Debt Refinancing and Corporate Bond Returns

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Abstract

This paper presents empirical evidence that the maturity structure of financial leverage affects future corporate bond returns, specifically through the rollover risk channel. We demonstrate a robust positive correlation between debt refinancing, as measured by refinancing intensity, and corporate bond returns. An increase of one standard deviation in a firm's short-term leverage is associated with a 32 basis point increase in excess bond returns per annum. Additionally, we demonstrate that the impact of debt refinancing is more significant when a firm is exposed to higher levels of credit risk and liquidity risk. This effect is particularly pronounced during financial crises, periods of elevated interest rates, and tight market conditions. Our research has important implications for corporate finance: firms should take into account the risk of rolling over their short-term debt when determining the maturity structure of their debt.

JEL Codes: G12; G02

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1 Introduction

The maturity structure of financial leverage plays a significant role in corporate finance and asset pricing. Firms that are exposed to higher levels of credit risk and liquidity risk may incur rollover losses when they issue new bonds to replace maturing bonds (He and Xiong, 2012). As demonstrated by Friewald, Nagler, and Wagner (2022), shareholders care about firm's debt maturity structure as the rollover loss is absorbed by the firm's equity holders. Consequently, a firm's need for debt refinancing is positively associated with the equity risk premium. As bonds and stocks represent claims on the same underlying assets of a firm, the equity risk premium should also manifest in the corporate bond market (Chordia, Goyal, Nozawa, Subrahmanyam, and Tong, 2017; Choi and Kim, 2018). Likewise, the immediacy of a company's debt refinancing needs may also result in higher risk premia for bond investors. By contrast, the classical debt overhang problem outlined by Myers (1977) and Diamond and Rajan (2001) suggests that short-term debt may improve a firm's financial flexibility and mitigate agency conflicts, thus resulting in lower expected bond returns. In this paper, we examine which of the two competing perspectives on the role of short-term debt impacts corporate bond prices.

The two distinct channels mentioned above have been explored by several recent studies , aiming to test how and why debt maturity structure may play a significant role in determining equity risk premia. One recent study from Friewald, Nagler, and Wagner (2022) is the first empirically applying He and Xiong (2012)'s model by testing the relationship between debt refinancing intensity (RI), a proxy for short-term debt, and firm's equity returns. Their noteworthy results demonstrate that equity investors demand a risk premium for short-term leverage compared to long-term leverage, as a way of being compensated for instant debt refinancing risk. Another important takeaway is that debt maturities are relevant for comprehending the leverage effects in both asset pricing and corporate finance. The role of debt refinancing risks in bond pricing, however, remains unexplored.

Our study investigates whether bond investors also exhibit the same pattern as equity investors, who demand a premium for short-term debt compared to long-term debt. To do so, we decompose firms' leverage ratios into short-term and long-term leverage, distinguishing between the debt that matures within the next three years and that which matures after the next three years. The principal outcome indicates that bondholders do not assign equal values to all types of leverage-related risks. More precisely, after controlling for firm- and bond-level characteristics, an increase of one standard deviation in a firm's short-term leverage is associated with a 0.32% annual increase in excess bond returns during the sample period. Also, while the returns on bonds rise with an increase in short-term leverage, no such effect is seen in long-term leverage. This result stems from the fact that short-term leverage increases the bond's exposure to dynamic rollover risk, whereas long-term leverage does not. As a result, bondholders require a higher risk premium for short-term leverage as opposed to long-term leverage. This observation provides initial evidence supporting the existence of debt maturity effects in the cross-section of bond returns. Our finding underscores the importance of debt rollover risk, rather than financial flexibility, as a potential channel for these effects.

After confirming that rollover risk mechanism speaks to the explanation of bond return variations for firms with different maturity structures of debt, our study explores additional aspects that are specific to bond markets given their unique characteristics. In recent years, there has been a notable decline in the use of long-term debt by US corporations. In tandem, Figure 1 reveals a consistent upward trajectory in the amount of corporate short-term debt(maturing within 1 to 3 years) for the past two decades. This shift towards shorter debt maturities has left companies more vulnerable to credit and liquidity shocks (Custódio, Ferreira, and Laureano, 2013).Understanding the changing financial obligations of U.S. corporations provides a basis for further analysis of rollover risk management needs.To address these issues, our paper empirically investigates the interaction of credit risks and liquidity risks with firms' refinancing intensity (a proxy for short-term leverage), and how these interactions further impact corporate bond returns.

Firstly, we demonstrate that the impact of refinancing intensity on corporate bond returns is more significant for firms exposed to higher credit risks.After accounting for firm and bond-level characteristics, we also find that high yield bonds are more vulnerable to debt rollover risks, while high-quality bonds remain relatively immune.This phenomenon arises because low-rated firms may encounter difficulties in refinancing maturing debt within short time frames, particularly during periods of tight credit conditions or financial frictions. This finding also correlates with Xu (2018), who discovers that bonds issued by speculative-grade firms are refinanced well before their maturity dates. These firms often issue new bonds with longer maturities to extend their maturity structures. However, early refinancing does not alter the maturity structure of investment-grade firms. Our findings suggest that speculative-grade firms are subjected to more intensive refinancing risks. This perspective likely explains why these firms adjust their refinancing intensity to lower levels in a procyclical manner and prepare to account for potential risk premia, in contrast to other investment-grade firms.

Next, we proceed by examining whether the positive premium linked to firms' debt refinancing intensity varies between liquid and illiquid bonds. Using the Amihud (2002) and Roll (1984) illiquidity measure as proxies for bond illiquidity, our findings demonstrate that the effect of debt refinancing intensity is stronger for illiquid bonds. The intuitive explanation is that, when a company issuing illiquid bonds needs to refinance debt within a shortened time frame, it may have to offer better terms, such as higher yields, to attract bond investors.

We also examine whether the effect of debt refinancing intensity on bond returns varies across different bond maturities. Our findings indicate a stronger debt refinancing intensity effect for bonds with longer maturity. Following Bai, Bali, and Wen (2019), we define short-maturity bonds as those maturing between one year and five years, while long-maturity bonds have a maturity of ten years or more. Specifically, an increase of one standard deviation in RI is linked to a 0.9% rise in annual risk premium for long-term bonds compared to short-term bonds. This suggests that bondholders may demand higher returns for long-term bonds issued by firms with a greater proportion of short-term debt, reflecting the higher refinancing risks associated with bonds with longer maturity.

Although default risk and liquidity risk premium are typically addressed as distinct concepts in the existing literature, it is not feasible to completely separate the two from bond risk premium. To test the robustness of our findings, we examine how the interaction between the impact of financial crises (as a proxy for both default and liquidity risks) and debt rollover risk affects future bond returns. He and Xiong (2012) show that the decrease in debt market liquidity results in an increase in both liquidity premium and default premium, which makes it challenging to differentiate between liquidity risk and credit risk. Therefore, in such a context, these two types of risk are interdependent and cannot be analyzed in isolation. The 2007-2009 financial crisis provided a perfect setting to examine the interrelated impact of credit risk and liquidity risk on debt maturity structure, and their compounded effects in the corporate bond markets. Our results demonstrate that during times of crisis, investors typically demand higher risk premia, as indicated by elevated bond returns. This increased expectation is a direct consequence of exogenous liquidity shocks, such as financial crises, which create a need for a greater rollover risk premium in response to the perceived market instability and unpredictability(He and Krishnamurthy, 2012).

Moreover, there is compelling anecdotal evidence indicating that firms often adapt their refinancing plans in response to significant increases in interest rates, [1] while Leland (1994) models that changes in interest rates have a substantial impact on debt maturity structure sensitivity. We further examine how, during an increasing interest rate environment, refinancing becomes more costly for firms seeking to replace existing debt, causing investors to demand higher risk premia. Next, we delve deeper into examining the debt refinancing premium under different market conditions. During periods marked by tight credit markets or increased investor risk aversion, bond investors typically demand higher risk premiums. To capture these market conditions, we employ two proxy measures: the risk aversion index (Bekaert, Engstrom, and Xu, 2022) and the issuer quality measure (Greenwood and Hanson, 2013). Our findings consistently demonstrate that investors demand higher premiums for debt rollover risk during periods characterized under tight credit market conditions.

Finally, having established that the maturity risk effect accurately represents a firm's rollover risk, we employ factor-mimicking portfolio procedures, also outlined in Friewald, Nagler, and Wagner (2022), to quantify the premia associated with a firm's debt maturity structures and evaluate their relationship with systematic risk. Specifically, we run spanning tests using the the well recognized bond risk factors documented in Fama and French (1993), Lin, Wang, and Wu (2011) and Bai, Bali, and Wen (2019). We first conduct a triple sort of bonds into portfolios based on their ratings, maturity, and associated debt maturity structure, which we proxy as refinancing intensity

[1] "Companies Hasten Debt Refinancing Plans Amidst Looming Higher Interest Rates, Says New Study", April 7, 2022, https://www.wsj.com/articles/companies-may-speed-up-refinancing-plans-as-higher-rates-loom-11649336684

(RI). This sorting procedure allows us to disentangle premia associated with other common factors from those linked to debt refinancing intensity. In alignment with previous research, our study reveals a notable positive premium for debt refinancing risk. Our findings underscore the correlation between a greater immediacy of debt refinancing and increased bond returns. The positive loadings observed in the spanning tests carry both statistical and economic significance, specifically in relation to the credit risk factor and the liquidity risk factor. These results are in line with our baseline findings.

Our research provides a distinctive perspective by examining the impact of financial leverage and maturity structure on bond returns building on a well-established rollover risk model. Motivated by the literature on structural models of credit risk, which explores the relative costs and benefits of short-term versus long-term debt, this paper investigates how bondholders price leverage-related risks differently and how firms' debt refinancing needs affect their bond returns. He and Xiong (2012) show that short-term debt exposes investors to debt rollover risk, while long-term debt mitigates the immediacy of debt refinancing needs. As a result, risks increase with short-term leverage, leading investors to demand risk premia for short-term compared to long-term leverage.[2] Alternatively, short-term debt may increase a firm's financial flexibility as a disciplining device for moral hazard (Jensen and Meckling, 1976), thus mitigating agency conflicts such as debt overhang (Myers, 1977; Diamond and Rajan, 2001). This could reduce risks associated with short-term leverage while increasing risks for long-term leverage. The two distinct mechanisms provide opposite economic implications for a firm's real economy.

An essential contribution of our paper is to empirically validate the role of short-term debt in accelerating rollover risk, as evidenced by an increase in bond risk premia associated with the proportion of short-term leverage, but not with total leverage as a whole. This finding has important implications for corporate finance. It suggests that companies should take into account the risk of refinancing their debt when determining the maturity of their debt obligations. Furthermore,

[2] In an earlier model, Acharya, Gale, and Yorulmazer (2011) investigate a scenario where firms that own assets do not possess any capital and must use the purchased risky asset as security to obtain short-term debt financing. They found that the frequent rollover of short-term debt could result in a reduction of the firm's ability to obtain additional debt. In contrast, He and Xiong (2012) demonstrate the severe outcomes of short-term debt, even when there are no limitations on equity issuance.

when seeking external financing, companies should not only assess their overall level of debt but also the risk associated with the portion of short-term debt that requires more frequent rollover. Noted that according to the model proposed by He and Xiong (2012), it is predicted that when a firm suffers losses in rolling over its maturing debt, equity holders bear the losses while maturing debt holders are paid in full. Our findings make a significant contribution by further extending the analysis of He and Xiong (2012). We demonstrate that in addition to equity investors, bondholders also require risk premia associated with the proportion of the firm's short-term debt. Given the apparent increase in US firms' propensity to use debt financing over the century (Graham, Leary, and Roberts, 2015), it is imperative for corporations to consider how they can optimally determine the maturity structure of their debt.[3]

Little is known about how rollover risk of short-term debt is priced in the corporate bond markets. Previous research has emphasized that firms often utilize staggered short-term debt to finance high-risk, long-term, and illiquid assets, which resulted in a freeze on rollover during the financial crisis. As a result of concerns regarding the future state of the market, short-term creditors were unwilling to renew their debt. Consequently, short-term debt exposes firms to funding risks on the liability side (Brunnermeier, 2009). Moreover, Cheng and Milbradt (2012) show that in the presence of both a risk-shifting problem and coordination problem among creditors, very short-term debt is inefficient from the perspective of total firm value as it leads to low creditor confidence. Our findings extend this line of reasoning by suggesting that the risk of rollover freeze may be passed on to the debt holders, resulting in bondholders expecting higher premia on short-term debt. Hence, bondholders may price long-term debt and short-term debt differently due to low creditor confidence and high funding risks. It is worth highlighting that the empirical work conducted by Friewald, Nagler, and Wagner (2022) has already demonstrated the impact of the maturity structure of financial leverage on the cross-section of equity returns. Since corporate bonds and stocks are both contingent claims on the same firm's assets, our paper is the first to demonstrate that, by using

[3]In Greenwood, Hanson, and Stein (2015) study, how the government should optimally determine the maturity structure of its debt is examined. If negative externalities are associated with private money creation, such as social costs resulting from asset fire sales due to extensive reliance on short-term financing, Greenwood, Hanson, and Stein (2015) argue that the government should tilt its issuance more towards short maturities, such as T-bills, thereby partially crowding out the private sector's use of short-term debt.

short-term leverage as an important proxy, corporate bond returns exhibit return predictability similar to that in equities. Our findings support the market integration theory of Choi and Kim (2018), indicating that if equity and corporate bond markets are connected, risk premiums in one market should reflect in the other, maintaining consistent magnitudes.

This paper also contributes to the body of literature studying the implications of debt maturity, particularly focusing on the underlying risks of short-term debt. For example, Diamond (2004) posits that borrowing large amounts of short-term debt can result in the threat of runs on firms;[4] thus, refinancing risk and short-term debt are critical aspects of costly enforcement in financial markets. Diamond and He (2014) points out that short-term debt has various drawbacks; for companies lacking external financing to fulfill debt obligations, it can result in premature business shutdowns and liquidations. Our paper builds upon the existing theoretical literature in this area to empirically examine the risk and return trade-off of short-term debt in corporate bond markets, demonstrating how the immediacy of debt refinancing needs affects its associated bond returns in the subsequent period.[5]

Finally, our paper adds to the line of research that investigates the factors that determine the returns of corporate bonds. Since the study by Gebhardt, Hvidkjaer, and Swaminathan (2005), more recent research has focused on testing various risk factors that determine the cross-section of corporate bond returns.[6] However, the impact of corporate factors on corporate bond pricing has been understudied (Huang and Shi, 2021). While this paper examines the interaction between refinancing intensity (RI) and risk factors to test the marginal effects of default risks and liquidity risks on corporate bond returns, its objective is not to discover a new risk factor or to determine whether RI is a potential risk factor. Rather, our study tests the risk-reward paradigm by treating refinancing intensity, expressed intuitively as short-term debt rollover risk, as a firm characteristic, and examines whether debt refinancing rollover risk is priced in corporate bonds. While our

[4]The firm run follows a similar logic as in the famous bank run models dating back to Diamond and Dybvig (1983).

[5]In a contemporary study, Hong, Hou, and Nguyen (2023) employ similar models to examine how firms' debt maturity structure affects investment, going beyond the impact of leverage. While their study emphasizes the significance of debt maturity structure in understanding corporate investment decisions, our focus lies specifically on the corporate bond markets.

[6]These studies, among others, include Collin-Dufresne, Goldstein, and Martin (2001); Eom, Helwege, and Huang (2004); Huang and Huang (2012);Huang, Nozawa, and Shi (2022), and several more.

methodology is consistent with that of Huynh and Xia (2021), our study differs significantly in terms of the research question being investigated. While their study examines the relationship between climate change news risk and bonds with a high climate change news beta, to determine whether these bonds provide higher returns and serve as good assets to hedge against climate change risk, our study focuses on the effects of corporate immediate refinancing needs on bond markets and corporate financing. As far as we are aware, our paper is the first to provide empirical evidence on this issue.

