinants of Bond Return Synchronicity

	Dependent Variable: Bond Return Synchronicity						
Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Intercept	-4.191***	-5.610***	-3.879***	-5.427***	-4.144***	-5.629***	-5.542***
	(-22.218)	(-12.147)	(-23.078)	(-12.064)	(-23.837)	(-13.226)	(-11.201)
IVgrade	0.296***	0.056					0.017
	(2.660)	(0.474)					(0.131)
Split			-0.146***	-0.132***			-0.130***
			(-3.391)	(-3.229)			(-3.124)
PublicIssuer					0.364***	0.166**	0.158**
					(5.440)	(2.530)	(2.370)
Rating		-0.029*		-0.028*		-0.033**	-0.027
		(-1.799)		(-1.811)		(-2.145)	(-1.640)
Age		-0.125***		-0.121***		-0.124***	-0.120***
		(-22.548)		(-22.216)		(-22.556)	(-22.017)
TTM		0.037***		0.038***		0.037***	0.038***
		(14.636)		(14.287)		(14.623)	(14.273)
log(Size)		0.236***		0.231***		0.237***	0.231***
		(4.052)		(3.763)		(4.058)	(3.767)
Turnover		0.389		1.187		0.384	1.172
		(1.611)		(1.086)		(1.598)	(1.084)
Coupon		0.020*		0.020*		0.021*	0.020*
		(1.726)		(1.657)		(1.778)	(1.676)
Callable		-0.092		-0.147**		-0.093	-0.147**
		(-1.257)		(-1.980)		(-1.260)	(-1.971)
Covenant		0.048		0.022		0.046	0.022
		(0.879)		(0.391)		(0.854)	(0.382)
Year FE	YES	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES	YES
N	88,570	88,570	82,121	82,121	88,570	88,570	82,121
Adj R^2	0.027	0.084	0.027	0.083	0.027	0.084	0.083

Panel B: Robustness for Impact of Rating Change on Bond Return Synchronicity

	Dependent Variable: Bond Return Synchronicity				
Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
Intercept	-5.726***	-5.734***	0.041	0.046	0.028
	(-13.938)	(-14.038)	(0.716)	(0.833)	(0.464)
Change	-0.188***				
	(-3.535)				
log(1+Intensity)		-0.176***			
		(-2.662)			
Up			-0.176***		
			(-3.384)		
Down				-0.261***	
				(-3.052)	
Mix					-0.595*
					(-1.943)
AfterInitial	-0.194***	-0.180***	-0.223***	-0.220***	-0.224***
	(-4.884)	(-4.277)	(-6.409)	(-5.592)	(-6.049)
Rank	0.075**	0.057**	0.046**	0.130***	0.206
	(2.400)	(2.324)	(1.992)	(2.686)	(1.170)
OnWatch	0.340***	0.343***	0.329***	0.357***	0.321***
	(6.016)	(6.900)	(7.738)	(5.314)	(7.493)
Rating	-0.028*	-0.028**	0.329***	0.357***	0.321***
	(-1.960)	(-2.036)	(7.738)	(5.314)	(7.493)
Age	-0.115***	-0.115***	-0.022	-0.029**	-0.029**
	(-16.687)	(-16.900)	(-1.636)	(-2.102)	(-2.440)
TTM	0.036***	0.036***	-0.119***	-0.114***	-0.118***
	(14.559)	(14.622)	(-19.872)	(-15.941)	(-18.749)
log(Size)	0.240***	0.240***	0.039***	0.035***	0.039***
	(4.101)	(4.095)	(17.167)	(14.012)	(16.808)
Turnover	0.376	0.374	0.281***	0.242***	0.293***
	(1.626)	(1.603)	(4.800)	(3.985)	(4.752)
Coupon	0.023**	0.023**	0.378*	0.427*	0.435**
	(2.077)	(2.041)	(1.781)	(1.790)	(1.999)
Callable	-0.092	-0.090	0.026**	0.033***	0.035***
	(-1.248)	(-1.245)	(2.497)	(2.800)	(3.216)
Covenant	0.051	0.051	-0.136*	-0.079	-0.127*
	(0.957)	(0.956)	(-1.935)	(-1.032)	(-1.760)
Year FE	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES
N	88,570	88,570	74,252	79,197	65,739
Adj R^2	0.088	0.087	0.100	0.089	0.103

