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Cheng-Few Lee and Min-Teh Yu

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INFORMATION RISK IN THE CORPORATE BOND MARKET

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ABSTRACT

This chapter studies the effect of information risk on the expected returns of corporate bonds. The measurement for the information risk is based on the microstructure framework—the probability of information-based trading (PIN). The authors find a significantly positive relation between expected corporate bond returns and information risk, controlling for the effects of other liquidity levels and bond characteristics. This relation is robust to using a variety of informed trading proxies and information risk measures, and controlling for ratings, debt crisis, and different sample periods. The authors' results strongly suggest that information risk is an important determinant of expected corporate bond returns.

Keywords: Information risk; informed trading; bond asset pricing; maturity; ratings

JEL Classification: G12; G13

1. INTRODUCTION

Information risk arises from information asymmetry between counterparties. Market microstructure literature provides structural models to show the process by which information is incorporated into prices. Easley et al. (2002) developed a model to show that information-based trading affects asset pricing. Empirically, the effect of informed trading has been studied for the equity and treasury markets. The information risk issue is considerably underexplored in the corporate bond market. Our paper attempts to fill this gap. The corporate bond market is an over-the-counter (OTC) market, in which transaction data are less

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transparent than the equity market, which can aggravate information asymmetry. In this paper, we investigate the information risk in the corporate bond market based on the microstructure model.

Information risk matters for asset pricing and trading decisions. An uninformed investor has a disadvantage relative to traders with better information and may thus require compensation for this risk. Morck et al. (2000) suggest that the information content of stock markets includes market-level and firm-level information. Easley et al. (2002) argue that private information influences price evolution, and their work sheds light on the effect of this price process. They propose a measure of the information risk, PIN, as the probability of information-based trading variable, and show that this risk variable dominates all other variables, including market β, in explaining returns. Easley et al. (2010) show that the PIN factor explains the premium of the Pástor–Stambaugh liquidity factor and the Amihud illiquidity factor. Fu (2009) shows that idiosyncratic volatility stems from a lack of information disclosure among firms with poor earnings prospects and is positively related to expected returns. The private information in the treasury bond market arises from heterogeneous interpretations of macroeconomic information, such as fiscal deficits, inflation expectations, GDP growth, and money supply. Li et al. (2009) examine the effect of information risk in the treasury bond market. They show a strong positive relation between expected treasury bond returns and information risk, which is robust to controlling for bond characteristics.

The literature shows that the mechanism of information incorporation in the corporate bond market is similar to the stock market in that it is driven by the common information flow and is driven by similar underlying fundamentals. Fleming et al. (1998) investigate the strong linkage between stock and bond markets, stating that each market is influenced by macroeconomic information and the characteristics of these markets. Hand and Holthausen (1992) find that stock and bond price effects are also observed for the bond rating agency downgrade or upgrade announcements. However, the investors in the corporate bond market are mainly institutional investors, which can lead to different effects. The information, such as firm-specific information and macroeconomic information, would affect the default risk, interest rate risk, inflation risk, liquidity risk, and call risk, thus affecting the trading behavior of the investors. Han and Zhou (2009) suggest that informed trading in the corporate bond market stems from its institutional nature. Some institutional investors have information advantages to get insider information by their privilege. Ivashina and Sun (2011) provide evidence that supports this argument. They find that institutional investors have access to firm-specific insider information, such as updated growth projections, covenant negotiations, and merger or divestiture plans, by meeting with the issuer or acquiring more information than other investors as the syndicated loan lender. Of course, institutional investors are better able to interpret public information than others. Ludvigson and Ng (2009) find that macroeconomic information is included in forecasts of excess bond returns. Jiang et al. (2023) document that macroeconomic news affects the asset pricing of corporate bonds.[1]