The remainder of this paper is organized as follows. In Section 2, we provide the literature review and hypothesis development for our analysis. Section 3 explains the data and methodology, while Section 4 presents our main findings. We then delve into the discussion of debt refinancing under different market conditions in Section 5. In Section 6, we assess the risk premium associated with a firm's debt maturity structure. Finally, our conclusions are presented in Section 7.

2 Related Literature and Hypothesis Development

2.1 Debt Maturity and Rollover Risk

The literature on theoretical corporate finance recognizes debt maturity choice as an significant component in the structural model of credit risk (Fischer and Cox, 1976; Leland, 1994). Recently, He and Xiong (2012) have demonstrated that a firm's existing debt structure can affect its refinancing intensity. The role of debt maturity is crucial in determining a firm's rollover risk, which is compounded by short-term debt. Firms with a higher proportion of short-term debt are more likely to face greater rollover risk, resulting in a higher risk premia during refinancing. [7] Specifically, the rollover risk model suggests that equity risk increases with short-term leverage but decreases with long-term leverage.

Building on the work of He and Xiong (2012), Friewald, Nagler, and Wagner (2022) examine the cross-sectional relationship between leverage and equity returns with a focus on the effects of

[7] Chen, Xu, and Yang (2021) take a nonstandard approach, different from Leland and Toft (1996) and He and Xiong (2012), to model firms that are not required to roll over matured debt immediately. Instead, firms are allowed to optimally adjust their capital structure when existing debt matures. With these caveats in mind, we indeed find direct evidence of the rollover risk premium, which bolsters the debt rollover mechanism.

debt refinancing intensity. Their findings reveal that shareholders are more cautious about a firm's debt maturity structure and, therefore, demand a higher equity premium when short-term debt is involved. This aligns with the notion that a firm's immediacy for debt refinancing, measured by short-term leverage, exposes its equity to more systematic risk.[8] This is commonly referred to as the *rollover risk* channel of short-term debt, suggesting that risk escalates with the short-term leverage.

In contrast, the concept of *financial flexibility* proposes that short-term debt can help reduce agency conflicts, especially those arising from debt overhang. Excessive long-term debt may cause shareholders to hold back investments in projects with positive net present value, as they expect the resulting profits will be used to repay existing debt holders. According to Myers (1977), firms can use short-term debt to minimize the costs of underinvestment and mitigate conflicts between bondholders and equity holders.[9] Meanwhile, Brockman, Martin, and Unlu (2010) show, from an executive compensation perspective, that short-term debt can mitigate agency costs of debt that arise from asset substitution,[10] which is consistent with Leland and Toft (1996)'s theoretical prediction.

The fundamental idea behind the *financial flexibility* channel is that short-term debt can discipline management, reduce moral hazard, and thus lower agency costs.[11] However, recent evidence challenges the traditional view and suggests that short-term debt may actually increase incentives for risk-taking, especially for firms that face financing frictions or constraints that limit their ability to make optimal default decisions. For instance, Della Seta, Morellec, and Zucchi (2020) develop a model demonstrating that short-term debt amplifies the effects of negative operating shocks, thereby increasing default risk and incentivizing risk-taking.

[8]Prior to Friewald, Nagler, and Wagner (2022), several studies focus on discussing various factors affecting firms' debt refinancing intensity; such as market conditions (Graham and Harvey, 2001), credit ratings (Diamond, 1991) and information asymmetry (Sufi, 2007).

[9]Nevertheless, a survey conducted by Graham and Harvey (2001) on companies' debt preference indicates limited support for the idea that short-term debt is utilized to mitigate underinvestment.

[10]In their seminal study, Jensen and Meckling (1976) demonstrate that shareholders are motivated to appropriate bondholders' wealth by shifting their investments to riskier options, which is commonly referred to as asset substitution.

[11]The idea that short-term debt can discipline management and reduce moral hazard was initially introduced by Barnea, Haugen, and Senbet (1980). Subsequent significant contributions to this literature include Calomiris and Kahn (1991),Leland (1998), Cheng and Milbradt (2012), and Huberman and Repullo (2014).

Drawing on these two arguments, researchers have explored the effects of debt rollover risk on various aspects of firms, including their investments, valuation, and cash holdings. For example, Almeida, Campello, Laranjeira, and Weisbenner (2011) investigate the actual effects of corporate debt maturity and find that long-term debt has a negative effect on a firm's investment decisions. Kalemli-Özcan, Laeven, and Moreno (2022) utilize a cross-country firm-bank matched database to reveal that firms with higher debt levels tend to reduce their investment more significantly after the financial crisis. This effect is more pronounced among firms holding short-term debt in countries experiencing sovereign stress, indicating that rollover risk plays a crucial role in influencing investment decisions. The study by Liu, Qiu, and Wang (2021) finds that the COVID-19 pandemic increased default risk, decreased stock returns, and impacted cash holdings for firms with higher debt rollover risk. According to Harford, Klasa, and Maxwell (2014), firms mitigate refinancing risk by increasing their cash holdings and saving from cash flows, suggesting that refinancing risk is a key determinant of cash holdings.

Different from the previous work mentioned above, our paper addresses a distinct aspect of debt rollover risk by examining the following research question: what is the effect of debt refinancing intensity on corporate bond returns?

2.2 Corporate Bond Return

For the past few decades, financial economists have employed various approaches to study the factors that determine corporate bond returns. One strain of literature focuses on the cross-sectional analysis of corporate bond returns, specifically examining the impact of risk factors in empirical research(Fama and French, 1993; Lin, Wang, and Wu, 2011; Bai, Bali, and Wen, 2019). One takeaway from this literature is that at least four factors are needed to explain the cross-sectional variation in average corporate bond returns. Bai, Bali, and Wen (2019) find that downside risk is the strongest predictor of future bond returns, and they introduced common risk factors of corporate bonds such as downside risk, credit risk, and liquidity risk, and market risk which all have significant impacts on the size/maturity sorts of corporate bonds.

Another strain of the literature concerns time-series evidence. These include risk and return of investment-grade and high-yield corporate bonds as asset classes (Fama and French, 1993; Kozhemiakin, 2007; Asvanunt and Richardson, 2016), corporate bond return predictability(Hong, Lin, and Wu, 2012; Greenwood and Hanson, 2013; Huang, Rossi, and Wang, 2015; Lin, Wu, and Zhou, 2018), and the determinants of individual corporate bond returns (Dick-Nielsen, Feldhütter, and Lando, 2012; Schestag, Schuster, and Uhrig-Homburg, 2016).

Following the spirit of Gebhardt, Hvidkjaer, and Swaminathan (2005), which indicates that beta (factor loading) is better at predicting expected returns compared to firm characteristics, many papers in the past two decades have focused on searching for or applying various risk factors to explain corporate bond returns. A potential shortcoming of purely using risk factors to determine asset prices is that if a certain firm characteristic cannot be fully explained by one of the distinguishing factors, it might seem irrelevant to consider when predicting future returns. In a nutshell, the financing intensity of a firm - which only measures the immediate refinancing needs of a firm - could be one such characteristic. Firms with various types of risks - liquidity, default, market - may all have to face the situation where their debt, either short-term or long-term, will be due within the next three years.

Based on the research question of our study, which attempts to investigate the possibility that bondholders actually care about firms' debt maturity structure and therefore price leverage associated with short-term and long-term debt differently, wee propose treating the main variable of interest in this study - refinancing intensity (RI) - as similar to capital structure, which is a key component of firm characteristics. Thus, by design, this study aims to bridge the rollover risk channel by testing a meaningful association between short-term debt and the excess return of corporate bonds. That said, the purpose of this study is not to search for a new risk factor to explain the cross-section of bond returns, but to empirically test how short-term debt is priced in corporate bond markets. This methodology is consistent with that of Friewald, Nagler, and Wagner (2022), shedding light on debt maturity structure implications on asset prices in the corporate finance literature.

Our paper is closely related to Lin, Wang, and Wu (2011), which study the pricing of liquidity risk in the cross-section of bond returns and find that the premia for liquidity risk is positive, indicating that bonds with higher sensitivity to market-wide liquidity shocks offer higher returns. However, one distinct difference between our study and that of Lin, Wang, and Wu (2011) is that they focus on market-wide liquidity shocks, while mine is the first to examine the impact of the firm-level idiosyncratic short-term debt level, i.e., refinancing intensity (RI), on the cross-section of bond returns. Meanwhile, Acharya, Amihud, and Bharath (2013) suggest the existence of time-varying liquidity risk of corporate bond returns, which is conditional on episodes of flight to liquidity. Acharya, Amihud, and Bharath (2013) contribute to the literature on how liquidity affects expected returns by demonstrating that the impact of liquidity shocks on asset prices is contingent upon the economic environment, with a significantly stronger effect observed during adverse economic times.

Our study presents a novel empirical inquiry into the impact of rollover risk on bond returns, setting it apart from the studies previously discussed. Pioneering research by He and Milbradt (2014) and more recent theoretical models, such as those developed by Wei, Xiao, Zhou, and Zhou (2023) and Zhou and Wei (2023), indicate that endogenous debt maturity, which involves balancing rollover risk and liquidity risk, can affect the liquidity risk premia on bonds. Firms issuing corporate bonds consider the liquidity risk premia as part of their debt cost. Consequently, liquidity risk can affect a firm's debt cost, leading to potential changes in its financing decisions and, ultimately, the bond risk premia. This result aligns with prior research on the debt rollover mechanism, including the studies by Cheng and Milbradt (2012) and Brunnermeier and Oehmke (2013).

2.3 Hypothesis Development

In this section, we present our research questions and hypotheses, which seek to examine the impact of debt refinancing intensity on corporate bond returns. We explore how firms strategically determine the maturity structure of their debt, with a specific focus on investigating the influence of short-term debt on rollover risk and its implications in the US corporate bond market. Drawing from the literature discussed above, we derive the following set of empirical hypotheses:

Hypothesis 1. **There is a positive relation between debt refinancing intensity (RI)**

and corporate bond returns.

In a scenario where a firm has the option to issue new debt, it weighs the monetary premium linked to short-term debt with the refinancing risk stemming from the need to frequently roll over its debt. In this setting, the optimal debt maturity hinges on a straightforward trade-off. On the one hand, tilting the issuance towards shorter maturities provides greater financial flexibility, resulting in a lower expected financing cost. On the other hand, adopting a strategy of short-term financing exposes the firm to rollover risk, as future interest rates are unpredictable (Nosbusch, 2008; Greenwood, Hanson, and Stein, 2015). This rollover risk entails real costs by introducing instability in future financing costs. This trade-off predicts a positive correlation between short-term leverage and the risk premium, as the aggregate short-term debt increases, the costs associated with rollover risk become more significant.

Expanding on the theoretical models from He and Xiong (2012), debt maturity plays an important role in determining the firm's rollover risk. This risk is heightened by the immediacy of a company's debt refinancing needs, which can be measured by its refinancing intensity (RI) or short-term leverage. The risks associated with leverage are not all equally priced by bond investors, and thus, the returns on bonds are likely to increase as the fraction of a company's short-term debt relative to its total debt rises (Diamond and Rajan, 2001; Friewald, Nagler, and Wagner, 2022).

Therefore, firms with a higher proportion of short-term debt are more vulnerable to rollover risk, as they may struggle to refinance maturing debt within a short time frame, particularly during periods of tight credit conditions or market stress. Consequently, bondholders may require risk premia when investing in bonds issued by firms with higher rollover risk, which would result in an increase in bond returns. Thus, we propose that corporate bond returns increase as the proportion of short-term debt (compared to total debt) increases, and hence the choice of debt maturity of the firm has an impact on the cross-section of bond returns.

Hypothesis 2. **The positive relation between debt refinancing intensity and corporate bond returns is more pronounced for bonds with higher default risk.**

The default risk premium on a firm's bond primarily depends on the creditworthiness of issuing firm (Fisher, 1959). Extensive research by financial economists has emphasized the crucial role of credit risk in shaping the risk premium of corporate bonds, with default risk accounting for a significant portion of this premium (Giesecke, Longstaff, Schaefer, and Strebulaev, 2011; Huang and Huang, 2012). Firms with higher credit risk face more significant challenges when refinancing their debts. As highlighted in He and Xiong (2012), the interaction between credit risk and rollover risk becomes particularly relevant when the bond approaches maturity. Investors become more concerned about the issuer's ability to refinance the debt, which can lead to a further decline in bond prices and higher yields. As such, this rollover risk is notably exacerbated for firms with higher credit risk due to their weaker financial positions. In contrast, highly-rated issuers possess more bargaining power in the credit market and are less susceptible to rollover risk. Thereafter, we expect that the impact of refinancing intensity on corporate bond returns is more pronounced for firms exposed to higher credit risk.

Hypothesis 3. **The positive relation between debt refinancing intensity and corporate bond returns is more pronounced for bonds with higher illiquidity.**

Liquidity plays an important role in asset pricing, as market participants are willing to pay a premium for more liquid asset, resulting in lower expected returns (Pástor and Stambaugh, 2003; Acharya and Pedersen, 2005; Li, Novy-Marx, and Velikov, 2019). Extensive research indicates that liquidity risk significantly influences expected bond returns in the corporate bond market (Bao, Pan, and Wang, 2011; Lin, Wang, and Wu, 2011). Investors typically demand higher returns for holding illiquid bonds due to the difficulty in trading these assets. Rollover risk becomes particularly relevant for bonds facing heightened liquidity risk. When a company with illiquid bonds undergoes debt refinancing, it may need to offer better terms, such as higher yields, to entice investors. Consequently, investors may require a higher risk premium for less liquid bonds due to the potential challenges associated with refinancing. This leads to a stronger positive relationship between debt refinancing intensity (RI) and bond returns for illiquid bonds as compared to more liquid counterparts. Another possible explanation is through the information asymmetry channel: illiquid bonds tend to exhibit greater information asymmetry between the issuer and investors

(Longstaff, 2002; Chen, Lesmond, and Wei, 2007). When firms face debt refinancing needs, less liquid firms are subject to increased risks arising from information asymmetry related to credit quality and financial performance. This reinforces the positive relation between RI and corporate bond returns for bonds with higher illiquidity.

Hypothesis 4. **The positive relation between debt refinancing intensity and corporate bond returns is more pronounced for bonds with longer maturities.**

In his seminal work, Merton (1974) provides a comprehensive analysis that explores the relationship between maturity variations and the risk associated with a firm's bonds. Building upon this foundation, our hypothesis suggests that the relationship between debt refinancing intensity and corporate bond returns exhibits an interesting pattern, specifically with respect to bond maturities.

There are two possible opposite directions for bond maturities in this context. On the one hand, bonds issued with shorter maturities might be subject to more severe refinancing risk because these bonds mature sooner, leading to a higher likelihood of earlier or more frequent refinancing. On the other hand, we propose that the positive correlation between these two factors will be more pronounced for bonds with longer maturities. In other words, as the intensity of debt refinancing increases, its impact on corporate bond returns will be more significant for bonds with longer maturities compared to those with shorter maturities. This vulnerability is due to the fact that bonds with longer maturities are particularly exposed to a firm's debt refinancing needs, as an extended time horizon increases the likelihood of requiring refinancing (Diamond and He, 2014).

As a result, companies with a higher proportion of short-term debt on their balance sheets are more likely to face higher refinancing costs for long-term bonds. In this context, short-term bonds encounter fewer risks associated with such obligations. By formulating this hypothesis, we aim to investigate whether the interaction between debt refinancing intensity and corporate bond returns is influenced by the maturity of the bonds.