Table 11. Robustness for the Sample Aggregated at Firm Level

This table reports robustness tests for sample aggregated at firm-year level. The aggregated firm sample in total covers 24,095 observations. The dependent variable is the firm's bond return synchronicity estimated from the standard market model, where the firm's return is the issue size value weighted average bond return including all bonds outstanding for the firm, and the market-wide bond index return is the issue size value weighted bond return including all the sample bonds. *IVgrade* is the investment-grade dummy variable indicating whether the firm belongs to investment-grade category. *Split* is the dummy variable indicating whether there is any bond issued by the firm bears different ratings between Moody's and S&P's. *PublicIssuer* is the public issuer dummy variable which takes the value of one if the firm is public listed and zero otherwise. *Change*, is a dummy that equals one if any rating change announcement has been assigned by the rating agency for the outstanding bonds of the firm in the year, otherwise zero. *log(Intensity)* is the logarithm transformation of the total number of dates when the firm has been assigned with credit rating change announcements throughout a given year. *Up* is a dummy variable that equals one if only rating upgrade announcements are observed for all the outstanding bonds of the firm during the year, otherwise zero. *Down* is a dummy variable which takes the value of one if all rating announcements are downgrades for the firm in a year. *Mix* is a dummy variable representing both upgrades and downgrades changes take place within a given firm-year. *AfterInitial* is a dummy that equals one if at least one bond issued by the firm has already undergone the very first rating change in our sample, otherwise zero. *Rank* refers to the cumulative number of years when the firm has experienced rating changes. *OnWatch* is a dummy that equals one if any bond of the firm has been put on the credit watch list by the rating agency during the year when rating changed. Characteristics at firm-level as *Rating*, *Age*, *TTM*, *Size*, *Coupon* and *Turnover* are defined as the issue size value weighted average of all the outstanding bonds. *Callable* is a dummy variable that takes the value of one if at least one bond of the firm is callable, and zero otherwise. *Covenant* is a dummy variable that equals one when at least one bond of the firm has covenant constraints. Industry and year fixed effects are included in all regressions. Robust t-statistics with clustered standard errors by issuer-level are reported in parentheses. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

Panel A: Robustness for Determinants of Bond Return Synchronicity

	Dependent Variable: Bond Return Synchronicity						
Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Intercept	-4.627***	-7.908***	-4.110***	-7.405***	-4.239***	-7.516***	-7.767***
	(-8.947)	(-11.097)	(-6.214)	(-10.397)	(-6.127)	(-10.514)	(-10.885)
Ivgrade	0.936***	0.267***					0.240***
	(18.908)	(4.629)					(4.101)
Split			-0.162***	-0.054*			-0.041
			(-4.132)	(-1.811)			(-1.370)
PublicIssuer					0.436***	0.001	0.016
					(8.188)	(0.032)	(0.433)
Rating		-0.048***		-0.069***		-0.073***	-0.048***
		(-6.426)		(-10.981)		(-12.878)	(-6.052)
Age		-0.064***		-0.059***		-0.062***	-0.061***
		(-13.122)		(-11.344)		(-12.853)	(-11.542)
TTM		0.029***		0.030***		0.029***	0.029***
		(9.596)		(9.452)		(9.575)	(9.464)
log(Size)		0.661***		0.667***		0.662***	0.666***
		(39.084)		(40.376)		(38.963)	(40.431)
Turnover		0.299		15.041***		0.310	14.737***
		(1.516)		(4.432)		(1.543)	(4.442)
Coupon		0.021*		-0.004		0.018	0.001
		(1.829)		(-0.286)		(1.560)	(0.048)
Callable		-0.189***		-0.233***		-0.177***	-0.244***
		(-3.497)		(-4.197)		(-3.280)	(-4.387)
Covenant		-0.043		-0.069		-0.041	-0.075
		(-0.782)		(-1.214)		(-0.726)	(-1.294)
Year FE	YES	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES	YES
N	24,095	24,095	22,873	22,873	24,095	24,095	22,873
Adj R^2	0.084	0.261	0.058	0.274	0.061	0.260	0.274