Due to the unique characteristics of corporate bonds, it is difficult for bonds to be traded on exchanges with standard contracts. Moreover, corporate bond prices are affected not only by issuers' characteristics but also by interest rates and credit ratings. Corporate bonds are traded OTC in the secondary market rather than on exchanges. Furthermore, transactions are often opaque to the investors, as the dissemination of pricing information is more limited for the corporate bond market than the equity market. US bond markets are becoming increasingly transparent because the National Association of Securities Dealers (NASD) requires dealers to report all OTC bond transactions through the Trade Reporting and Compliance Engine (TRACE) reporting system. Dissemination of the corporate bond market took place in. Bessembinder et al. (2006) and Edwards et al. (2007) find a reduction in transaction costs with the establishment of the TRACE system, and public traders benefit from price transparency. The transparency of corporate bond trading activity helps reduce price dispersion (Asquith et al. 2013). Price transparency makes the order flow information available to the investors and affects their trading behavior. Importantly, TRACE provides a microstructure database to help investors evaluate the information risk in the corporate bond market.

This paper provides a comprehensive empirical analysis of the effect of information risk on expected corporate bond returns using an extensive transaction data sample. We apply the TRACE database to acquire the price, yield, trade, and volume of each transaction of the corporate bond. Then, we merge the transaction data with the Fixed Investment Securities Database (FISD) database to obtain information for the rating, coupon, size, and age of the bond. We estimate information risk PIN (the probability of information-based trading), suggested by the Easley, Hvidkjaer and O'Hara (EHOH) model (Easley et al. 2002). Using the cross-section regression methodology of Fama and MacBeth (1973), we examine the effect of information risk on the pricing of corporate bonds.

The empirical results strongly support the hypothesis that information risk is priced in the corporate bond market. First, our results show that information risk, measured by PIN, plays an important role in corporate bond pricing after controlling for the effects of other risk factors, liquidity, and bond characteristics. Prior studies have recognized that the information risk affects the equity market and treasury market. Our study presents the first evidence that information risk is priced in the corporate bond market. The coefficients of PIN estimated by Fama–MacBeth or Litzenberger–Ramaswamy regressions are both positive and significant at the 1% level. The effect of information risk is of economic significance. Based on the information risk coefficient estimated by the Litzenberger–Ramaswamy (Fama–MacBeth) regression, a one standard deviation change in information risk is associated with a change in an excess return of 11 (5) basis points per month, which accounts for about 21% (9.4%) of the average monthly corporate bond excess returns, which is economically meaningful and significant. The results strongly suggest that information risk is priced in the corporate bond market.

Second, we explore the effect of the information risk for bonds with different characteristics, such as ratings, issue size, and time delay in information dissemination. The empirical evidence shows that information risk is priced in all different kinds of bonds. Third, this result is robust to different empirical specifications of the corporate bond pricing model and various proxies for the information risk. Overall, the evidence suggests that the information risk effect on corporate bond pricing is robust, indicating that it is an important determinant of expected corporate bond returns.

Our paper contributes to the literature on corporate bond pricing. First, we estimate the information risk in the corporate bond market based on the informed trading measured by the EHOH model (Easley et al. 2002). Second, we show that the information risk explains the expected corporate bond return in the cross-section, and this explanatory power is robust to controlling for conventional risk factors, expected liquidity, and bond characteristics. Third, we find that the informed trading risk varies with different phases of trading information dissemination in the corporate bond market.

The remainder of the paper is organized as follows: Section 2 describes the data and measurement of the information risk. Section 3 examines whether information risk is priced in the cross-section of individual corporate bond returns. Section 4 further provides the evidence with alternative information risk measures, portfolio analysis based on corporate bond rating, and debt crisis for the robustness tests. Section 5 concludes.

2. DATA AND ESTIMATION OF INFORMATION RISK

2.1 Data

Our data mainly come from two sources: TRACE and the FISD. TRACE provides transaction data in the corporate bond market. The bond-specific characteristic information comes from the FISD database.