3 Data, Sampling, and RI Measure

3.1 Data and Sampling

The sample used in this study consists of leveraged, non-financial firms that are listed on the NYSE, NASDAQ, and AMEX from July 2002 to December 2020.[12] Our corporate bond sample is compiled from two major sources: (1) the enhanced version of Trade Reporting and Compliance Engine (TRACE) Enhanced database, which provide transaction data of all publicly traded corporate bonds in the U.S.; and (2) Mergent fixed income securities database (FISD), which contains information on bond issue and issuer characteristics. Based on Dick-Nielsen (2014) approach, we clean the TRACE data by eliminating canceled, corrected, and reversed trades. We then merge TRACE with the Mergent FISD to gain insight into corporate bond issuers and issues, such as offering amount, offering date, maturity date, coupon rate, coupon type, interest payment frequency, bond type, and bond rating. Following Bai, Bali, and Wen (2019), we further restrict our sample of corporate bonds to those listed and traded in the US public market, eliminating bonds that: i) are issued through private placement and under the 144A rule; ii) have maturity of less than one year and issue amount of less than $1 million; iii) are preferred shares, mortgage backed, asset backed, convertible and exchangeable as well as floating coupon rates; iv) have missing information on coupon, rating, interest payment frequency, and bonds.

Accounting data are collected from the Compustat Annual and Quarterly Fundamental Files and stock returns are obtained from the Center for Research in Security Prices (CRSP). To ensure the accuracy of future return analyses, a six-month lag was incorporated when merging these data sets, as recommended by Fama and French (1992). This conservative approach ensures that the accounting data are known prior to their use in subsequent return analyses, potentially reducing the possibility of erroneous conclusions. In accordance with Cooper, Gulen, and Schill (2008) and Friewald, Nagler, and Wagner (2022), We eliminate financial firms (SIC codes 6000-6999) and companies with non-positive book equity. We also exclude firms with non-positive total assets and market equity. Since the purpose of the paper is to investigate the impact of debt maturity, we require firms' leverage ratios to be non-zero. Specifically, We treat missing values of $dd1$ and $dltt$

[12] We start the sample in 2002 as this coincides with the availability of data from the TRACE Enhanced database.

as zero and set missing values of $dd2$ to $dd5$ to zero if at least one is non-missing. Moreover, we enforce that all debt items ($dd1$ to $dd5$, $dltt$) must be non-negative. In addition, we implement two extra filters (Almeida, Campello, Laranjeira, and Weisbenner, 2011). The first filter eliminates observations where the total debt ($dd1$ + $dltt$) exceeds the total assets, while the second filter eliminates observations where debt maturing in more than a year ($dltt$) is less than the sum of debt maturing in two, three, four, and five years ($dd2$ + $dd3$ + $dd4$ + $dd5$) from the balance sheet date.

The final sample consists of 296,864 observations on bond-months spanning from July 2002 to December 2020, covering 7,812 corporate bonds issued by 664 unique firms. On average, there are approximately 1,330 bond observations per month over the sample period.

3.2 Variables of Interest and Control Variables

In light of the steadily growing upward trajectory in the amount of corporate debt maturing in the near term, as demonstrated in Figure 1, we recognize that relying solely on the aggregate maturing debt may offer only preliminary insights into a firm's debt maturity structure. The size of a firm can lead to significant misleading effects; for instance, larger firms may possess a higher dollar amount of short-term debt but a relatively low short-term debt ratio compared to smaller firms. To gain a more accurate understanding, we delve deeper by decomposing a firm's leverage into two components: short-term leverage (debt maturing in the next three years) and long-term leverage (debt maturing after the next three years).

The focal point of this study is the debt refinancing intensity (RI). As described in Friewald, Nagler, and Wagner (2022), RI is defined as the ratio of short-term debt ($dd1$ + $dd2$ + $dd3$) to total debt ($dd1$ + $dltt$), as shown below:

$$RI = \frac{dd1 + dd2 + dd3}{dd1 + dltt} \tag{1}$$

Specifically, RI measures the proportion of debt maturing in the next three years over total debt (i.e., the sum of short-term and long-term debt). The RI measure takes on high values when firms have a higher short-term leverage ratio and expose bondholders to debt rollover risk.

As illustrated in Figure 2, during the sample period from 2001 to 2021, the short-term leverage ranges between 7-9%, while the long-term leverage ranges between 15-20%. Notably, the refinancing intensity (a proxy for short-term leverage) peaked in the year 2009 within the observed period. This decomposition allows us to delve deeper into the debt maturity profiles of firms, providing a more nuanced understanding of their risk exposure and refinancing patterns.

In addition, we also compare the impact between refinancing intensity and leverage ratio. In accordance with Öztekin and Flannery (2012) and Harford, Klasa, and Maxwell (2014), we definite the leverage ratio, LEV, as the ratio of total short-term and long-term debt relative to total assets, as shown below:

$$LEV = \frac{dd1 + dltt}{AT} \tag{2}$$

This paper aims to investigate the impact of debt maturity, which requires to concentrate on observations where $LEV > 0$, as otherwise, RI cannot be determined. In our primary analyses, we use a sample that covers all levered firms (All-LEV), but we also perform analyses on a sample that excludes AZL firms. Consistent with Strebulaev and Yang (2013) and Friewald, Nagler, and Wagner (2022), we define AZL firms as those with $LEV < 0.05$. By utilizing this All-but-AZL sample, we ensure that our findings concerning the impact of debt maturity on bond returns are not influenced by firms with minimal leverage.

Once leverage and debt refinancing intensity are measured, the next essential metric is the bond return. Following Lin, Wang, and Wu (2011), Bai, Bali, and Wen (2019) and others, we calculate the monthly corporate bond return i at time t as:

$$r_{i,t} = \frac{P_{i,t} + AI_{i,t} + C_{i,t}}{P_{i,t-1} + AI_{i,t-1}} - 1 \tag{3}$$

where $P_{i,t}$ is defined as the transaction price, $AI_{i,t}$ as the accrued interest, and $C_{i,t}$ as the coupon payment, if applicable, for bond i in month t. Consistent with Bai, Bali, and Wen (2019), we represent bond i's excess return as $R_{i,t}$, where $R_{i,t} = r_{i,t} - r_{f,t}$ and $r_{f,t}$ is the risk-free rate approximated by the one-month Treasury bill rate.

To account for potential factors affecting bond returns, we incorporate a comprehensive list of bond-level and firm-level control variables. First, we include variables that capture differences in firm characteristics such as firm size, defined as the natural logarithm of the market value of the issuer's common equity, and return on equity (ROE), which accounts for cross-sectional variations in issuers' cash flows and is calculated as income before extraordinary items divided by the book value of common equity. Secondly, we control for bond-specific factors such as bond maturity (in years), credit rating, and issue size. To convert letter ratings to a continuous numerical scale, we assign a score ranging from 1 (highest) to 22 (lowest), with AAA=1, AA+=2, AA=3, and so on down to C=21, and D=22. Ratings of 10 (BBB-) and below are classified as investment grade, while ratings above 10 are non-investment grade. Additionally, we incorporate measures of corporate bond illiquidity (Illiquidity) using the Amihud (2002) measure and Roll (1984) measure and return reversal (Reversal), which is calculated as the bond's excess return in the previous month. Finally, we control for the coupon rate and the presence of callable bonds using a dummy variable. The variable construction details are provided in Appendix.

3.3 Summary Statistics

Table 1 reports the time-series average of the cross-sectional bond returns distribution and bond characteristics. To minimize the influence of extreme values, we winsorize all continuous variables at their 1st and 99th percentiles. The monthly excess bond return has a mean of 0.45% with a standard deviation of 3.64%. The range of excess returns spans from -0.47% to 1.32%, as indicated by the 25th to 75th percentiles. The distribution of bond excess return is similar to the findings reported in Huynh and Xia (2021).[13]

The average values of RI and LEV are 0.27 and 0.32, respectively, and the average firm size ($MACP$) is \$65.3 billion with an average ROE of 0.15. In our analysis, we limit our sample to leveraged, non-financial firms with corporate debt issues. In comparison to Friewald, Nagler, and Wagner (2022), our sample firms exhibit lower RI but are larger in size and have higher

[13]In Huynh and Xia (2021), the average monthly bond excess return is 0.50%, ranging from -0.52% to 1.49% between the 25th to 75th percentiles. It is worth noting that our sample covers a longer time span, including an additional six years compared to their study.

profitability.[14] Typically, large and profitable firms have greater access to corporate bonds to finance their operations and investments, whereas smaller firms face limitations in accessing the corporate bond market. The sample consists of bonds with a median rating of 7 (i.e., A-) and an average time-to-maturity of 10.46 years.[15] Different from Bai, Bali, and Wen (2019), which analyzes bonds issued by both public and private firms, our sample bonds, issued by publicly listed firms, have higher credit ratings and longer time-to-maturity. The average bond issue size is $0.65 billion and approximately 80% of the bonds included are callable bonds.[16]

We adopt the estimation methodology proposed by Merton (1974) and Bharath and Shumway (2008) to estimate the expected default frequency (EDF) of the bond issuers. The average of EDF is 0.02 with a standard deviation of 0.09. It is important to highlight that the majority of bond issuers exhibit relatively low expected default frequencies and more than 75% of the firms in our sample have an EDF of 0.01% or less. We employ two bond illiquidity measures. The first measure is the Amihud illiquidity measure (ILQ^{Amihud}), which quantifies the the price impact of a trade per unit traded. On average, ILQ^{Amihud} is 1.22%, indicating that an average bond experiences a price movement of 1.22% when a trade of $1 million takes place.[17] The second measure we employ is the Roll illiquidity measure (ILQ^{Roll}), which represents the bid-ask spread expressed as a percentage. The average of ILQ^{Roll} is 1.23% with a standard deviation of 1.89%. The distribution of these illiquidity measures aligns closely with previous studies such as Dick-Nielsen, Feldhütter, and Lando (2012) and Schestag, Schuster, and Uhrig-Homburg (2016), providing a comparable assessment of bond illiquidity.

[14]In Friewald, Nagler, and Wagner (2022), the average RI is 0.40, while the average market value of equity is $3.32 billion, and the average ROE is 0.011.

[15]The numerical credit rating of the bonds is determined using the following letter rating conversion scheme: AAA=1, AA+=2, ..., C=21, and D=2. Our primary source for credit ratings is the Standard & Poor's (S&P) ratings obtained from the Financial Information Services Division (FISD). In cases where S&P ratings are unavailable, we rely on Moody's or Fitch ratings if they are accessible. Bonds without identifiable ratings are excluded from our analysis.

[16]Our findings align with those of Huang, Qin, and Wang (forthcoming), where the average issue size is reported as $0.63 billion, and around 75% of the bonds in their sample were issued with call options.

[17]Consistent with Dick-Nielsen, Feldhütter, and Lando (2012),focus on institutional trades and exclude any trades with a traded volume lower than $100,000 USD.

4 Main Results

4.1 Debt Refinancing and Corporate Bond Returns

In this section, we examine the relationship between a firm's rollover risk, represented by debt refinancing intensity (RI), and its future returns at the bond-month level. As discussed in the Section 2, bond investors may demand a higher risk premium when there is higher rollover risk caused by short-term leverage, while the potential benefit of refinancing flexibility may reduce agency costs, leading to lower bond returns. To examine the effect of short-term leverage on corporate bond returns, we employ a panel regression approach to perform monthly regressions on individual bond returns, while controlling for time fixed effects and firm fixed effects. The model is specified as follows:

$$R_{i,t+1} = \alpha + \beta RI_{j,t} + \gamma' Controls_{i,j,t} + \tau_t + \lambda_j + \epsilon_{i,t+1} \quad (4)$$

where i indexes bond, j indexes firm and t indexes year. $R_{i,t+1}$ denotes bond i's excess return in month *t+1*. Debt refinancing intensity (RI) is defined as the proportion of short-term debt to total debt. To account for factors that may affect bond returns, the analysis includes a set of firm and bond-level variables, consistent with previous research on corporate bond returns (Lin, Wang, and Wu, 2011; Bai, Bali, and Wen, 2019). First, we include LEV, defined as total debt to total assets, as a crucial control variable to assess whether the relationship between RI and bond returns is merely a manifestation of a firm leverage (Friewald, Nagler, and Wagner, 2022). Second, we control for other firm characteristics, such as firm size ($MCAP$) and return on equity (ROE), which are widely used as firm-level controls in bond return literature. Third, the analysis includes several bond characteristics, such as bond maturity, credit rating, issue size, reversal return, bond illiquidity measures (proxied by the Amihud (2002) measure), coupon rate, and a dummy variable for callable bonds. Additionally, year (τ) fixed effects and bond issuer (λ) fixed effects are included in the regression to account for potential time-series trends and other unobserved firm characteristics.

Table 2 shows several key results. Panel A shows that the coefficients of RI are significantly positive, in the presence of LEV and other variables known to affect bond returns. First, in Column (1), we conduct a univariate regression of firms' excess returns on their debt refinancing intensity, denoted as RI. In Column (2), we include both RI and LEV (leverage ratio) jointly. On the one hand, our results suggest that bond returns are unrelated to leverage —the coefficients estimate for LEV is insignificant in all specifications (highest $| t |$ is 1.45). On the other hand, we find a positive link between RI and bond returns (t-statistic= 2.32), which implies that excess bond returns increase in a firm's fraction of short-term relative to total debt. Second, the positive correlation between RI and bond returns remains robust after controlling for various bond issuer - and firm-level variables. As shown in Columns (3) and (4), the correlation between RI and bond returns is both economically and statistically significant. Third, the economic significance of the predicting power is also sizable. For instance, in Column (4), the coefficient estimate for RI is 0.165 (with a t-statistic of 3.18). This suggests that, a one standard deviation increase in RI measure is associated with an increase of 2.64 bps (0.16 x 0.165 = 0.0264 %) in the bond return over the next month, which is equivalent to approximately 32 basis point of the annualized excess bond return. Given that the average annualized excess bond return in the sample is 5.4 %, the variation in debt refinancing intensity (RI) of short-term debt accounts for about one-thirteenth (1/13) of the explanatory power for excess bond return during the sample period.

Panel B of Table 2 reports the results of the main specification of Eq.(4) in the sample that excludes AZL firms (those with LEV $<$ 0.05). Using the same control variables and fixed effects as in Table 2, the results of RI are even stronger economically and statistically, with significant coefficient estimates at the 1% level in all univariate and joint regressions (t-statistic between 2.68 and 3.37).After excluding the AZL firms, the fact that the RI results are stronger while the coefficients on leverage are insignificant indicates the importance of conducting a joint analysis of both leverage and debt maturity effects. Another interesting observation is that, although the coefficient estimates in Panel B are stronger than those in Panel A, the number of observations does not change significantly. For instance, in Column (3), the number of observations decreases from 296,864 in Panel A to 290,040 in Panel B, representing a negative change of only -2.3%. This is perceptible, given that our sample consists only of public firms that issue bonds in the US markets.

Compared to the sample of equity-issuing firms in Friewald, Nagler, and Wagner (2022), a smaller proportion of bond-issuing firms meet the criteria to be classified as "zero-levered". As a result, in the subsequent empirical tests, we utilize the entire sample of firms. This decision is based not only on the subtle difference between the overall sample and the exclusion of the zero-levered (AZL) group but also on our preference for a more conservative approach in the subsequent tests. (The *RI* coefficient in Panel A is 0.165, which is slightly smaller than the coefficient in Panel B, which is 0.196.)

