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Monetary Policy and Risk-Taking: Evidence from Thai Corporate Bond Markets*

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Abstract

This paper examines the risk-taking channel of monetary policy in the context of Thai corporate bond market. Based on newly-issued non-financial corporate bonds from 2001 to the third quarter of 2020, we find that low interest rates are associated with greater issuance of bonds with worse risk ratings, which is more pronounced for bonds from the property sector. In addition, these bonds tend to have longer maturity. However, we do not find evidence of compression of risk premium or underpricing of risks during these low-rate periods. We then examine whether any types of bond investors are prone to the search-for-yield behaviour. Using the Bank of Thailand's confidential debt securities holding dataset from 2013 onward, our results show that individuals, rather than banks and institutional investors, are the prime holder of high-risk bonds. Conditional on bond risk ratings, only two groups of bondholders appear to bias toward higher-yield bonds. These include individuals and other depository financial institutions, namely saving cooperatives and money market mutual funds. Our results point toward weak evidence of risk-taking among corporate bond investors during the low-rate environment.

Keywords: monetary policy, interest rate, risk taking, search for yield, corporate bond, underpricing of risk, excess bond premium

JEL Classifications: E44, E52, G11, G12.

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1 Introduction

The debate on the link between interest rates and financial intermediaries' risk-taking behaviors, also known as the risk-taking channel of monetary policy, has gained much attention since the 2008-09 global financial crisis. In particular, low interest rates may encourage banks and other financial institutions to take on more leverage and risks on their portfolios. Theory has offered several explanations. Among them, Borio and Zhu (2012) suggest that low rates boost asset and collateral values while reducing price volatility, which in turn downsize estimates of default probabilities and encourage higher risk positions. According to Adrian and Shin (2010), as liabilities of financial intermediaries are mostly short-term, expansionary monetary policy improves marginal lending profitability, thereby boosting their forward-looking measure of capital. This raises their risk-bearing capacity, allowing them to leverage up and expand their assets to cover riskier projects or investment. In addition, monetary easing induces low returns on risk-free assets and hence encourages investment managers to search for higher-yield risky investments in order to achieve the target rate of returns (Rajan, 2006).[1]

A number of studies provide empirical evidence to support such link, which implies that central banks cannot safely neglect the implications of eased monetary policy on financial stability risks. There is strong evidence that when interest rates are low, financial intermediaries, especially banks, soften their lending standards by lending more to borrowers with greater default risks and reducing their loans spread (Maddaloni and Peydro, 2011; Jiménez et al., 2014; Ioannidou et al., 2015; Dell'Ariccia et al., 2017). The results are robust across a wide range of countries, granularity of the dataset and identification strategies employed. Nevertheless, research on the risk-taking channel mainly focuses on banks, whereas evidence beyond the banking sector is rather scarce. A handful of empirical studies specifically highlight the search-for-yield incentives of certain financial firms and intermediaries such as insurance companies (Becker and Ivashina, 2015), money market mutual funds (Di Maggio and Kacperczyk, 2017) or even pension funds (Andonov et al., 2017). Articles that focus on the search-for-yield behavior within corporate bond markets are also limited (Becker and Ivashina, 2015; Czech and Roberts-Sklar, 2017; Choi and Kronlund, 2018). However, they all focus on the behavior of institutional investors, and on the case of advanced countries like the U.S. and the UK.

This paper contributes by examining the risk-taking channel of monetary policy

[1] A decline in policy rates also decreases the cost of banks' liabilities, thereby increasing the surplus the monopolistic bank extracts from borrowers (Valencia, 2014). In addition, low rates reduce financial institutions' portfolio income and then decrease the incentive to monitor (Dell'Ariccia et al., 2014).

in the context of Thai corporate bond market, which has increasingly become an important source of corporate financing over the past decade. The Thai policy interest rate has remained at an exceptionally low level since 2015, which may propel risk-taking incentives among financial investors, especially in the corporate bond markets that offer a menu of investment assets with different risks and return. Therefore, we aim to shed light on whether low interest rates contribute to higher ex-ante risks of newly-issued bonds, as well as how they impact the pricing of risks. We then delve into the search-for-yield behavior of corporate bond investors, which is arguably the key factor that incentivizes risk-taking during low-rate periods. The key difference from the previous articles is that this paper expands the set of bond investors beyond institutional investors to include retail investors. To our knowledge, this paper is also the first to provide emerging-market perspectives on risk-taking behaviour that takes place outside the banking sector.