Panel B: Robustness for Impact of Rating Change on Bond Return Synchronicity

	Dependent Variable: Bond Return Synchronicity				
Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
Intercept	-7.571***	-7.564***	-7.616***	-7.325***	-7.411***
	(-10.447)	(-10.417)	(-8.064)	(-11.311)	(-11.194)
Change	-0.133***				
	(-2.678)				
log(Intensity)		-0.176***			
		(-2.934)			
Up			-0.070		
			(-1.031)		
Down				-0.181***	
				(-2.674)	
Mix					-0.673**
					(-2.475)
AfterInitial	-0.108***	-0.107***	-0.110***	-0.095***	-0.111***
	(-3.157)	(-3.149)	(-2.981)	(-2.635)	(-2.868)
Rank	0.019	0.019	0.016	0.022	0.126
	(1.087)	(1.169)	(0.742)	(0.877)	(1.593)
OnWatch	0.138***	0.148***	0.153***	0.181***	0.202***
	(3.540)	(3.737)	(3.182)	(4.145)	(3.736)
Rating	-0.070***	-0.069***	-0.073***	-0.071***	-0.073***
	(-12.151)	(-12.128)	(-11.914)	(-11.445)	(-11.257)
Age	-0.060***	-0.060***	-0.064***	-0.062***	-0.066***
	(-12.154)	(-12.166)	(-12.071)	(-12.021)	(-12.093)
TTM	0.029***	0.029***	0.031***	0.028***	0.030***
	(9.497)	(9.509)	(9.940)	(8.903)	(9.011)
log(Size)	0.664***	0.664***	0.668***	0.666***	0.674***
	(38.145)	(38.197)	(36.628)	(36.064)	(35.099)
Turnover	0.303	0.304	0.275	0.300	0.272
	(1.513)	(1.512)	(1.535)	(1.538)	(1.579)
Coupon	0.020*	0.020*	0.024*	0.025**	0.032**
	(1.721)	(1.754)	(1.938)	(2.065)	(2.457)
Callable	-0.176***	-0.176***	-0.215***	-0.178***	-0.242***
	(-3.289)	(-3.284)	(-3.748)	(-3.160)	(-3.974)
Covenant	-0.041	-0.042	-0.049	-0.021	-0.015
	(-0.744)	(-0.757)	(-0.834)	(-0.352)	(-0.238)
Year FE	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES
N	24,095	24,095	20,285	20,914	17,638
Adj R^2	0.261	0.261	0.264	0.265	0.266

Table 12. Robustness for the Sample with Trading Frequency Requirement

This table reports robustness tests when the bond return synchronicity is estimated based on the bond-year sample requiring at least 100 daily return observations per year. The sample covers 47,485 bond-year observations, spanning from 2002 to 2015. The dependent variable is bond return synchronicity estimated from the standard market model, where the market-wide bond index return is the issue size value weighted bond return including all the sample bonds. *IVgrade* is the investment-grade dummy variable indicating whether the bond belongs to investment-grade category. *Split* is the dummy variable indicating whether there is rating difference between Moody's and S&P's. *PublicIssuer* is the public issuer dummy variable which takes the value of one if the issuer is a public listed firm and zero otherwise.*Change*, is a dummy that equals one if the bond has been assigned with rating change announcements by the rating agency in the year, otherwise zero. *log(Intensity)* is the logarithm transformation of the total number of credit rating change announcements for the bond in a given year. *Up* is a dummy variable that equals one if only rating upgrade announcements are observed the bond during the year, otherwise zero. *Down* is a dummy variable which takes the value of one if all rating announcements are downgrades for the bond in a year. *Mix* is a dummy variable representing both upgrades and downgrades changes take place within a given bond-year. The rest of the variables are defined as in Table 7. Industry and year fixed effects are included in all regressions. Robust t-statistics with clustered standard errors by issuer-level are reported in parentheses. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