The economic meanings of the control variables are consistent with what has been found in previous studies. In Column (4), firm size is positive and statistically significant, while *ROE* is negative and statistically significant. This suggests that larger firms tend to have higher bond returns, while firms with lower *ROE* tend to have higher bond returns. Regarding the bond characteristics, maturity, credit rating, and issue size are positive and highly statistically significant. This means that bonds with longer maturities, issued by firms with higher credit ratings, and larger issue size tend to have higher returns, after controlling for the effects of other variables in the model. Return reversal are negative and highly statistically significant, indicating that investors require higher risk premia for bonds whose returns tend to exhibit negative autocorrelation, or "reversal", which is associated with lower returns in the subsequent period. The illiquidity measure exhibits a positive and significant relationship, aligning with the findings of the bond liquidity literature, which suggests a negative association between bond liquidity and returns.

In sum, the regression results indicate a positive link between the bond returns of firms and their intensity of debt refinancing. The observation that bond returns increase as the proportion of short-term debt (compared to total debt) increases offers preliminary support for the presence of debt maturity effects in the cross-section of bond returns. This finding highlights the role of debt rollover risk, rather than financial flexibility, as a possible channel. Our finding is consistent with what was found in Friewald, Nagler, and Wagner (2022), which also substantiates the presence of a debt rollover risk channel. Collectively, these results also support the notion that the risk premium in the equity market should manifest itself in the corporate bond market, as bonds and stocks represent claims on the same underlying assets of the firm (Chordia, Goyal, Nozawa, Subrahmanyam, and Tong, 2017; Choi and Kim, 2018).

Taken together, the initial finding from Table 2 provides evidence in support of *Hypothesis 1*, which proposes a positive relationship between debt refinancing intensity (RI) and corporate bond returns. Bondholders do not price all leverage-related risk equally. Firms that rely more heavily on short-term debt are exposed to heightened rollover risk, as they may face difficulties in refinancing their maturing debt within a tight time frame. Therefore, bondholders require higher risk premia associated with short-term leverage.

4.2 Debt Refinancing and Default Risk

In this section and the next, we consider two significant components of risk premia that are commonly believed to have significant impacts on corporate bond returns - default premia and liquidity premia (Fama and French, 1993; Lin, Wang, and Wu, 2011; Bao, Pan, and Wang, 2011; Huang and Huang, 2012).[18] As stated in *Hypothesis 2*, a firm is exposed to a higher debt rollover risk for bonds that are associated with high credit risk. Therefore, investors demand higher risk premia for firms that have a higher risk of default, and we anticipate a more significant impact of RI on future corporate bond returns. To account for the possible impact of default risk, we add an interaction term between RI and default risk proxies (DEF) to the baseline regression Eq.(4), as follows:

$$R_{i,t+1} = \alpha + \beta_1 RI_{j,t} * DEF_{i,t} + \beta_2 RI_{j,t} + \beta_3 DEF_{i,t} + \gamma' Controls_{i,j,t} + \tau_t + \lambda_i + \epsilon_{i,t+1} \qquad (5)$$

where $R_{i,t+1}$ refers to bond i's excess return in month *t+1*. We assess default risk (DEF) using two distinct approaches: the expected default frequency (EDF) and the credit rating ($Rating$).

[18] Recent research has consistently demonstrated the significance of credit risk and liquidity risk as determinants of corporate bond returns. Specifically, Fama and French (1993) highlight the critical role of credit risk in influencing corporate bond returns, a finding that has been reaffirmed by Bai, Bali, and Wen (2019). Lin, Wang, and Wu (2011) and Bao, Pan, and Wang (2011) show that bond illiquidity in corporate bonds is substantial and document a strong positive relation between corporate bond returns and liquidity risk. Huang and Huang (2012) demonstrate that credit risk accounts for one-third of the variation of yield spreads for investment grade bonds, and a much higher fraction of yield spreads for high yield bonds. Additionally, Friewald, Jankowitsch, and Subrahmanyam (2012) focus the liquidity effect in period of financial crisis and find that bond liquidity accounts for 14% of the market-wide credit spread changes.

To estimate EDF, we employ the Merton distance to default model proposed by Merton (1974) and utilize the approach outlined in Bharath and Shumway (2008).[19] Further, for each month, we classify the sample into terciles and designate firms falling within the top tercile as high EDF firms ($High\ EDF$). The second measure of default risk is the bond's credit rating. We transform the credit rating, which is a numerical variable ranging from 1 (AAA) to 22 (D), using a logarithmic transformation to obtain a continuous variable ($\ln(1 + Rating)$). Additionally, we define a dummy variable to identify high-yield bonds (HY). The HY variable is a dummy variable that takes a value of 1 if the bond is classified as a high-yield bond (i.e., credit rating ranging from 11 (BB+) to 22 (D)), and 0 otherwise. The coefficient β_1 is the primary variable of interest in this regression as it captures the interaction effect of default risk proxies and RI on future bond returns. The control variables and firm- and year-fixed effects are the same set used in the baseline regressions.

Table 3 presents empirical results. We estimate a bond issuer's default risk using expected default frequency (EDF) for Columns (1)-(2) and credit rating ($Rating$) for Columns (3)-(4). In Column (1), we examine the interaction effect between RI and EDF on bond returns. The coefficient on the interaction term is 1.365, with a t-statistic of 2.14, suggesting that the debt refinancing effect on bond returns is stronger for firms with higher credit risk. Specifically, a one standard deviation increase in EDF leads to a 0.12 increase in the effect of RI. To gain further insight into the interaction effect between RI and EDF, we divide the sample into tercile groups based on their EDF values for each month. The top and medium terciles are categorized as high and medium EDF firms, respectively. We then examine the interaction of these two indicators with RI in Column (2). The coefficients on $RI * High\ EDF$ and $RI * Medium\ EDF$ are both positive and significant, confirming a strong debt refinancing effect for firms with higher credit risk. Specifically, a one standard deviation increase in RI lead to 0.4% and 0.3% increase in monthly bond risk premia for high and low EDF groups, respectively, while the RI effect for low EDF is found to be insignificant.

In Column (3), we introduce the natural logarithm of (1+Rating) as a proxy for a firm's credit risk. As anticipated, the coefficient on $RI * Ln(1 + Rating)$ is positive and statistically significant,

[19] According to Moody's Analytics, EDF credit measures have consistently outperformed the rating agencies in distinguishing between defaulting and non-defaulting firms.

indicating that the effect of RI on future bond returns is amplified when credit risk is higher. Interestingly, when we include the interaction term, the coefficient on RI becomes negative. This shift in the coefficient could be attributed to the influence of the financial flexibility of short-term leverage on low credit risk firms. Specifically, the effect of RI on bond returns is negative for bonds with a credit rating of AA- or higher, but positive for bonds rated A+ or lower. For instance, for a credit rating of 5 (A+), which corresponds to the 20th percentile, the RI effect is positive at 0.03.[20] In addition, the RI effect for BBB- rated bonds amounts to 0.29. A one standard deviation increase in RI is associated with a 0.05% increase in monthly bond returns.

In Column (4), we use the high yield dummy variable (HY) as a proxy for high credit risk and run the same set of regressions. The coefficient on $RI * HY$ is 1.19, with a corresponding t-statistic of 4.78. This implies that a one standard deviation increase in RI is associated with a 19 basis point increase in monthly bond returns, which is equivalent to a 2.28% increase in annual bond returns. Moreover, we find that the coefficient on RI becomes insignificant, indicating that the impact of RI on bond returns seems to be primarily concentrated on high yield bonds. Considering the insights gained from Column (3), we can argue that the insignificant coefficient in this column may be attributed to a mixed effect of RI among investment-grade bonds, resulting in an overall lack of significance for RI.

Overall, our empirical findings support *Hypothesis 2*, which suggests that the effect of RI on corporate bond returns is more pronounced when a firm is exposed to higher credit risk. This aligns with He and Xiong (2012)'s calibration, which indicates that market confidence in a firm's ability to rollover their debts deteriorates as a function of the credit risk of firms with different credit ratings and debt maturities. As our results demonstrate, this debt rollover risk is significantly intensified for firms with high expected default frequency and lower credit ratings.

4.3 Debt Refinancing and Bond Liquidity

In this analysis, we investigate whether the impact of debt refinancing intensity on corporate bond returns is amplified when the bond is exposed to higher levels of liquidity risk. Liquidity is a

[20] Taking Ln(1+5) = 1.79, multiplying it by 0.428 gives 0.77. Adding this to the coefficient on RI (-0.74) yields a total RI effect of 0.03 for A-rated bonds.

critical pricing factor in the US corporate bond market, as bonds with higher liquidity levels typically exhibit lower expected returns compared to similarly rated bonds with lower liquidity(Lin, Wang, and Wu, 2011; Bao, Pan, and Wang, 2011; Friewald, Jankowitsch, and Subrahmanyam, 2012). An interesting and unique aspect of this market is that liquidity discrepancies across individual bonds are quite apparent: very few bonds are traded frequently, while most other bonds are rarely traded at all (Mahanti, Nashikkar, Subrahmanyam, Chacko, and Mallik, 2008). Additionally, trading in the US corporate bond market involves significantly higher transaction costs compared to the stock market, leading market participants to expect significant liquidity premia, as argued by Amihud and Mendelson (1986).

In a similar context, bond liquidity risk is a critical determinant of corporate bond returns, and investors demand higher returns for holding illiquid bonds(Bao, Pan, and Wang, 2011; Lin, Wang, and Wu, 2011). Therefore, when a company with illiquid bonds undergoes debt refinancing, it may need to offer better terms, such as higher yields, to attract investors. To test the *Hypothesis 3*, we include the interaction term between *RI* and *Illiquidity* to the baseline model and perform the following panel regression:

$$R_{i,t+1} = \alpha + \beta_1 RI_{j,t} * Illiquidity_{i,t} + \beta_2 RI_{j,t} + \beta_3 Illiquidity_{i,t} + \gamma' Controls_{i,j,t} + \tau_t + \lambda_i + \epsilon_{i,t+1} \quad (6)$$

The specification is similar to Eq.(5) except we interact *RI* with *Illiquidity*. We apply the same set of control variables and fixed effects as before. Bond illiquidity is measured using the Amihud illiquidity measure (Amihud, 2002) for the first two columns and the Roll illiquidity measure (Roll, 1984) for the next two columns. A higher value of the illiquidity measures implies that the bond is more illiquid. The results are presented in Table 4, where the coefficient on the interaction term reflects the impact of bond illiquidity on the relationship between debt refinancing and corporate bond returns. Per *Hypothesis 3*, we anticipate a positive value for the coefficient estimate β_1 of the interaction term.

In Columns (1), we use the Amihud (2002) illiquidity measure as a proxy for bond illiquidity. Consistent with our expectations, we find that the coefficient of *RI* and *Illiquidity* is positive and significant at the 5% level. This suggests that the positive effect of debt refinancing on bond returns is amplified in the presence of higher illiquidity levels. In addition, we find that the coefficient on RI is insignificant, suggesting that the debt refinancing effect concentrating on bonds with greater illiquidity level. In Column (2), we divide the sample into three groups based on Amihud measure for each month. The $High\ ILQ$ group represents the top tercile with the most illiquid bonds, while the $Medium\ ILQ$ group denotes the middle tercile with moderately liquid bonds. We interact RI with dummy variables of high and medium illiquidity bonds. Interestingly, we find that the coefficient on RI and $High\ ILQ$ is positive and significant, suggesting that the liquidity is primarily among illiquid bonds. Specifically, a one standard deviation increase of RI is associated with a 0.04% increase in monthly bond returns for the high illiquidity bonds.

Next, we employ the Roll illquidity measure for Columns (3) and (4). Consistent with previous findings, we observe that the interaction terms between RI and *Illiquidity* is positive and statistically significant in Column (3). Notably, we find that the effect of illiquidity on debt refinancing is stronger in comparison. In Column (4), the coefficient on $RI * High\ ILL$ is 0.647, which is significant at the 1% level, while the coefficient on $RI * Medium\ ILL$ is 0.140, significant at the 10% level. These results suggest that a one standard deviation increase in RI leads to a 0.1% and 0.02% increase in monthly bond returns for the most illiquid and medium illiquid bond groups, respectively. In addition, the insignificant coefficient on RI indicates that investors do not appear to be significantly concerned about rollover risk when bonds can be readily bought or sold in the market without substantially impacting their prices.

In summary, our empirical findings provide support for *Hypothesis 3*, indicating that illiquidity plays a crucial role in the relationship between short-term leverage and bond returns. Our findings shed light on the existing literature regarding bond return predictability (Bekaert, Harvey, and Lundblad, 2007; Amihud, Hameed, Kang, and Zhang, 2015). We propose that the market participants should consider not only the liquidity component of corporate bonds but also its interaction with the debt maturity structure at the firm level. By considering both components simultaneously, we can better understand and assess their substantial impact on future bond premia.

4.4 Debt Refinancing and Bond Maturity

Short-term debt exposes bondholders to debt rollover risk, as noted by He and Xiong (2012) and confirmed by our research findings. As outlined in *Hypothesis 4*, corporate bonds exhibit heterogeneity in their term structure, which results in varying expected debt rollover risk for bonds with different maturities. Bonds with longer maturities are more likely to be impacted by a firm's debt refinancing activities, given that the longer the horizon, the greater the probability of the debt requiring refinancing. Consequently, firms with a higher proportion of short-term debt in their balance sheet are likely to face higher refinancing costs for long-term bonds compared to short-term bonds that are less exposed to such risks.

Taking this aspect into consideration, if a firm experiences losses in rolling over its maturing debt, the holders of long-term bonds bear these losses and demand a higher risk premium, while holders of maturing debt are typically paid in full. To examine this hypothesis, we investigate whether the effect of debt refinancing on bond returns varies across different maturities. Similar to the previous regression specification, we include the interaction term between RI and $Maturity$ to our baseline regression, as follows:

$$R_{i,t+1} = \alpha + \beta_1 RI_{j,t} * Maturity_{i,t} + \beta_2 RI_{j,t} + \beta_3 Maturity_{i,t} + \gamma' Controls_{i,j,t} + \tau_t + \lambda_i + \epsilon_{i,t+1} \quad (7)$$

where β_1 captures the effect of bond maturity on the relation between RI and future bond returns. We anticipate a positive coefficient if the debt refinancing poses a higher risk for long-term bonds. Two measures of maturity are applied in our model. The first measure is the natural logarithm of maturity in years ($Ln(Maturity)$). For the second measure, we divide the sample into three groups based on their maturity structure: short-maturity bonds ($Short - Term$) mature between one year and five years, medium-maturity bonds ($Medium - Term$) mature between five years and ten years, and long-maturity bonds ($Long - term$) have a maturity of ten years or more. This categorization aligns with the approach used in Bai, Bali, and Wen (2019).

The regression results are presented in Table 5. In Column (1) , we use $Ln(Maturity)$ to proxy bond maturity. Consistent with expectations, the coefficient on the interaction term is positive and significant at the 5% level, indicating a stronger debt refinancing effect for bonds with longer maturity. In Column (2), we use dummy variables to represent different maturity groups. Notably, the coefficients on $RI * Long - term$ are positive and highly significant at the 5% level, indicating that the debt financing effect is particularly strong for long-term bonds. Specifically, an increase of one standard deviation in RI is linked to a 0.9 % increase in annualized risk premium for long-term bonds compared to short-term bonds. In other words, when a firm is more exposed to rollover risk, investors require a higher risk premium for long-term bonds. In contrast, the coefficients on $RI * Medium - term$ and RI are both statistically insignificant. This implies that the debt refinancing effect on risk premia primarily applies to long-term bonds.