In an effort to increase price transparency in the US corporate bond market, the NASD required the dealers to report secondary market transactions by TRACE in July 2002. The TRACE system captures all OTC market activity in publicly traded TRACE-eligible securities (investment grade, high yield, and convertible corporate debt). We collect the data for price, execution date, execution time, quantity, and identification of buy or sell trade. Dissemination of trading information took place in phases, with actively traded, investment-grade bonds becoming transparent before thinly traded, high-yield bonds. On July 1, 2002 (Phase 1), FINRA introduced TRACE, including Investment Grade TRACE-eligible bonds with an initial issue of $1 billion or greater. On March 3, 2003 (Phase 2), transactions of all Investment Grade TRACE-eligible bonds with at least $100 million par value (original issue size) or rated A or higher are reported on the TRACE system. On October 1, 2004 (Phase 3), the dissemination of bond transactions extends to all bonds that are not eligible for delayed dissemination. Up until July 1, 2005, all bond transactions were reported with a 15-minute delay. TRACE started to report transactions immediately upon

trading on January 9, 2006. The transparency of corporate bond trading activity helps reduce price dispersion in the bond market (Asquith et al., 2013).

The FISD database provides detailed issuance information for publicly offered US bonds and the issuers, as well as transactions by insurance companies. This database contains issue-specific information such as coupon rates and coupon schedules, Fitch IBCA, Moody's, S&P, and Duff & Phelps credit ratings, offering amount, and issuer-specific information such as industry codes (SIC and NAICS), ticker and exchange listings for over 140,000 corporate bonds maturing in 1990 or later.

Our sample contains corporate bond transaction records from July 2002 to December 2014. We use the filtering algorithm presented in Dick-Nielsen (2014) to clean the TRACE database. We delete the error transactions, agency transactions, and interdealer double-counted transactions. We merge the TRACE database with FISD and drop the bonds that are not recorded in FISD, as well as the bonds with a floating or odd frequency of coupon payments. We also drop bonds without the identification of rating records in FISD. We use Moody's rating as a rating record; if it is not available, we use Standard and Poor's (S&P) rating when possible. In order to calculate the measurement of information risk, we require bonds with at least 60 trading days records for the preceding 6-month period. Finally, we require bonds with at least 15 months of transaction records for regression estimation. After these data screenings, we have a total of 10,993 bonds in our final sample: 331 Aaa bonds, 1,254 Aa bonds, 3,154 A bonds, 2,990 Baa bonds, and 3,264 speculative bonds.

We calculate the monthly corporate bond return for each individual bond at time t using the following formula:

$$r_t = \frac{P_t + C_t - (P_{t-1} + AI_{t-1})}{P_{t-1} - AI_{t-1}} \tag{1}$$

where P_t is the monthly bond price, AI_t denotes accrued interest, and C_t is the coupon payment, if any, on month t. P_{t-1} and AI_{t-1} are the price and accrued interest for the previous trading month $t-1$. We use the last transaction price at the end of each month to calculate the bond's monthly return. If the bond does not have the transaction on the last trading day of the month, we use the method of interpolation, similar to Lin et al. (2011), to calculate the return using the last transaction price of the month and the first transaction price of the following month.

The Fama-French three factors, Market, small minus big (SMB), and high minus low (HML), could be downloaded from Kenneth French's data library.[2] The default premium (DEF) is equal to the difference between the ten-year Treasury bond yield and the one-month Treasury bill rate. The term spread (TERM) is equal to the difference between Moody's seasoned Baa corporate bond yield minus the 10 year Treasury bond yield. The monthly yield of the 10-year Treasury bond yield, Moody's seasoned Baa corporate bond yield, and the

one-month Treasury bill rate are obtained from the Federal Reserve Bank of St Louis database (FREDII).

Moreover, we collect data for bond characteristics such as coupon, issue, size, age, and rating for each individual bond from FISD. These variables have been used as proxies for the level of term and default risk of bonds (Green & Odegaard, 1997; Longstaff et al. 2005). To control the corporate bond market liquidity, we use two marketwide liquidity proxies suggested by Amihud (2002) and Pástor and Stambaugh (2003). Lin et al. (2011) show that liquidity risk is an important determinant of expected corporate bond returns.