Panel A: Robustness for Determinants of Bond Return Synchronicity

	Dependent Variable: Bond Return Synchronicity						
Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Intercept	-6.023***	-10.735***	-5.740***	-9.967***	-5.914***	-10.131***	-10.537***
	(-12.869)	(-14.856)	(-13.139)	(-13.297)	(-11.864)	(-13.204)	(-14.904)
IVgrade	0.883***	0.438***					0.403***
	(12.943)	(7.086)					(6.294)
Split			-0.226***	-0.054*			-0.039
			(-4.797)	(-1.779)			(-1.269)
PublicIssuer					0.365***	0.070*	0.091***
					(5.457)	(1.956)	(2.580)
Rating		-0.023**		-0.050***		-0.060***	-0.016***
		(-2.233)		(-5.855)		(-7.467)	(-1.526)
Age		-0.111***		-0.105***		-0.108***	-0.107***
		(-20.177)		(-18.369)		(-19.300)	(-19.137)
TTM		0.045***		0.049***		0.046***	0.048***
		(18.592)		(18.119)		(18.584)	(18.003)
log(Size)		0.690***		0.683***		0.692***	0.680***
		(25.078)		(24.287)		(24.481)	(24.639)
Turnover		0.850***		1.958		0.837***	1.870
		(5.682)		(1.636)		(5.393)	(1.643)
Coupon		0.021*		-0.004		0.017	0.007
		(1.869)		(-0.325)		(1.468)	(0.549)
Callable		0.035		0.006		0.053	-0.010
		(0.653)		(0.114)		(0.989)	(-0.181)
Covenant		-0.015		-0.018		-0.038	-0.054
		(-0.299)		(-0.357)		(-0.729)	(-1.049)
Year FE	YES	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES	YES
N	47,485	47,485	44,114	44,114	47,485	47,485	44,114
Adj R^2	0.116	0.288	0.097	0.286	0.096	0.286	0.288

Panel B: Robustness for Impact of Rating Change on Bond Return Synchronicity

	Dependent Variable: Bond Return Synchronicity				
Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
Intercept	-10.171***	-10.202***	-11.932***	-10.927***	-10.776***
	(-12.557)	(-12.364)	(-47.863)	(-14.506)	(-7.992)
Change	-0.275***				
	(-4.892)				
log(1+Intensity)		-0.200***			
		(-2.866)			
Up			-0.178**		
			(-2.072)		
Down				-0.419***	
				(-5.516)	
Mix					-0.608*
					(-1.906)
AfterInitial	-0.158***	-0.144***	-0.191***	-0.149***	-0.173***
	(-4.887)	(-4.434)	(-6.001)	(-4.287)	(-5.325)
Rank	0.096***	0.057**	0.072	0.150***	0.260
	(3.177)	(2.077)	(1.560)	(3.756)	(1.521)
OnWatch	0.417***	0.408***	0.309***	0.496***	0.314***
	(6.544)	(6.769)	(6.457)	(6.896)	(6.479)
Rating	-0.060***	-0.059***	-0.057***	-0.060***	-0.057***
	(-8.827)	(-8.426)	(-7.513)	(-8.559)	(-8.393)
Age	-0.104***	-0.103***	-0.102***	-0.105***	-0.103***
	(-17.853)	(-17.557)	(-17.471)	(-17.528)	(-17.662)
TTM	0.045***	0.045***	0.048***	0.045***	0.049***
	(18.219)	(18.317)	(19.623)	(18.523)	(20.480)
log(Size)	0.692***	0.692***	0.738***	0.704***	0.764***
	(26.442)	(26.226)	(31.207)	(27.895)	(34.820)
Turnover	0.834***	0.831***	0.857***	0.848***	0.888***
	(5.955)	(5.826)	(6.949)	(5.949)	(6.980)
Coupon	0.022**	0.020*	0.019*	0.026**	0.025**
	(1.997)	(1.771)	(1.703)	(2.361)	(2.353)
Callable	0.041	0.048	0.023	0.022	-0.013
	(0.850)	(0.966)	(0.439)	(0.457)	(-0.237)
Covenant	-0.004	-0.005	0.024	-0.014	0.014
	(-0.082)	(-0.108)	(0.491)	(-0.291)	(0.287)
Year FE	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES
N	47,485	47,485	39,731	42,589	35,347
Adj R^2	0.290	0.290	0.306	0.296	0.314

Table 13. Robustness for the Synchronicity Using Merrill Lynch Index

This table reports the robustness tests when the bond return synchronicity is estimated from the market model where market index is using Merrill Lynch Corporate Bond Master Index, whose constituents only are investment-grade bonds. Our sample therefore restricts to investment-graded bonds and covers 61,497 bond-year observations, spanning from 2002 to 2015. *Split* is the dummy variable indicating whether there is rating difference between Moody's and S&P's. *PublicIssuer* is the public issuer dummy variable which takes the value of one if the issuer is a public listed firm and zero otherwise. *Change*, is a dummy that equals one if the bond has been assigned with rating change announcements by the rating agency in the year, otherwise zero. *log(Intensity)* is the logarithm transformation of the total number of credit rating change announcements for the bond in a given year. *Up* is a dummy variable that equals one if only rating upgrade announcements are observed the bond during the year, otherwise zero. *Down* is a dummy variable which takes the value of one if all rating announcements are downgrades for the bond in a year. *Mix* is a dummy variable representing both upgrades and downgrades changes take place within a given bond-year. The rest of the variables are defined as in Table 7. Industry and year fixed effects are included in all regressions. Robust t-statistics with clustered standard errors by issuer-level are reported in parentheses. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