In a nutshell, our empirical findings indicate that the impact of debt financing is more pronounced for bonds with longer maturities. While short-term bonds issued by firms with a higher rollover risk may not command a premium from investors, the immediacy of a firm's debt refinancing needs can lead to a higher bond risk premium, especially for long-term bonds. This implies that bondholders may seek higher returns for long-term bonds issued by firms with a higher proportion of short-term debt on their balance sheets, reflecting the increased refinancing risks associated with such bonds. These findings support *Hypothesis 4*.

5 Debt Refinancing under Various Market Conditions

This section extends our previous comprehensive analysis, revealing a robust positive correlation between debt refinancing, quantified by refinancing intensity, and its impact on corporate bond returns. We explore the intriguing implications of debt refinancing across diverse market scenarios, with a specific focus on examining how this correlation significantly intensifies during periods of financial crises, heightened interest rates, and tight market conditions. This sheds light on the intersection of debt refinancing and market fluctuations, aiming to demonstrate that the debt refinancing risk premium experiences significant intensification during critical conditions.

5.1 Debt Refinancing and Financial Crisis

The structure model of credit risk suggests that the interplay between default risk and liquidity risk may have a significant effect on bond risk premia, particularly for firms face debt rollover needs. As shown in He and Xiong (2012), the deterioration in debt market liquidity leads not only to a higher liquidity premium but also to a higher default premium, making it difficult to separate liquidity risk from credit risk, or vice versa. In other words, the two types of risk are intertwined and cannot be considered in isolation. The financial crisis of 2007-2009 resulted in a significant credit and liquidity crisis in the corporate bond market, providing a unique opportunity to examine the interaction effect of credit and liquidity risk on the impact of debt financing intensity on bond risk premia.

In this section, we employ the presence of financial crisis as an exogenous shock and examine how the debt refinancing effect is affected when both credit and liquidity are elevated at the same time. Following the predictions from *Hypothesis 2* and *Hypothesis 3*, we propose that the positive relation between debt refinancing intensity and corporate bond returns is more significant during times of financial crisis. we employ a similar specification as in the baseline model, while incorporating an interaction term between the *RI* measure and the *Crisis* variable. The empirical specification is designed as follows:

$$R_{i,t+1} = \alpha + \beta_1 RI_{j,t} * Crisis + \beta_2 RI_{j,t} + \beta_3 Crisis + \gamma' Controls_{i,j,t} + \tau_t + \lambda_i + \epsilon_{i,t+1} \quad (8)$$

The main variable of interest is the interaction term between RI and $Crisis$, which captures the impact of crisis on the debt refinancing effect on bond returns. $Crisis$ is a dummy variable for the financial crisis. Specifically, it takes a value of 1 for periods between December 2007 and June 2009, as determined by the National Bureau of Economic Research (NBER) business cycle dating committee, and 0 otherwise.

Table 6 illustrates the results from the financial crisis interaction. Column (1) represents the findings of test that examines the interaction effect between RI and $Crisis$, considering both firm-level and bond -level control variables. The coefficient estimate of the interaction term is 1.33, which is statistically significant at 1% level (t-statistics = 3.87). More specifically, the results indicate that a one standard deviation rise in RI is linked with a 0.23% increase in future monthly bond returns, which translates to a 2.71% increase in annual bond returns. The economic magnitude is significant, given the comparison of this number to the average annual bond returns during the sample period. This result is also consistent with that of Lin, Wang, and Wu (2011)'s study, which suggests that bonds with higher sensitivity to market-wide liquidity shocks offer higher returns. It is worth emphasizing that the coefficient estimate β_2 represents the impact of RI on bond returns specifically during non-crisis conditions in the sample periods. While the estimate remains positive, it is statistically significant at the 10% level, indicating a relatively smaller effect size (decreasing from 0.165 in panel A of Table 2 to 0.079). However, when we consider the influence of the financial crisis, the coefficient estimate for RI undergoes a significant increase, suggesting that the effect of debt maturity risk becomes more pronounced during the crisis. This finding is consistent with the results reported in Almeida, Campello, Laranjeira, and Weisbenner (2011).

As a robustness check, we extend our analysis to investigate the interaction effect between RI and high market illiquidity on bond returns. During crisis periods, the market-wide illiquidity in the bond market is expected to be significantly high. To capture the influence of bond market illiquidity, we construct a market illiquidity index based on the approach used by Dick-Nielsen, Feldhütter, and Lando (2012). High bond market illiquidity (*High MKT ILQ*) is defined as the period when the market illiquidity index exceeds the median value observed over the entire sample period. We anticipate a more pronounced impact of RI on bond returns during periods of high market illiquidity.As presented in Column (2) of our results, we observe a positive and statistically significant coefficient for the interaction term, supporting our findings that exogenous market-wide shocks can aggregate the risk premium associated with debt refinancing. Furthermore, the coefficient on RI becomes statistically insignificant, suggesting that the influence of debt refinancing risk becomes more prominent during periods of elevated market illiquidity.

As a whole, the results from Table 6 suggests that the rollover risk, which becomes increasingly prominent during financial crisis periods, is a critical factor for bond investors. At times of elevated risks, investors typically demand higher risk premia, as demonstrated by increased bond returns.

This heightened expectation is a direct consequence of exogenous default and liquidity shocks, such as the financial crises, where the need for greater rollover risk premia arises in response to the perceived instability and unpredictability of the market environment (Brunnermeier and Pedersen, 2009; He and Krishnamurthy, 2012).

5.2 Debt Refinancing and Interest Rate Environment

In this subsection, we delve into the interaction effect of debt refinancing and different interest rate environments on corporate bond returns. Notably, the sensitivity of the debt structure to fluctuations in interest rates has been demonstrated by Leland (1994) and Goldstein, Ju, and Leland (2001). Consequently, the ramifications of different interest rate scenarios on debt refinancing can carry substantial implications for both borrowers and lenders alike. Refinancing existing debt in a high-interest-rate environment leads to higher interest expenses, resulting in a higher bond premium. In addition, interest rates fluctuate over time, creating a changing interest rate environment. Specifically, during an increasing interest rate environment, refinancing becomes more costly for firms seeking to replace existing debt, causing investors to demand higher compensations. To examine this interaction effect, we perform the following regression:

$$R_{i,t+1} = \alpha + \beta_1 RI_{j,t} * FRR_{i,t} + \beta_2 RI_{j,t} + \beta_3 FRR_{i,t} + \gamma' Controls_{i,j,t} + \tau_t + \lambda_i + \epsilon_{i,t+1} \qquad (9)$$

where β_1 captures the interaction effect of different interest rate environments on future bond returns. The variable FRR refers to the dummy variable for various interest rate environments. To identify the high interest rate environment, we rely on historical federal funds rate. The average federal funds rate is 1.40% over the sample period, with values ranging from 0.09% at the 10th percentile to 4.5% at the 90th percentile. We use two dummy variables to proxy the high interest rate environment. The first dummy variable ($FFR \geq 2\%$) is based on the federal funds rate being 2% or more, which serves as the threshold for the 75th percentile of the sample federal fund rate. The second dummy variable ($FFR \geq 4.5\%$) is based on the federal funds rate being 4.5% or more, the threshold for the 90th percentile. These dummy variables allow us to capture periods when the interest rates were relatively high. To identify the periods of increasing interest rates, we use the interest rate hike announcements made by the Federal Reserve. Throughout the sample period, the Federal Reserve has implemented interest rate hikes a total of 26 times. In our analysis, we consider the refinancing effect during the month of the announcement and the subsequent month as the treatment period.[21] Thus, our initial approach involves utilizing the dummy variable, *FFR Increase*, to identify the periods with interest rate hikes. In addition, we take into account the cumulative changes of federal fund rates over the past one-year periods. Specifically, we examine two types of cumulative changes in federal fund rates: those between 25 to 100 bps denoted as *FFR Inc. 25-100 bps*, and those exceeding 100 bps referred to as *FFR Inc.* $> 100bps$.

Table 7 presents the panel regression results, revealing a compelling story about the debt refinancing effect, particularly in high-interest rate environments and periods of interest rate hikes. In Column (1), we observe that during periods when the federal fund rate is 2% or higher, a one standard deviation increase in a firm's refinancing intensity (RI) leads to a monthly excess return increase of 5.62 bps (equivalent to 67 bps per annum). Notably, as depicted in Column (2), the interaction effect becomes even more pronounced when the average interest rate reaches 4.5% or higher. We observe that a one standard deviation increase in RI is associated with an impressive 17.7 bps monthly excess return increase, equivalent to 212 bps per annum. These findings suggest that a high-interest rate environment may lead to elevated financing costs, causing borrowers to demand a higher risk premium, thereby intensifying the debt refinancing effect.

In Column (3) and (4), we observe a noteworthy trend wherein the refinancing effect strengthens during periods of increasing interest rates. Specifically, a one standard deviation increase in RI leads to a 7 bps increase in monthly excess returns during periods characterized by federal fund rate hikes. To account for historical interest rate changes, we construct dummy variables for cumulative interest rate hikes between 25-100 bps and those exceeding 100 bps, respectively. As expected, our findings indicate that the debt refinancing effect becomes even more pronounced when the

[21] In our analysis, we examine the interaction effect of debt refinancing and announcements of interest rate hikes. Thus, we study the impact during the months of announcement and the subsequent months. Furthermore, in an untabulated table, we explore the effects over the entire interval of a series of interest rate hikes. For instance, if the Fed raises the interest rate in the first month of the year and follows up with another increase three months later, we treat the entire three-month period as the treated period. Employing this alternative approach yields comparable results, reinforcing the robustness of our findings.

cumulative interest rate changes are greater. This intuitively aligns with the notion that higher interest rates impose additional financing costs on firms, making refinancing more challenging and, consequently, enhancing the impact of the refinancing effect.

5.3 The Effect of Investor Sentiment and Risk Aversion on Debt Refinancing Risk Premium

In this section, we further explore the debt refinancing premium across various market conditions. In periods characterized by tight credit markets or when investors exhibit greater risk aversion, bond investors typically require higher risk premiums. This is because the deterioration in debt market liquidity not only results in a higher liquidity premium but also an elevated default premium (He and Xiong, 2012). To test the conjecture, we use two approaches to proxy market conditions.

The first approach we employ is the risk aversion index developed by Bekaert, Engstrom, and Xu (2022), denoted as RA^{BEX}. This index utilizes a dynamic no-arbitrage asset pricing model that incorporates equities and corporate bonds. It serves as a measure of aggregate risk aversion that varies over time, reflecting the prevailing risk appetite of market participants. Higher values of the index indicate greater levels of risk aversion among market participants. A high risk aversion period is identified when the risk aversion index in month (t-1) is in the top quintile of the sample period.

The second approach is the issuer quality measure introduced by Greenwood and Hanson (2013), referred to as $SENT^{GH}$. This measure estimates the average differences in issuer quality between high and low net debt issuer firms. The $SENT^{GH}$ measure takes on high values when low-quality firms are disproportionately issuing debt securities. Increased issuance of low-quality (i.e., high-EDF) bonds is indicative of prosperous periods in the corporate bond market when investor sentiment is strong. Conversely, a low-sentiment period is defined as a month (t - 1) in which the credit market sentiment falls within the bottom quintile of the sample period.

To investigate the impact of investor sentiment and risk aversion on the debt refinancing risk premium, we augment the baseline regression model (Eq. (4)) by incorporating interaction terms between RI and the dummy variables representing low sentiment and high risk aversion. The regression model is expressed as follows:

$$R_{i,t+1} = \alpha + \beta_1 RI_{j,t} * DUM_{i,t} + \beta_2 RI_{j,t} + \beta_3 DUM_{i,t} + \gamma' Controls_{i,j,t} + \tau_t + \lambda_i + \epsilon_{i,t+1} \quad (10)$$

where DUM represents dummy variables for high risk aversion and low-sentiment periods. All other variables are defined the same manner as described in Eq.(4). The regression results are reported in Table 8. Specifically, the results of the model that employs the RA^{BEX} measure are reported in Columns (1) and (2), and the $SENT^{GH}$results are reported in Columns (3) and (4).

In Column (1), we examine the impact of risk aversion. As expected, the coefficient on the interaction between RI and Ln (RA^{BEX}) is positive, indicating that the debt refinancing premium increases during periods characterized by "risk aversion." The deterioration in debt market liquidity amplifies the effect of a firm defaulting at a higher boundary, as liquidity risk and default risk can compound each other (He and Xiong, 2012). Consequently, investors expect higher rollover risk premiums when they are burdened with maturing debt and exposed to risk aversion appetite. In Column (2), the coefficient on the interaction term of RI and *High RA* is 0.432, significant at the 1% level with a t-statistic of 2.75. This result has twofold implications: Firstly, the coefficient of RI under risk aversion conditions is significantly stronger than during all sample periods. Compared to Table 2, where the RI coefficient is 0.165, it highlights the increased impact of RI when aggregate risk aversion of market participants is high. Secondly, we can interpret the result as follows: a one standard deviation increase in RI corresponds to a 0.08% increase in monthly bond excess returns (equivalent to a 0.97% increase in annualized bond returns) when the *High RA* dummy equals 1. In both models, we have included firm-level characteristics and bond-level characteristics, respectively. These findings provide direct evidence that risk aversion among investors influences the debt refinancing premium.

In Columns (3) and (4), we replicate the regressions using the investor sentiment index as a proxy for market conditions. Consistent with our earlier findings, the coefficient on the interaction between RI and Ln (1 + $SENT^{GH}$) is negative and significant, and the interaction with *Low Sentiment* is significantly positive. During periods characterized by low sentiment (tight) market conditions, a one standard deviation increase in RI is associated with a 0.17% increase in monthly bond excess returns (equivalent to a 2.09 % increase in annualized bond returns). Our results indicate that bondholders demand higher premiums for maturity risk during periods of tight credit markets.

6 The Premium for Debt Refinancing Risk

In this section, we build upon our previous findings, which reveal a significantly positive relationship between debt refinancing intensity and bond returns through cross-sectional regression analysis. To delve deeper into the impact of debt refinancing risk on bond returns, we employ portfolio procedures commonly used in empirical asset pricing studies. Our objective is twofold: first, to measure the risk premium associated with debt refinancing risk, and second, to examine how this premium interacts with common risk factors that serve as proxies for systematic risk. By doing so, we aim to gain a better understanding of the significance and implications of debt refinancing risk in the cross-section of bond returns.

We begin by conducting a triple 2×3×3 sort based on firms' rating (i=1,2), maturity (j=1,2,3) and debt refinancing intensity (k=1,2,3). The portfolios are constructed from independent sorts, enabling us to separate the premia associated with credit ratings from the premia associated with debt refinancing risk while also controlling for bond maturity effects. We denote the excess returns of the 18 portfolios by R_t^{ijk} and capture return differentials associated with debt refinancing intensity ($R_{RI,t}$) from the respective portfolio interseactions by

$$R_{RI,t} = \frac{1}{6}\left(\sum_{i=1}^{2}\sum_{j=1}^{3} R_t^{ij3} - \sum_{i=1}^{2}\sum_{j=1}^{3} R_t^{ij1}\right) \tag{11}$$

As clarified initially, our goal here is not to search for new debt-related bond factors. Instead, we employ these procedures to estimate the premia associated with the debt maturity structure in a manner consistent with the construction of portfolio risk factors that have demonstrated success in pricing the cross-section of bond returns. The similar spirit is also applied in Friewald, Nagler, and Wagner (2022).