Based on newly-issued non-financial corporate bonds from 2001 to the third quarter of 2020[2], we find that low policy interest rates are associated with the greater issuance of bonds with low creditworthiness, i.e., non-investment-grade bonds and unrated bonds. This relationship is more pronounced for bonds issued by companies in the property sector, a sector with the largest corporate bond outstanding. This finding conforms to that of the bank risk-taking articles (Dell'Ariccia et al., 2017; Jiménez et al., 2014). Additionally, we find that low interest rates also lead to the issuance of bonds with longer maturity, suggesting that under the low-rate environment, increased riskiness within corporate bond markets may derive from both credit and maturity risks. In particular, it is mainly risky bonds that have lengthened maturity.

Despite more risky bonds in the market, we do not observe any evidence of compression of risk premium, or risk underpricing. In particular, we fail to find that riskier firms enjoy a coupon discount compared to safer firms when they issue bonds during periods of low interest rates. Instead, their coupon spread over yield of government bond of similar maturity becomes even larger during these periods. This finding renders evidence of risk-taking among corporate bond investors less clear-cut, since in theory we would expect declining risk premium if the risk-taking channel is to be identified. Our result, therefore, contrasts with the compression of risk premium found in the case of banks (Ioannidou et al., 2015; Paligorova and Santos, 2017), and security broker and dealer sector (Adrian and Shin, 2010). Nevertheless, it is in line with Paligorova and Santos (2017), who find the positive association between low interest rates and spreads of risky corporate bonds. The

[2]11 September 2020

latter paper argues that, as bond investors are not protected by the safety net, they may not engage in risk-taking as much as banks. In our paper, we also construct a time-series measure called excess bond premium (EBP) a la Gilchrist and Zakrajšek (2012), to detect evidence of risk underpricing. We show that EBP tends to fluctuate and does not exhibit a clear relationship with the level of policy rate. During periods of exceptionally low interest-rate levels since 2015, EBP of risky bonds even shows an increasing trend, implying a more risk-averse attitude of bond investors.

Last, we turn to the confidential debt securities holding database to explore whether any types of bond investors are prone to the search-for-yield incentives. Due to data availability, the periods studied only run from 2013 onward, which mostly cover periods when the Thai policy rate is set low. Among 8 bondholder groups considered, we find that, rather than banks and institutional investors, individuals are the prime holder of high-risk bonds. This may be attributed to their risk preference, but also to the lack of institutional and regulatory constraints facing them, which allow them to take on more risks than other bondholder groups. Conditional on bond risk ratings, we still find that individuals reach for yield in choosing their investment. That is, they appear to bias toward higher-yield bonds within subset of bonds of roughly similar risk level. The only institutional investor group that appears to engage in searching-for-yield is 'other depository financial institutions', which comprise saving cooperatives and money market mutual funds (MMF). Saving cooperatives, like some other financial institutions, face regulatory constraints that force them to hold only A-rated corporate bonds. Our result implies that they will search for highest-yielding A-rated bonds when contemplating their investment. Compared to the literature that previously studies the search-for-yield behaviour within the corporate bond market, this paper suggests novel bond investor types that may be prone to risk-taking in this market.