Table 1 reports the summary statistics of corporate bond return, rating, coupon, issue size, and age for the full sample. Return is the monthly corporate bond return calculated by Eq. (1). Rating is the numerical rating for a corporate bond rating, ranging from 1 to 22 (AAA–D) based on Moody's, and if not available, then we use S&P's ratings (i.e., AAA = 1, AA+ = 2, . . ., CCC = 19, CC = 20, C = 21, and D = 22). Coupon is the bond interest payment in percentage of the par value. Size is the corporate bond issue size in million dollars. Age is the number of months since the corporate bond issuance. Over the sample period, the monthly average corporate bond return is 0.53%. Bond characteristics are comparable to those reported in prior studies. The numerical rating is, on average, 9.04, which falls into the category of investment bonds. Coupon rates have a monthly average of 6.08%. The issue size of the corporate bond has a monthly average of 692 million dollars. Bond age on average is 5.44 years, which means on average corporate bonds have been issued for a little over 5 years.

2.2 Estimation of Information Risk

In this section, we present the models and empirical methodologies for information risk in the corporate bond market. We first describe the sequential trade

Table 1. Summary Statistics of Corporate Bond.

Variable	Mean	Standard Deviation	Minimum	Median	Maximum	N
Return	0.53	3.88	−14.35	0.56	15.67	364,220
Rating	9.04	4.44	1	8	22	364,220
Coupon	6.08	1.86	0	6.13	15	364,220
Size	692	648	25	500	3,500	364,220
Age	65.29	43.19	17	53	470	364,220

This table reports summary statistics of the main variables used in this study. The sample covers 364,220 bond-month observations from July 2002 to December 2014. For each variable, we report the sample means, standard deviations, minimum, median, and maximum. Return is the monthly corporate bond return calculated by Eq. (1). Rating is the numerical rating for a corporate bond rating, ranging from 1 to 22 (AAA–D) based on Moody's, if not available, the use S&P's (i.e., AAA = 1, AA+ = 2, . . ., CCC = 19, CC = 20, C = 21, and D = 22). Coupon is the bond interest payment in the percentage of the par value. Size is the corporate bond issue size in million dollars. Age is the number of months since the corporate bond issuance.

model of EHOH (2002) and the estimation of PIN using trade data of individual bonds.

A number of studies describe the procedure to measure information-based trading by a structural model (Easley et al. 1996, 1997a, 1997b, 2002). Easley et al. (2002) show that PIN is a good proxy for information risk. The information captured by PIN is viewed as private, not public information, which is measured by α from the frequency of the information events. The new information is a signal regarding the underlying asset value, where good news means a high asset value $\overline{V_i}$ with probability $(1 - \delta)$, and bad news mean the asset is worth V_i with probability δ. On each trading day, traders arrive according to a Poisson process throughout the day. The market maker sets prices to buy or sell to execute orders as they arrive. Informed trades arrive at rate μ, whereas orders from uninformed buyers arrive at rate ϵ_b, and orders from uninformed sellers arrive at rate ϵ_s. Informed traders buy if they have seen good news and sell if they have seen bad news. The market maker observes the trade (either a buy or a sale) and uses this information to update his beliefs.

The EHOH model provides a structural model that works backward to provide firm-specific estimates of the information risk. In this model, the likelihood function for the probability of information-based trading on a single trading day is

$$\begin{aligned} L(\theta|B,S) = (1-\alpha)e^{-\epsilon_b}\frac{\epsilon_b^B}{B!}e^{-\epsilon_s}\frac{\epsilon_s^S}{S!} + \alpha\delta e^{-\epsilon_b}\frac{\epsilon_b^B}{B!}e^{-(\mu+\epsilon_s)}\frac{(\mu+\epsilon_s)^S}{S!} \\ + \alpha(1-\delta)e^{-(\mu+\epsilon_b)}\frac{(\mu+\epsilon_b)^B}{B!}e^{-\epsilon_s}\frac{\epsilon_s^S}{S!} \end{aligned} \tag{2}$$

where B and S are total buy trades and sell trades for the day, respectively, and $\theta = (\alpha, \mu, \epsilon_b, \epsilon_s, \gamma)$ is a parameter vector. The above likelihood represents a mixture of distributions where trades are weighted by the probability of a "good news day" $\alpha(1 - \delta)$, a "bad-news day" $(\alpha\delta)$, and a "no-news day" $(1 - \alpha)$.