6.1 Portfolio Summary Statistics

Table 9 presents summary statistics for the portfolios used in computing the premia for rating, maturity and debt refinancing risk. First, we note that there is little dispersion in RI for both the investment-grade and high-yield portfolios (0.27 for both), as well as for the short-term and long-term portfolios (0.28 and 0.27 respectively). Consistent with prior research, we find that bond rating and the term of maturity are two primary determinants of bond returns. The HY-minus-IG return differential is 0.39% per month for EW and VW portfolios. Similarly, the long-minus-short return differential is 0.39% for EW and 0.36% for VW portfolios. Second, the variation in rating and maturity is small across RI portfolios. The average rating of high-RI portfolio is 9.7 (10 is equivalent to BBB- rating) and the average rating of low-RI portfolio is about half notch higher at 10.2 (i.e., rated slightly below BBB-). By contrast, the rating difference is more than 6 notches between IG and HY portfolios (6.85 versus 12.98). Additionally, the average maturity of high-RI portfolio is slightly shorter than that of the low-RI portfolio (10.6 vs. 11.1).

By closely examining the portfolio averages of firm and bond characteristics commonly employed in constructing risk factors, we observe notable differences between the low and high RI portfolios. First, the high RI portfolio exhibits a significantly larger average size ($MCAP$) compared to the low RI portfolio, with a ratio of approximately 2:1. In terms of the M/B ratio, high RI group is slightly higher than low RI (2.76 versus 2.68). Second, the average asset growth of the high RI group is less than half that of the low RI group (0.08 versus 0.03). This suggests that firms burdened with more short-term debt have limited opportunities to increase their total assets since they frequently need to refinance their short-term debt. However, the high RI group demonstrates higher profitability, with an average return of 0.10 compared to 0.07 for the low RI group. Third, the bond market β (β^{Bond}) is 1.21 for high RI portfolio while it is 1.28 for low RI portfolio. Both portfolios have the same level of downside risk at the 0.08%.[22] Finally, the illiquidity measure Amihud (2002) demonstrates that the high RI portfolio is almost twice as high as the low RI portfolio.

[22] For convenience of interpretation, we multiply the original VaR measure by -1. Note that the original maximum likely loss values are negative since they are obtained from the left tail of the return distribution. After multiplying the original VaR measure by -1, a positive value of VaR is interpreted as indicating higher downside risk.

These results provide valuable economic insights into the characteristics and differences between the low and high RI portfolios, shedding light on factors such as firm size, profitability, asset growth, market sensitivity, downside risk, and liquidity.

6.2 Spanning Regression Results

By applying factor mimicking portfolio procedures, we gain insight into the connection between debt-related premia and systematic risk, and determine whether these premia can be explained by standard risk factors. Specifically, in our analysis of the premia related to debt refinancing risk, we employ the high-minus-low returns from equation (11). Our aim is to investigate whether these return differentials adequately compensate bondholders for their exposure to systematic risk. To achieve this, we conduct spanning regressions utilizing the commonly recognized bond risk factors proposed by Fama and French (1993), Lin, Wang, and Wu (2011) and Bai, Bali, and Wen (2019).

Table 10 presents the time-series averages of the high-minus-low return differentials based on refinancing intensity (R_{RI}), along with the results of spanning regressions using the common bond risk factors. All t-statistics, enclosed in brackets, are calculated using HAC standard errors with Newey and West (1987) method and the optimal truncation lag recommended by Andrews (1991).

The results in Column (1) show that the RI premium is significantly positive with an estimate of 0.10% per month (t-statistic = 2.18). Column (2) shows that RI premium is positively related to bond market risk with a loading of 0.21 (t-statistic =2.63). In Column (3), we include the remaining bond risk factors constructed by Bai, Bali, and Wen (2019), namely, downside risk factor (DRF), credit risk factor (CRF) and liquidity risk factor (LRF), to the spanning regressions. For the refinancing premium, we find significantly positive loadings on the credit risk factor (t-statistic = 2.67) and the liquidity risk factor (t-statistic = 2.27). However, we find an insignificant alpha, as well as insignificant loadings on the bond market risk and downside risk factors.

These results show that the cross-section of bond returns exhibits a positive premium for debt refinancing risk. A higher immediacy of debt refinancing is associated with higher bond returns, reflecting an increased exposure to systematic risk. Specifically, the positive exposure to credit risk factor and liquidity risk factor illustrates the compensation for debt refinancing risk. These findings align with our proposed hypotheses (*Hypothesis 2* and *Hypothesis 3*), emphasizing the pricing of credit risks and liquidity risks in relation to firms' debt maturity structures. In total, our results highlight the crucial role of short-term debt in magnifying a firm's rollover risk, as initially discussed in the model proposed by He and Xiong (2012).

7 Conclusion

Global fixed income markets outstanding were \$126.9 trillion in 2021, while global equity market capitalization amounted to \$124.4 trillion (SIFMA, 2022). In the United States, corporate bond issuance reached \$2.0 trillion, compared to an initial public offering (IPO) volume of \$153.5 billion. While corporate bond markets and equity markets share similar size and significance in the economy, the academic understanding of the risk-return trade-off is comparatively less developed in corporate bond markets than in equity markets.

Our paper aims to offer a unique perspective on bond returns by examining the relationship between debt maturity choices and leverage-related premia in corporate bond returns. As in Friewald, Nagler, and Wagner (2022), we decompose firms' leverage into two categories: short-term debt (maturing within three years) and long-term debt (maturing in more than three years). In addition, we construct a debt refinancing intensity (RI) variable, a proxy for short-term leverage, that captures a firm's immediate refinancing needs. we show that bonds with a higher RI are associated with a higher excess return in the next period, and the effect of RI is more pronounced under conditions of more intense default and liquidity risk. Our empirical evidence shows that bond premia associated with short-term and long-term leverage are intrinsically different: bond returns increase in short-term leverage but not in long-term leverage. This finding indicates that bondholders do not price all leverage-related risk equally.

The principal findings of this paper align with the concept of the debt rollover risk channel. Specifically, bond investors demand higher premia for bonds issued by companies with high levels of short-term debt due to the greater risk of needing to refinance that debt. The empirical finding also demonstrates that this refinancing risk is significantly heightened during challenging circumstances, particularly for firms with lower credit ratings. Additionally, bonds that are less liquid on secondary markets are subject to greater refinancing risks. Bond investors understand that these less liquid bonds cannot be sold off as easily as the more liquid ones, so they require higher premia to offset any potential losses.

The implications of our findings shed light on corporate finance applications: firms should consider the risk of debt refinancing when choosing their debt maturity structure. When raising external capital, companies need to account for the risk of short-term leverage, rather than just the overall leverage. Furthermore, as proposed in De Fiore and Uhlig (2015), the endogenously evolving debt structure may impact the possibility for companies to switch between bank financing and bond financing. In line with this, since a firm's bond capital becomes more expensive with a higher proportion of short-term leverage, firms may opt to finance more through bank financing. However, if banks also evaluate the risk associated with short-term debt differently, this would ultimately aggregate the refinancing needs for the firms overall. A possible extension would be to investigate the spillover effect of this debt refinancing intensity for firms with financial frictions.

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Appendix: Variable Definition

The variables used in the paper are listed below (with Compustat data items in parentheses).

- *Excess Bond Return* is defined as the monthly return of an individual bond in excess of the one-month T-bill rate (Lin, Wang, and Wu, 2011; Bai, Bali, and Wen, 2019).
- *RI* is debt refinancing intensity, defined as the ratio of short-term debt (dd1+dd2+dd3) to total debt (dd1+dltt) (Friewald, Nagler, and Wagner, 2022).
- *Leverage* (*LEV*) is the sum of short-term debt (dd1) and long-term debt (dltt) scaled by total assets (at) at the end of each quarter (Baker and Wurgler, 2002).
- *Firm Size (MCAP)* the market value of a firm's common equity (prc * shrout) at the end of each month. The market value of equity is measured in billions.
- *ROE* is return on equity, defined as the income before extraordinary items (ib) divided by the book value of common equity (ceq).
- *Maturity* is a bond's time to maturity in years.
- *Rating* is the bond's numerical credit rating based on the following letter rating conversion scheme: AAA=1, AA+=2, ..., C=21 and D=2. We mainly use the Standard & Poor's (S&P) rating from the FISD; when it is not available, we use Moody's or Fitch rating when possible and drop bonds whose ratings are not identified. Following Huynh and Xia (2021), we use natural logarithm of one plus rating ($ln(1 + rating)$) in the regression analysis.
- *Issue Size* is the principal amount outstanding of a given bond in a million dollars.
- *Reversal* is the excess bond returns in the prior month.
- ILQ^{Amihud} is the Amihud illiquidity measure (Amihud, 2002). It measures the price impact of a trade per unit traded. For each corporate bond i, the measure is the daily average of absolute returns $r_{i,t}$ divided by the trade size Q_i of consecutive transactions:

$$\text{Amihud}_{i,j} = \frac{1}{N}\sum_{t=1}^{N}\frac{|r_i|}{Q_i} \tag{A1}$$

  where N is the number of returns on day t. At least two transactions are required on a given day to calculate the measure, and we define a monthly Amihud measure by taking the median of daily measures within the month.

- ILQ^{Roll} is the Roll illiquidity measure. Roll (1984) finds that the percentage bis-ask spread equals two times the square roo of minus the covariance between consecutive returns:

$$\text{Roll}_t = 2\sqrt{-cov(R_{t,k}, , R_{t,k-1})} \tag{A2}$$

  where $R_{t,k}$ and $R_{t,k-1}$ are returns to two consecutive traded indexed by k and $k-1$, are the covariance is computed over all trades during a 21-day window ending on day t. We require at least one trade during the 21-day window for the daily Roll measure to be valid. Then the monthly Roll measure is the median of all valid daily Roll measures during the month.

- *Coupon* is the bond's annual coupon rate in percentages.
- *Call* is the dummy variable for callable bonds.
- *HY* is the dummy variable for high yield bonds that are rated below BBB-.
- *Crisis* is the dummy variable for the financial crisis, defined from December 2007 to June 2009.
- *FRR* refers to the federal fund rate, which is a dummy variable representing various interest rate environments.
- $SENT^{GH}$ is measured as the default risk of high-debt issuers (hd) with that of low-debt issuers (ld), following Greenwood and Hanson (2013). We compare the credit quality of firms that issue large amounts of debt to that of firms that issue little debt or are retiring debt.

$$SENT_t^{GH} = \frac{\sum_{i \in hd_{it}} \text{EDF Rank}_{it}}{N_t^{hd_{it}}} - \frac{\sum_{i \in ld_{it}} \text{EDF Rank}_{it}}{N_t^{ld_{it}}} \tag{A3}$$

where EDF Rank represents the decile rank of a bond issuer's expected default frequency. The numbers of high-debt issuance firms and low-debt issuance firms are denoted as $N^{hd_{it}}$ and $N^{ld_{it}}$ respectively. Debt issuance is calculated as the change in assets (at) minus the change in book equity (seq) from Compustat, scaled by lagged assets. A bond issuer's expected default frequency is computed following Merton (1974) and Bharath and Shumway (2008). $SENT^{GH}$ compares the average EDF rank of issuers with high net debt (net debt issuance in the top quintile of the sample) to that of issuers with low net debt (net debt issuance in the bottom quintile of the sample). $SENT^{GH}$ assesses the overall credit quality sentiment in both the loan and bond markets. Higher values of $SENT^{GH}$ indicate a greater presence of debt issuers with poor credit quality, serving as a barometer for the issuer quality in the credit market.

- RA^{BEX} is a time-varying risk aversion index obtained from Bekaert, Engstrom, and Xu (2022).
- *EDF* is the expected default frequency developed by Moody's Analytics to estimate the default probability based on Merton's (1974) framework. The estimation of *EDF* involves two steps. In the first step, we calculate the distance to default (DD) measure for each individual bond issuer using the following formula:

$$DD = \frac{ln(V/D) + (\mu - 0.5\sigma_v^2)T}{\sigma_v\sqrt{T}} \tag{A4}$$

where V is the firm's market value; D is the sum of a firm's current debt (dlc) and half of the firm's long-term liabilities (dltt) (Bharath and Shumway, 2008); T is the forecasting horizon of 1 year. Besides, μ denotes the firm's asset return and σ_v represents the firm's asset volatility, both estimated following the approach described in Bharath and Shumway (2008). In the second step, we estimate the default probability as $(1 - Norm(DD))$ where $Norm$ represents a normal cumulative density function.

- *VaR* refers to the 5% value at risk, which is calculated based on the lower tail of the bond return distribution. Specifically, it is obtained by taking the second lowest monthly return observation from the previous 36 months and multiplying it by -1 (Bai, Bali, and Wen, 2019).

- *Bond Market* β *(*β^{bond}*)* is estimated from the time-series regressions of individual bond excess returns on the bond market excess returns using a 36-month rolling window.

- *Asset Growth* (*AG*) is the year-over-year percentage change in total assets (at) from the end of fiscal year $t - 2$ to the end of fiscal year $t - 1$ (Cooper, Gulen, and Schill, 2008).

- *Market-to-book ratio (M/B)* is the ratio of market value to book value of an asset, defined by dividing the sum of market capitalization and total assets minus the book value of equity by total assets.

Table 1: Summary Statistics

This table reports summary statistics for bond-month observations over the sample period from July 2002 to December 2020. The descriptive statistics include the sample mean, 25th percentile, median, 75th percentile, and standard deviation of the variables used in this study. The variables analyzed in this study include monthly excess bond returns ($Excess\ Return$, %) and refinancing intensity (RI), as well as several firm characteristics, such as leverage (LEV), market value of equity ($MCAP$, in billions), and return on equity (ROE). Bond characteristics include maturity in years ($Maturity$), credit rating ($Rating$), issuing amount ($Issue\ Size$, in billions), expected default freqency (EDF), Amihud illiquidity measure (ILQ^{Amihud}), Roll illiquidity measure (ILQ^{Roll}) and the dummy variable for callable bonds ($Call$). Variables are defined in the Appendix.

Variable	N	Mean	25th Pctl.	Median	75th Pctl.	Std. Dev.
Excess Return [in %]	296,864	0.45	-0.47	0.27	1.32	3.64
RI	296,864	0.27	0.16	0.24	0.35	0.16
LEV	296,864	0.32	0.23	0.31	0.40	0.12
MCAP [$ Bil]	296,864	65.30	12.68	28.84	73.57	98.94
ROE	296,864	0.15	0.06	0.12	0.21	0.27
Maturity	296,864	10.46	4.00	7.00	16.00	9.67
Rating	296,864	7.45	6.00	7.00	9.00	2.85
Issue Size [$ Bil]	296,864	0.65	0.30	0.50	0.75	0.64
EDF	296,691	0.02	0.00	0.00	0.00	0.09
ILQ^{Amihud} [% in $ Mil]	264,832	1.22	0.23	0.54	1.30	2.03
ILQ^{Roll} [%]	296,660	1.23	0.31	0.71	1.48	1.89
Call	296,864	0.80	1.00	1.00	1.00	0.40

Table 2: Debt Refinancing and Corporate Bond Returns

This table presents the panel regression results of monthly excess bond returns on RI and LEV over the sample period from July 2002 to December 2020. Panel A reports results of all levered firms while Panel B exclue AZL firms (All-but-AZL), defined as firms with a leverage ratio below 5%. The dependent variable is the monthly corporate return, which is the difference between bond raw return estimated from Eq. (3) and 1-month Treasury bill rate. The main variables of interest are relative intensity (RI) and leverage (LEV). Other firm characteristics include firm size (Ln(MCAP)), defined as the natural logarithm of the market value of the issuer's common equity and return on equity (ROE). Bond characteristic variables include the natural logarithm of the maturity in year (Ln(Matuiry), the natural logarithm of one plus credit rating (Ln(1+Rating)), and the natural logarithm of issuer size (Ln(Issue Size), return reversal (Reversal) and dummy variables for callable bond (Call). Variables are defined in the Appendix. Bond issuer and year fixed effects are included in all regressions and t-values based on standard errors clustered at the bond level are reported in parentheses. *, ** or *** denotes the significance at the 10%, 5%, or 1% level, respectively.