1.1 Literature Review

This paper makes contributions to the literature on the risk-taking channel of monetary policy. As mentioned, while research in this area is abundant, it mainly focuses on banks' behavior toward loan origination. There is conclusive evidence that low interest rates incentivize banks to take on higher risks in their portfolio. Using estimated default frequency of listed banks in the EU and the U.S. as the risk-taking indicator, Altunbas et al. (2014) show that low interest rates over an extended period of time contribute to an increase in bank risk. Based on loan-level data, Dell'Ariccia et al. (2017) find for the U.S. that bank risk-taking as measured by the risk ratings of the bank's loan portfolio is negatively associated with short-

term interest rates. Moreover, using credit registry information, Jiménez et al. (2014) and Ioannidou et al. (2015) find a positive relationship between low interest rates and the probability of extending loans to riskier borrowers with ex-ante less creditworthiness and a higher ex-post default rate for the case of Spain and Bolivia, respectively. In a macro setting, Maddaloni and Peydro (2011) offer a link between monetary policy and changes in lending standards observed in lending survey.[3] In addition, a few articles explore how monetary policy affects the loan pricing. In particular, Ioannidou et al. (2015) and Paligorova and Santos (2017) observe loan pricing discount for riskier borrowers in periods of low interest rates. Our paper is the first to uncover these relationships in the context of corporate bond markets.

On the search-for-yield behavior, recent articles provide evidence of such behavior for certain financial investors following monetary policy accommodation. Di Maggio and Kacperczyk (2017) find that low interest rates induce U.S. money funds, which are obliged to invest in safe short-term assets, to invest in riskier asset classes and reduce the fee they charge their investors. Their results are supported by Chodorow-Reich (2014), who show that these funds with higher administrative costs do reach for higher returns over the brief periods of 2009-11. Moreover, there exists evidence that low interest rates: lead fund managers within the eurozone to shift their portfolio investment into the riskier equity market (Hau and Lai, 2016); induce U.S. public pension funds to increase their allocation to risky assets (Andonov et al., 2017); and encourage U.S. active equity mutual funds to engage in excessive risk-taking (Kim and Olivan, 2015). Hanson and Stein (2015) also document variations in term premia that are attributed to demand effects from yield-oriented investors.

Our paper comes closest to Becker and Ivashina (2015), Czech and Roberts-Sklar (2017) and Choi and Kronlund (2018), who study the search-for-yield behavior within corporate bond markets. However, they only focus on behavior of institutional investors. Becker and Ivashina (2015) show that U.S. insurance companies tend to invest in higher-yielding securities within each rating category. In the context of UK, Czech and Roberts-Sklar (2017) find that insurance companies, hedge funds and asset managers tilt their portfolios towards higher risks, higher-yielding bonds. Both papers also show this behaviour depends crucially on business cycle phases and reverses during stress periods. Choi and Kronlund (2018) study U.S.

[3]For more evidence of the relationship between monetary policy and bank risk-taking, also see Delis et al. (2017) and Paligorova and Santos (2017) using a dataset from the syndicated corporate loan market; and, Bonfim and Soares (2018) for the case of Portugal. In the case of Thailand alone, Ratanavararak and Ananchotikul (2018), using account-level data and a duration analysis, suggest that low rates may lead to higher loan hazard rates and lower loan quality for long-term loans, particularly those in the portfolio of small and medium banks.

corporate bond mutual funds, and find that they engage in more reaching for yield during a low-rate environment, which helps them attract more inflows. Our paper contributes by not only examining the case of emerging markets, but also expanding the set of investors to include retail investors such as individuals and corporates. Our results show that the only institutional investor group that appears to reach for yields is saving cooperatives and MMF, which have not earlier been at the focus of the past literature. In addition, we also fail to find evidence that institutional investors like insurance companies engage in searching for yields.[4]

To the extent that our results highlight proclivity of individuals to engage in searching for yields, our paper is in line with Lian et al. (2019). Using randomized investment experiment, the latter paper shows that low interest rates lead to significantly higher allocations to risky assets among diverse populations. Their explanations are based on investor psychology, from the fact that people may form reference points of investment returns to the salience of returns on risky assets in different interest rate environments. To our knowledge, our paper is among the first to provide empirical evidence based on administrative data that sheds light on reach-for-yield incentives among individuals. The other related study is from Daniel et al. (2021), who explore individual portfolio holdings and conclude that low interest rates lead to significantly higher demand for high-dividend stocks and high-yield bonds, hence the term 'reach for income'.