Imposing sufficient independence conditions across trading days, the model gives the likelihood function across I days.

$$V = L(\theta|M) = \prod_{i=1}^{I} \mathrm{L}(\theta|B_i, S_i) \tag{3}$$

where (B_i, S_i) is trade data for day $i = 1, \cdots, I$ and $M = ((B_1, S_1), \cdots, (B_I, S_I))$ represents the data set. Maximizing the above likelihood function over θ given the data M, we estimate the underlying structural parameters of the model (i.e., $\alpha, \mu, \epsilon_b, \epsilon_s, \delta$).

Using the estimated model parameters, we can construct the theoretical opening bid and ask prices. The model states that a market maker sets trading prices according to his expected losses to informed trades and expected gains from trading with uninformed traders. The balance of gains and losses yields the spread between bid and ask prices. The probability of informed trading based on the opening trade, PIN, is:

$$\text{PIN} = \frac{\alpha\mu}{\alpha\mu + \epsilon_s + \epsilon_b} \tag{4}$$

where $\alpha\mu + \epsilon_s + \epsilon_b$ is the arrival rate for all trades, and $\alpha\mu$ is the arrival rate of information-based trades. The above ratio is the fraction of orders that arise from informed traders or the probability that the opening trade is information-based. Easley et al. (2002) show that PIN has a significant positive effect on expected stock returns.

To apply the concept of PIN to the corporate bond market, we need to lay out the information structure in the corporate bond market. In the EHOH model, the private information is interpreted as inside information on a firm's cash flow. For example, the EHOH model has been used to capture the information risk in the treasury market. The traders who hold private information in the treasury market have advantages in accessing macroeconomic information such as fiscal deficits, inflation expectations, GDP growth, and money supply. However, corporate bond responses are different from those of treasury, and the behavior of corporate bonds is more similar to that of their equity counterparts. A company tends to issue one class of stock shares, though some may have multiple classes of stock shares. In contrast, a company tends to issue multiple bonds with different coupon rates, credit ratings, maturity dates, etc.

Moreover, the main participants in the corporate bond market are institutional investors. The traders not only bear both default risk and interest rate risk from the bond side but also bear the business risk and financial risk from the stock side. As a result, private information in the corporate bond market is similar to that of the underlying stock, mainly coming from inside information. Some traders have their proprietary valuation of the firm, reflecting the inside information for the firm. Their information on the firm's real default risk and premium for its bond is embedded in the order flow in the corporate bond market. Market makers observe the order flow to set prices to buy or sell.

On the other hand, uninformed traders in the corporate bond market represent regular investors who only hold public information and cannot observe the entire order flow. Because the corporate bond market is an OTC market, the low transparency raises the information uncertainty in the corporate bond market. Beginning in July 2002, TRACE improved transparency to increase information efficiency in the corporate bond market. So, we focus on private information in the corporate bond market after the introduction of TACE.

The EHOH model can be estimated using as few observations as 60 trading days, and the bond transactions meet this data requirement. Nevertheless, to increase the reliability of estimation, we estimate the model parameters over a rolling 6-month period with at least 60 trading days. Table 2 summarizes the parameter estimates. The mean (median) probability of an information event α is 0.07 (0.03), while the mean (median) probability of bad news δ is 0.35 (0.13). The probability of bad news δ is lower than that of good news. The mean (median) arrival rate μ of informed orders is 16.64 (9.88). The mean (median) arrival rate ϵ_b of uninformed buy orders is 5.56 (3.9), and the mean (median)