Panel A. All Levered Firms				
	(1)	(2)	(3)	(4)
RI	0.114**	0.117**	0.129**	0.165***
	(2.29)	(2.32)	(2.55)	(3.18)
LEV		0.130	0.144	-0.154
		(1.11)	(1.34)	(-1.45)
Ln(MCAP)			0.099***	0.196***
			(3.07)	(6.19)
ROE			-0.326***	-0.280***
			(-4.71)	(-5.20)
Ln(Maturity)				0.170***
				(20.47)
Ln(1+Rating)				0.661***
				(8.99)
Ln(Issue Size)				0.039***
				(5.05)
Reversal				-0.062***
				(-5.31)
Illiquidity				0.116***
				(9.11)
Call				0.009
				(0.48)
Issuer Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
No. of obs.	296,864	296,864	296,864	264,832
$Adj.R^2$	0.025	0.025	0.026	0.040

Panel B. All but AZL				
	(1)	(2)	(3)	(4)
RI	0.149***	0.150***	0.164***	0.196***
	(2.68)	(2.69)	(2.94)	(3.37)
LEV		0.116	0.116	-0.171
		(0.93)	(1.02)	(-1.51)
Ln(MCAP)			0.101***	0.199***
			(3.05)	(6.11)
ROE			-0.324***	-0.278***
			(-4.59)	(-5.02)
Ln(Maturity)				0.172***
				(21.15)
Ln(1+Rating)				0.689***
				(8.86)
Ln(Issue Size)				0.038***
				(4.96)
Reversal				-0.064***
				(-5.41)
Illiquidity				0.114***
				(9.30)
Call				0.010
				(0.51)
Issuer Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
No. of obs.	290,040	290,040	290,040	258,464
$Adj.R^2$	0.026	0.026	0.026	0.040

Table 3: The Effect of Default Risk on Debt Refinancing

This table presents the panel regression results of the effect of default risk on debt refinancing and corporate bond returns. The dependent variable is the monthly corporate return, which is the difference between bond raw return estimated from Eq.(3) and 1-month Treasury bill rate. The main variables of interest are interaction terms between default risk proxies and relative intensity (RI). A bond's default risk is proxied using two measures: expected default frequency and the bond's credit rating. The expected default frequency (EDF) is estimated based on methods proposed by Merton (1974) and Bharath and Shumway (2008). For each month, we classify bond issuers that fall within the top quintile as firms with a high expected default frequency (High EDF). We take the natural logarithm of credit rating (Ln(1+Rating)). High yield bonds (HY) include bonds with ratings of BB+ or lower. Other firm characteristics include leverage (LEV), firm size (Ln(MCAP)), defined as the natural logarithm of the market value of the issuer's common equity and return on equity (ROE). Bond characteristic variables include the natural logarithm of the maturity in year (Ln(Matuiry), and the natural logarithm of issuer size (Ln(Issue Size), return reversal (Reversal) and dummy variables for callable bond (Call). Variables are defined in the Appendix. Bond issuer and year fixed effects are included in all regressions and t-values based on standard errors clustered at the bond level are reported in parentheses. *, ** or *** denotes the significance at the 10%, 5%, or 1% level, respectively.

	Expected Default Frequency		Credit Rating	
	(1)	(2)	(3)	(4)
RI* EDF	1.365**			
	(2.14)			
RI* High EDF		0.227**		
		(2.09)		
RI* Medium EDF		0.179**		
		(2.11)		
RI* Ln(1+Rating)			0.428**	
			(2.24)	
RI * HY				1.187***
				(4.78)
RI	0.120**	0.014	-0.740*	-0.015
	(2.37)	(0.22)	(-1.91)	(-0.30)
EDF	-0.245			
	(-0.81)			
High EDF		0.037		
		(1.07)		
Low EDF		-0.021		
		(-0.86)		
Ln(1+Rating)			0.508***	
			(5.91)	
HY				0.261***
				(3.18)
LEV	0.022	-0.040	-0.153	-0.098
	(0.23)	(-0.41)	(-1.43)	(-1.06)
Ln(MCAP)	0.139***	0.147***	0.194***	0.188***
	(4.74)	(4.35)	(6.12)	(6.00)
ROE	-0.309***	-0.317***	-0.280***	-0.313***
	(-5.73)	(-5.77)	(-5.20)	(-5.83)
Ln(Maturity)	0.166***	0.166***	0.169***	0.167***
	(20.18)	(20.16)	(20.42)	(20.48)
Ln(Issue Size)	0.039***	0.039***	0.039***	0.043***
	(5.13)	(5.18)	(5.04)	(5.61)
Reversal	-0.062***	-0.062***	-0.062***	-0.062***
	(-5.26)	(-5.26)	(-5.31)	(-5.32)
Illiquidity	0.117***	0.117***	0.116***	0.116***
	(9.13)	(9.11)	(9.11)	(9.14)
Call	0.034*	0.037**	0.008	0.035*
	(1.79)	(2.00)	(0.41)	(1.84)
Issuer Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
No. of obs.	264,712	264,832	264,832	264,832
$Adj.R^2$	0.039	0.039	0.040	0.040

Table 4: The Effect of Liquidity Risk on Debt Refinancing

This table presents the panel regression results of the effect of liquidity risk on debt refinancing and corporate bond returns. The dependent variable is the monthly corporate return, which is the difference between bond raw return estimated from Eq.(3) and 1-month Treasury bill rate. The main variables of interest are interaction terms between liquidity risk proxies and relative intensity (RI). A bond's liquidity risk is assessed using two measures: the Amihud illiquidity measure (Amihud, 2002) and the Roll illiquidity measure (Roll, 1984; Dick-Nielsen, Feldhütter, and Lando, 2012). Further, at the end of each month, the sample is divided into terciles based on the Amihud illiquidity measure. The top tercile group, known as High ILQ, comprises the least illiquid bonds. The middle tercile group is known as Medium ILQ. Other firm characteristics include leverage (LEV), firm size (Ln(MCAP)), defined as the natural logarithm of the market value of the issuer's common equity and return on equity (ROE). Bond characteristic variables include the natural logarithm of the maturity in year (Ln(Matuiry), the natural logarithm of credit rating (Ln(1+Rating)), and the natural logarithm of issuer size (Ln(Issue Size), return reversal (Reversal) and dummy variables for callable bond (Call). Variables are defined in the Appendix. Bond issuer and year fixed effects are included in all regressions and t-values based on standard errors clustered at the bond level are reported in parentheses. *, ** or *** denotes the significance at the 10%, 5%, or 1% level, respectively.

	Amihud Illiquidity		Roll Illiquidity	
	(1)	(2)	(3)	(4)
RI * Illiquidity	0.242**		0.434***	
	(2.27)		(3.15)	
RI * High ILQ		0.240**		0.647***
		(2.10)		(4.03)
RI * Medium ILQ		0.099		0.140*
		(1.20)		(1.69)
RI	-0.121	0.046	-0.364*	-0.031
	(-0.94)	(0.66)	(-1.95)	(-0.37)
Illiquidity	0.049*		0.126***	
	(1.90)		(4.20)	
High ILQ		0.064*		-0.042
		(1.86)		(-0.93)
Medium ILQ		0.007		-0.055*
		(0.24)		(-1.94)
LEV	-0.164	-0.142	-0.350***	-0.110
	(-1.54)	(-1.33)	(-2.92)	(-0.89)
Ln(MCAP)	0.196***	0.195***	0.187***	0.194***
	(6.20)	(6.10)	(5.66)	(5.81)
ROE	-0.275***	-0.294***	-0.251***	-0.315***
	(-5.11)	(-5.32)	(-3.63)	(-4.37)
Ln(Maturity)	0.168***	0.207***	0.084***	0.185***
	(20.41)	(23.97)	(6.19)	(18.98)
Ln(1+Rating)	0.649***	0.709***	0.563***	0.804***
	(9.09)	(9.14)	(7.04)	(9.65)
Ln(Issue Size)	0.044***	0.002	0.076***	-0.024*
	(5.37)	(0.33)	(6.32)	(-1.95)
Reversal	-0.063***	-0.062***	-0.117***	-0.106***
	(-5.40)	(-5.25)	(-8.80)	(-8.12)
Call	-0.008	-0.034*	0.037	-0.015
	(-0.36)	(-1.83)	(1.47)	(-0.62)
Issuer Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
No. of obs.	264,832	264,832	296,660	296,660
$Adj.R^2$	0.04	0.036	0.052	0.039

Table 5: Debt Refinancing and Bond Maturity

This table presents the panel regression results of the effect of bond maturity on debt refinancing and corporate bond returns. The dependent variable is the monthly corporate return, which is the difference between bond raw return estimated from Eq.(3) and 1-month Treasury bill rate. The main variables of interest are the interaction terms between relative intensity (RI) and bond maturity. Ln(Maturity) represents the natural logarithm of a bond's time to maturity in years. Long-term is a dummy variable that takes the value of 1 for bonds with a maturity of ten years or more. Medium-term is the dummy variable that takes the value of 1 for bonds with a maturity between five years and ten years. Firm characteristics include leverage (LEV), include firm size (Ln(MCAP)), defined as the natural logarithm of the market value of the issuer's common equity and return on equity (ROE). Bond characteristic variables include the natural logarithm of the maturity in year (Ln(Matuiry), the natural logarithm of credit rating (Ln(1+Rating)), and the natural logarithm of issuer size (Ln(Issue Size), return reversal (Reversal) and dummy variables for callable bond (Call). Variables are defined in the Appendix. Bond issuer and year fixed effects are included in all regressions and t-values based on standard errors clustered at the bond level are reported in parentheses. *, ** or *** denotes the significance at the 10%, 5%, or 1% level, respectively.

	(1)	(2)
RI * Ln(Maturity)	0.160**	
	(2.15)	
RI * Long-term		0.396**
		(2.32)
RI * Medium-term		0.000
		(0.00)
RI	-0.155	0.072
	(-0.89)	(1.10)
Ln(Maturity)	0.128***	
	(6.28)	
Long-Term		0.198***
		(4.92)
Medium-Term		0.143***
		(6.67)
LEV	-0.151	-0.151
	(-1.42)	(-1.42)
Ln(MCAP)	0.197***	0.198***
	(6.19)	(6.21)
ROE	-0.280***	-0.281***
	(-5.19)	(-5.20)
Ln(1+Rating)	0.653***	0.637***
	(9.00)	(8.79)
Ln(Issue Size)	0.039***	0.043***
	(5.10)	(5.44)
Reversal	-6.216***	-6.199***
	(-5.31)	(-5.30)
Illiquidity	0.115***	0.115***
	(9.13)	(9.11)
Call	0.004	0.026
	(0.19)	(1.32)
Issuer Fixed Effects	Yes	Yes
Year Fixed Effects	Yes	Yes
No. of obs.	264,832	264,832
$Adj.R^2$	0.040	0.039

Table 6: Debt Refinancing and Financial Crisis

This table presents the panel regression results of the effect of debt refinancing and corporate bond returns during the financial crisis period. The dependent variable is the monthly corporate return, which is the difference between bond raw return estimated from Eq.(3) and 1-month Treasury bill rate. The main variables of interest are the interaction terms between *RI* and *Crisis*, as well as *RI* and *High MKT ILQ*. The financial crisis period (*Crisis*) is defined as the period from December 2007 to June 2009. The high market illiquidity period is determined as the period when the market illiquidity index (Dick-Nielsen, Feldhütter, and Lando, 2012) is above the median value over the entire sample period. Other firm characteristics include leverage (LEV), firm size (Ln(MCAP)), defined as the natural logarithm of the market value of the issuer's common equity and return on equity (ROE). Bond characteristic variables include the natural logarithm of the maturity in year (Ln(Matuiry), the natural logarithm of credit rating (Ln(1+Rating)), and the natural logarithm of issuer size (Ln(Issue Size), return reversal (Reversal) and dummy variables for callable bond (Call). Variables are defined in the Appendix. Bond issuer and year fixed effects are included in all regressions and t-values based on standard errors clustered at the bond level are reported in parentheses. *, ** or *** denotes the significance at the 10%, 5%, or 1% level, respectively.

	(1)	(2)
RI * Crisis	1.330***	
	(3.87)	
RI * High MKT ILQ		0.423***
		(4.97)
RI	0.079*	-0.034
	(1.69)	(-0.61)
Crisis	0.077	
	(0.83)	
High MKT ILQ		-0.671***
		(-13.31)
LEV	-0.175	-0.198*
	(-1.62)	(-1.86)
Ln(MCAP)	0.177***	0.199***
	(5.46)	(6.24)
ROE	-0.271***	-0.277***
	(-5.04)	(-5.11)
Ln(Maturity)	0.172***	0.170***
	(20.73)	(20.45)
Ln(1+Rating)	0.654***	0.663***
	(9.13)	(9.05)
Ln(Issue Size)	0.038***	0.040***
	(5.01)	(5.18)
Reversal	-6.281***	-0.067***
	(-5.39)	(-5.54)
Illiquidity	0.113***	0.117***
	(9.12)	(9.21)
Call	0.011	0.009
	(0.59)	(0.47)
Issuer Fixed Effects	Yes	Yes
Year Fixed Effects	Yes	Yes
No. of obs.	264,832	264,832
$Adj.R^2$	0.040	0.041

Table 7: Debt Refinancing and Interest Rate Environment

This table presents the panel regression results of the interaction effect of interest rate environment and debt refinancing on corporate bond returns. The dependent variable is the monthly corporate return, which is the difference between bond raw return estimated from Eq.(3) and 1-month Treasury bill rate. The main variables of interest are the interaction terms between RI and dummy variables representing various interest rate environments. $FFR \geq 2\%$ represents periods with federal fund rates of 2% or more. $FFR \geq 4.5\%$ represents periods with federal fund rates of 4.5% or more. *FFR Increase* represents periods with federal fund rate hikes. *Cum. FFR Inc. 25-100 bps* and *Cum. FFR Inc.*$>$ 100*bps* represent periods with federal fund rate hikes of 25-100 bps and more than 100 bps, respectively, over the past 1-year period. Firm characteristics include leverage (LEV), include firm size (Ln(MCAP)), defined as the natural logarithm of the market value of the issuer's common equity and return on equity (ROE). Bond characteristic variables include the natural logarithm of the maturity in year (Ln(Matuiry), the natural logarithm of credit rating (Ln(1+Rating)), and the natural logarithm of issuer size (Ln(Issue Size), return reversal (Reversal) and dummy variables for callable bond (Call). Variables are defined in the Appendix. Bond issuer and year fixed effects are included in all regressions and t-values based on standard errors clustered at the bond level are reported in parentheses. *, ** or *** denotes the significance at the 10%, 5%, or 1% level, respectively.