Panel A: Robustness for Determinants of Bond Return Synchronicity

	Dependent Variable: Bond Return Synchronicity				
Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
Intercept	-6.537***	-8.183***	-6.672***	-8.158***	-8.092***
	(-35.129)	(-29.436)	(-38.110)	(-30.121)	(-28.776)
Split	-0.182***	-0.138***			-0.128***
	(-3.500)	(-3.723)			(-3.450)
PublicIssuer			0.570***	0.169***	0.175***
			(8.873)	(4.129)	(4.344)
Rating		-0.077***		-0.084***	-0.080***
		(-8.503)		(-8.893)	(-8.730)
Age		-0.105***		-0.097***	-0.103***
		(-14.187)		(-8.562)	(-13.997)
TTM		0.039***		0.039***	0.039***
		(14.274)		(14.170)	(14.187)
log(Size)		0.313***		0.330***	0.307***
		(10.378)		(11.391)	(10.127)
Turnover		6.512		5.852*	6.263
		(1.610)		(1.753)	(1.563)
Coupon		0.006		-0.011	0.009
		(0.338)		(-0.455)	(0.507)
Callable		-0.056		-0.011	-0.062
		(-0.904)		(-0.168)	(-0.994)
Covenant		0.046		-0.039	-0.015
		(0.915)		(-0.735)	(-0.292)
Year FE	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES
N	61,497	61,497	66,059	66,059	61,497
Adj R^2	0.068	0.170	0.074	0.175	0.170

Panel B: Robustness for Impact of Rating Change on Bond Return Synchronicity

	Dependent Variable: Bond Return Synchronicity				
Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
Intercept	-8.241***	-8.275***	-8.669***	-8.196***	-8.717***
	(-30.139)	(-30.673)	(-31.735)	(-29.800)	(-30.936)
Change	-0.474***				
	(-4.560)				
log(1+Intensity)		-0.611***			
		(-5.207)			
Up			-0.029		
			(-0.423)		
Down				-0.768***	
				(-5.383)	
Mix					-1.140***
					(-2.712)
AfterInitial	-0.291***	-0.277***	-0.259***	-0.288***	-0.255***
	(-7.748)	(-7.121)	(-6.101)	(-7.856)	(-6.202)
Rank	0.160**	0.150***	0.035	0.233**	0.224
	(2.421)	(2.793)	(1.166)	(2.540)	(0.949)
OnWatch	0.190***	0.242***	0.331***	0.252***	0.392***
	(3.319)	(4.704)	(8.429)	(4.191)	(8.402)
Rating	-0.078***	-0.075***	-0.072***	-0.084***	-0.074***
	(-8.746)	(-8.037)	(-7.850)	(-9.238)	(-8.084)
Age	-0.089***	-0.089***	-0.092***	-0.092***	-0.093***
	(-8.068)	(-8.075)	(-7.409)	(-9.240)	(-8.699)
TTM	0.038***	0.038***	0.041***	0.037***	0.040***
	(13.926)	(13.915)	(15.306)	(13.217)	(14.683)
log(Size)	0.332***	0.331***	0.399***	0.329***	0.404***
	(12.077)	(12.116)	(16.618)	(12.131)	(16.758)
Turnover	5.789*	6.018*	6.261*	5.777*	6.155*
	(1.748)	(1.749)	(1.703)	(1.698)	(1.683)
Coupon	-0.002	-0.002	0.003	0.003	0.006
	(-0.081)	(-0.108)	(0.144)	(0.159)	(0.278)
Callable	-0.014	-0.007	-0.063	-0.012	-0.050
	(-0.241)	(-0.118)	(-1.094)	(-0.204)	(-0.897)
Covenant	0.006	0.005	-0.020	-0.006	-0.032
	(0.104)	(0.102)	(-0.387)	(-0.122)	(-0.613)
Year FE	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES
N	66,059	66,059	55,985	61,162	51,462
Adj R^2	0.178	0.179	0.191	0.181	0.193