	(1)	(2)	(3)	(4)
RI * FFR $\geq$ 2 %	0.240***			
	(2.87)			
RI * FFR $\geq$ 4.5 %		0.987***		
		(7.92)		
RI * FFR Increase			0.302***	
			(3.66)	
RI * Cum. FFR Inc. 25-100 bps				0.336***
				(3.65)
RI * Cum. FFR Inc. $>$ 100 bps				0.536***
				(4.03)
RI	0.111**	0.118**	0.137**	0.125**
	(1.99)	(2.05)	(2.54)	(2.34)
FFR $\geq$ 2%	0.344***			
	(9.55)			
FFR $\geq$ 4.5 %		-0.339***		
		(-5.41)		
FFR Increase			-0.066**	
			(-2.26)	
Cum. FFR Inc. 25-100 bps				0.002
				(0.05)
Cum. FFR Inc. $>$ 100 bps				-0.369***
				(-6.87)
LEV	-0.148	-0.156	-0.146	-0.141
	(-1.39)	(-1.47)	(-1.37)	(-1.33)
Ln(MCAP)	0.188***	0.202***	0.195***	0.196***
	(5.89)	(6.33)	(6.15)	(6.16)
ROE	-0.274***	-0.280***	-0.281***	-0.281***
	(-5.09)	(-5.19)	(-5.21)	(-5.22)
Ln(Maturity)	0.170***	0.170***	0.170***	0.170***
	(20.50)	(20.44)	(20.45)	(20.42)
Ln(1+Rating)	0.660***	0.664***	0.662***	0.663***
	(8.97)	(9.09)	(8.99)	(9.00)
Ln(Issue Size)	0.038***	0.040***	0.039***	0.039***
	(4.96)	(5.15)	(5.08)	(5.10)
Reversal	-0.063***	-0.062***	-0.062***	-0.062***
	(-5.35)	(-5.32)	(-5.31)	(-5.31)
Illiquidity	0.116***	0.116***	0.116***	0.116***
	(9.16)	(9.09)	(9.10)	(9.09)
Call	0.009	0.007	0.009	0.008
	(0.48)	(0.38)	(0.45)	(0.43)
Issuer Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
No. of obs.	264,832	264,832	264,832	264,832
$Adj.R^2$	0.040	0.040	0.040	0.040

Table 8: The Effect of Investor Sentiment and Risk Aversion on Debt Refinancing Risk Premium

This tables presents results of panel regressions examining the effect of credit sentiment and risk aversion on the debt refinancing risk premium. The dependent variable is the monthly corporate return, which is calculated as the difference between bond raw return estimated from Eq.(3) and 1-month Treasury bill rate. Risk aversion is estimated using the risk aversion index developed by Bekaert, Engstrom, and Xu (2022) (RA^{BEX}). Investor sentiment is measured using the issuer quality measure introduced by Greenwood and Hanson (2013) ($SENT^{GH}$). The dummy variable, *High Risk Aversion*, equals one during high risk aversion periods. A high risk aversion period is identified when the risk aversion index in month $(t-1)$ is in the top quintile of the sample period. The second dummy variable, *Low Sentiment*, takes a value of one during low-sentiment periods. A low-sentiment period is defined as a month $(t-1)$ in which the credit market sentiment falls within the bottom quintile of the sample period. The main variables of interest is the relative intensity (RI) and its interaction with the two dummy variables. Other firm characteristics include leverage (LEV), firm size (Ln(MCAP)), defined as the natural logarithm of the market value of the issuer's common equity and return on equity (ROE). Bond characteristic variables include the natural logarithm of the maturity in years (Ln(Matuiry), the natural logarithm of credit rating (Ln(1+Rating)), and the natural logarithm of issuer size (Ln(Issue Size), return reversal (Reversal) and dummy variables for callable bond (Call). Variables are defined in the Appendix. Bond issuer and year fixed effects are included in all regressions and t-values based on standard errors clustered at the bond level are reported in parentheses. *, ** or *** denotes the significance at the 10%, 5%, or 1% level, respectively.

	(1)	(2)	(3)	(4)
RI * Ln (RA^{BEX})	0.836*			
	(1.71)			
RI * High RA		0.432***		
		(2.75)		
RI * Ln (1+ $SENT^{GH}$)			-0.858***	
			(-2.94)	
RI * Low GH				0.968***
				(2.76)
RI	-0.739	0.071	0.182**	0.123
	(-1.40)	(1.33)	(2.30)	(1.40)
Ln (RA^{BEX})	1.433***			
	(11.43)			
High RA		0.220***		
		(4.33)		
Ln (1+ $SENT^{GH}$)			-1.223***	
			(-13.37)	
Low GH				0.660***
				(6.19)
LEV	-0.138	-0.153	-0.576***	-0.579***
	(-1.30)	(-1.44)	(-3.10)	(-3.14)
Ln(MCAP)	0.134***	0.177***	0.191***	0.183***
	(4.10)	(5.57)	(4.40)	(4.32)
ROE	-0.260***	-0.272***	-0.318**	-0.309**
	(-4.85)	(-5.06)	(-2.32)	(-2.27)
Ln(Maturity)	0.174***	0.170***	0.028	0.018
	(21.10)	(20.49)	(1.34)	(0.86)
Ln(1+Rating)	0.633***	0.653***	1.071***	1.061***
	(8.92)	(8.96)	(7.18)	(7.14)
Ln(Issue Size)	0.034***	0.038***	0.072***	0.081***
	(4.48)	(4.93)	(3.55)	(3.94)
Reversal	-0.057***	-0.062***	-0.110***	-0.110***
	(-4.94)	(-5.31)	(-6.16)	(-6.12)
Illiquidity	0.103***	0.113***	0.072***	0.079***
	(8.28)	(8.93)	(5.11)	(5.55)
Call	0.006	0.008	0.065**	0.067**
	(0.33)	(0.41)	(2.15)	(2.23)
Issuer Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
No. of obs.	264,832	264,832	264,832	264,832
$Adj.R^2$	0.043	0.040	0.060	0.054

Table 9: Portfolio Characteristics Sorted by Rating, Maturity, and Refinancing Intensity

We summarize the characteristics of portfolios from independent 2×3×3 sorts on rating, maturity, and refinancing intensity (RI). Each month, we use bond rating to split the bonds into two groups, investment grade (IG) and high yield grade bonds (HY); independently, to sort bonds into three maturity groups, short-term, medium-term and long-term bonds; and independently, to sort bonds into three RI groups, for the low 30%, middle 40% and high 30% of the ranked RI. Taking the intersections of the two rating, three maturity, and three RI groups, we compute the monthly average characteristics of the $2\times3\times3 = 18$ portfolios. IG (HY) are the average characteristics of the nine investment-grade (high-yield) portfolios. Short-term (Long-term) are the average characteristics of six short-term (long-term) portfolios of maturity. Low (High) are the average characteristics of six low (high) portfolios of RI. We report averages for rating, maturity, RI, market value of equity ($MCAP$), market to book (M/B), asset growth (AG), return on equity (ROE), bond market beta (β^{bond}), (-1) × value at risk at the 5% level (VaR), the Amihud illiquidity measure, bond size, and equal-weighted (EW) and value-weighted (VW) excess returns. Variables are defined in the Appendix. Our sample covers all bonds issued by levered, nonfinancial NYSE, NASDAQ and Amex firms over the 2002 to 2020 period, in total 296,864 monthly bond return observations for 7,812 bonds.

	Rating		Maturity		Refinancing Intensity(RI)	
	IG	HY	Short-Term	Long-Term	Low	High
Rating	6.85	12.98	9.89	9.92	10.23	9.68
Maturity (Years)	11.54	9.92	3.28	21.30	11.06	10.58
RI	0.27	0.27	0.28	0.27	0.11	0.45
MCAP [$ Bill]	66.68	10.17	37.37	44.11	24.53	52.08
LEV	0.30	0.39	0.35	0.35	0.34	0.35
M/B	3.15	2.16	2.75	2.47	2.68	2.76
AG	0.07	0.02	0.04	0.04	0.08	0.03
ROE	0.16	-0.04	0.06	0.04	0.07	0.10
β^{Bond}	1.24	1.27	0.84	1.69	1.28	1.21
VaR [in %]	0.05	0.10	0.06	0.10	0.08	0.08
Amihud	3.21	5.50	2.81	6.68	3.65	5.40
Bond Size [$ Bill]	0.69	0.43	0.55	0.53	0.52	0.60
Ret [EW in %]	0.42	0.81	0.44	0.83	0.57	0.67
Ret [VW in %]	0.43	0.82	0.41	0.77	0.55	0.63

Table 10: Spanning Tests of Return Differentials Associated with Refinancing Intensity against the Bond Riks Factors

This tables presents results for spanning regression of high-minus-low return differentials associated with refinancing intensity. We estimate refinancing risk premia from independent 2×3×3 sorts on rating, maturity, and refinancing intensity (RI). Each month, we use bond rating to split the bonds into two groups, investment grade and non-investment grade bonds; independently, to sort bonds into three maturity groups, short-term, medium-term and long-term bonds; and independently, to sort bonds into three RI groups, for the low 30%, middle 40% and high 30% of the ranked RI. Taking the intersections of the two rating, three maturity, and three RI groups, we compute the monthly equal-weighted and value-weighted returns of the 2×3×3=18 portfolios. Then we estimate the difference between the average returns on the six high- and the six low RI portfolios. In the spanning regressions, we use bond market returns (MKT^{Bond}), downside risk (DRF), credit risk (CRF), and liquidity risk (LRF) factors of Bai, Bali, and Wen (2019). The t-statistics are based on HAC standard errors using Newey and West (1987) with optimal truncation lag chosen as suggested by Andrews (1991). Our sample covers all bonds issued by levered, nonfinancial NYSE, NASDAQ and Amex firms over the 2002 to 2020 period, in total 296,864 monthly bond return observations for 7,812 bonds.

	Equal-Weighted Portfolios			Value-Weighted Portfolios		
	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	0.103**	-0.014	-0.066	0.082**	-0.022	-0.069
	(2.18)	(-0.11)	(-1.20)	(2.01)	(-0.23)	(-0.67)
MKT^{Bond}		0.208***	0.093		0.191**	0.073
		(2.63)	(1.26)		(2.44)	(0.85)
DRF			-0.043			-0.055
			(-0.82)			(-1.13)
CRF			0.106***			0.095**
			(2.67)			(2.29)
LRF			0.094**			0.083**
			(2.27)			(2.05)

Figure 1: U.S. Corporate Short-term Debt Maturing from 2001 to 2020

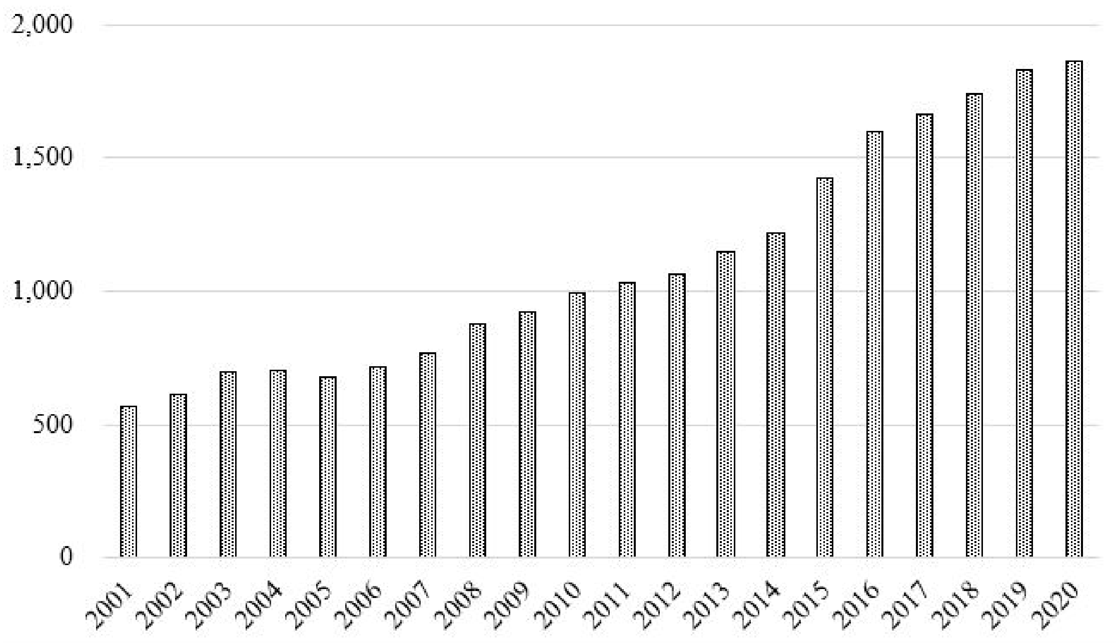

Figure 1 portrays the maturing trends of corporate debt for all U.S. corporations between the years 2001 and 2020, with a specific focus on debt that matures within a 1 to 3-year time frame. The data is represented in billions of U.S. dollars, and the graph visually illustrates how the amount of corporate debt maturing within this duration has evolved over the past two decades. Each year is plotted along the x-axis, while the corresponding amount of debt is displayed on the y-axis. This information offers valuable insights into the changing financial obligations of U.S. corporations and provides a basis for further analysis of rollover risk management needs.
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Figure 2: Debt Refinancing Intensity and Firm Leverage

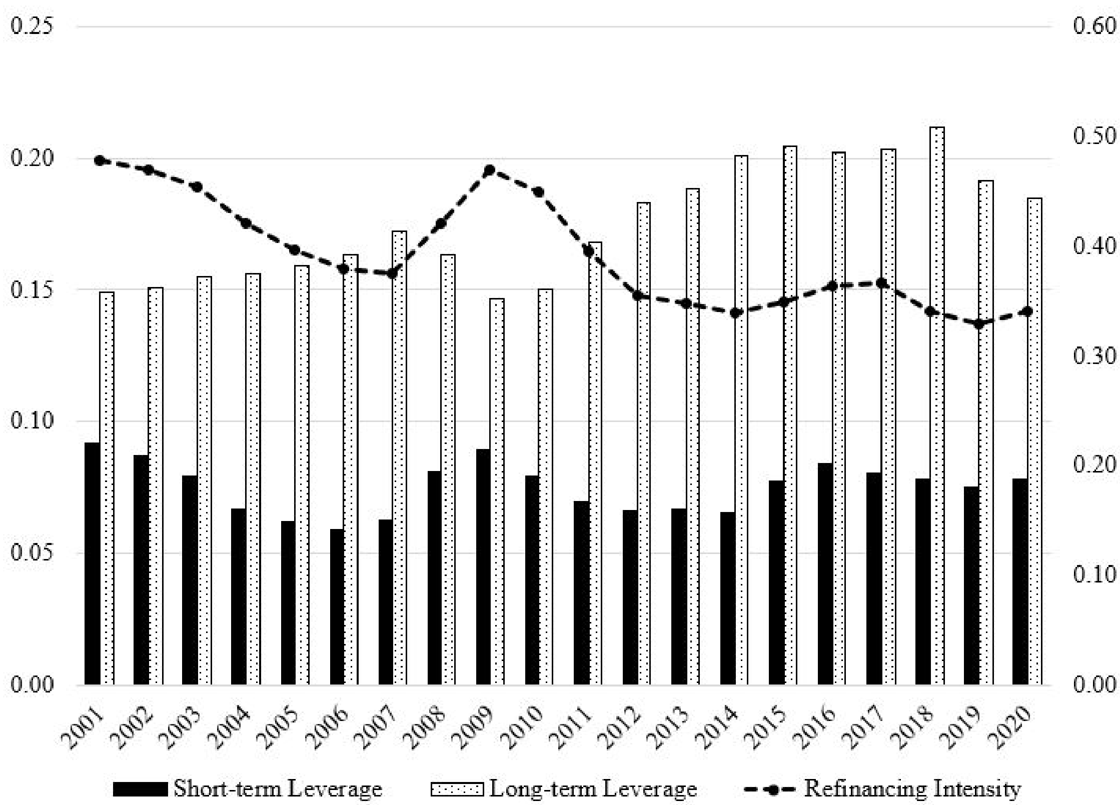

Figure 2 illustrates firm leverage and its associated debt refinancing intensity.The refinancing intensity (RI) is defined as the ratio of short-term debt ($dd1$ + $dd2$ + $dd3$) to total debt ($dd1$ + $dltt$), which measures the proportion of debt maturing in the next three years over total debt (i.e., the sum of short-term and long-term debt). A firm's leverage is decomposed into two components: short-term leverage (debt maturing in the next three years) and long-term leverage (debt maturing after the next three years).