The rest of the paper is organized as follows. The next section describes the data used for this study and highlights key stylized facts pertaining to Thai corporate bond markets. Section 3 provides the methodology used to perform the analyses. Section 4 provides estimates of the relationship between monetary policy and risky bond issuance and pricing, as well as the investigation of the 'search-for-yield' behavior across various groups of bondholders. Section 5 concludes with key policy implications.

2 Data

This paper relies on two main datasets. First, we use information on newly-issued non-financial corporate bonds from the Thai Bond Market Association (ThaiBMA). The dataset, which runs from 2001Q1 to 2020Q3, provides both issue and issuer characteristics such as issue credit rating, maturity, size, coupon rate and issuer's

[4] As opposed to literature, we only consider primary corporate bond markets, given limited participation and transactions within the secondary markets. Most retail investors adopt a buy-and-hold strategy instead of constantly optimizing and adjusting their portfolio. Given the relatively illiquid market, corporate bond spreads in the secondary markets are rather volatile and affected by non-fundamental or market factors.

business sector. As in Becker and Ivashina (2015), we use issue risk ratings as a proxy for bond credit risks given their standardized and well-established scales. Whenever issue rating is not available, we use credit rating of bond issuer on the issue date instead. We obtain issuer ratings from various sources such as TRIS rating website, ThaiBMA website and Bloomberg. Both issue and issuer ratings, in all cases, come from two local rating agencies, i.e., TRIS Rating and Fitch Ratings (Thailand). We broadly classify risk ratings into 4 groups: A, BBB, non-investment grade and unrated, with A group being the safest followed by BBB. The A group includes bonds with risk ratings A- or above. Meanwhile, the non-investment-grade group consists of bonds with ratings BB+ or below. Given our interest in the pricing of risks and the search-for-yield behavior, we focus exclusively on corporate bonds with fixed coupon payments. Commercial papers are not included in our sample, also partly due to their short maturity and thus limited risks. In addition, we exclude corporate bonds whose maturity exceeds 20 years, which might become outliers.

The second dataset is from the confidential debt securities holding database, which provides information on holding amount of individual debt securities, both public and private, by 24 bondholder types. Custodians and securities firms report this data on a monthly basis to the Bank of Thailand to enhance monitoring of securities market conditions. Following the establishment of Thailand Financial Instrument Information Center (TFIIC), from November 2012 the Bank of Thailand also requests data from securities registrars. Hence, for the sake of data completeness, we employ this dataset from 2013 onwards. This dataset covers information on holding of each particular bond until the bond matures. However, we only use holding data in the month each bond is issued. That is, we are only interested in position-taking at times of bond issuance, while ignoring bond purchases and sales in the subsequent months that occur in the secondary market, which is rather illiquid due to limited transactions. In addition, data on debt securities holding amount are available both in par and market values. We rely on the former in our analysis.

In examining the search-for-yield behavior among bond investors, we classify bondholders into 8 groups from 24 bondholder types. These include (1) pension and provident funds, (2) mutual funds (except money market funds: MMF), (3) insurances, (4) commercial banks and specialized financial institutions, (5) other depository financial institutions (e.g., cooperatives and MMF), (6) corporates, (7) individuals, and (8) government agencies and others (e.g., social security office, central bank, universities, hospitals, non-profit organizations and non-residents). This classification is in line with that used by ThaiBMA, and meets a requirement

that enables us to publish our findings. See Table A1 in the Appendix for details of classification.[5]

We then merge these two datasets with issuer characteristics and macroeconomic variables from Bloomberg, SETSMART and CEIC. However, issuer characteristics are only available for companies listed on the stock exchange market. If these variables are included into regression, we risk losing observations of unlisted firms, which account for around 20 percent of the observations. To the extent that these firms are likely to be small and risky, without these observations our results may be subjected to sample-selection biases. Therefore, we use equations without issuer characteristics as our main regression specification, while including them for some robustness exercises. Our sample includes a total of 2526 bonds from 247 companies during 20-year periods, 2,046 observations of which have issuer characteristics available.

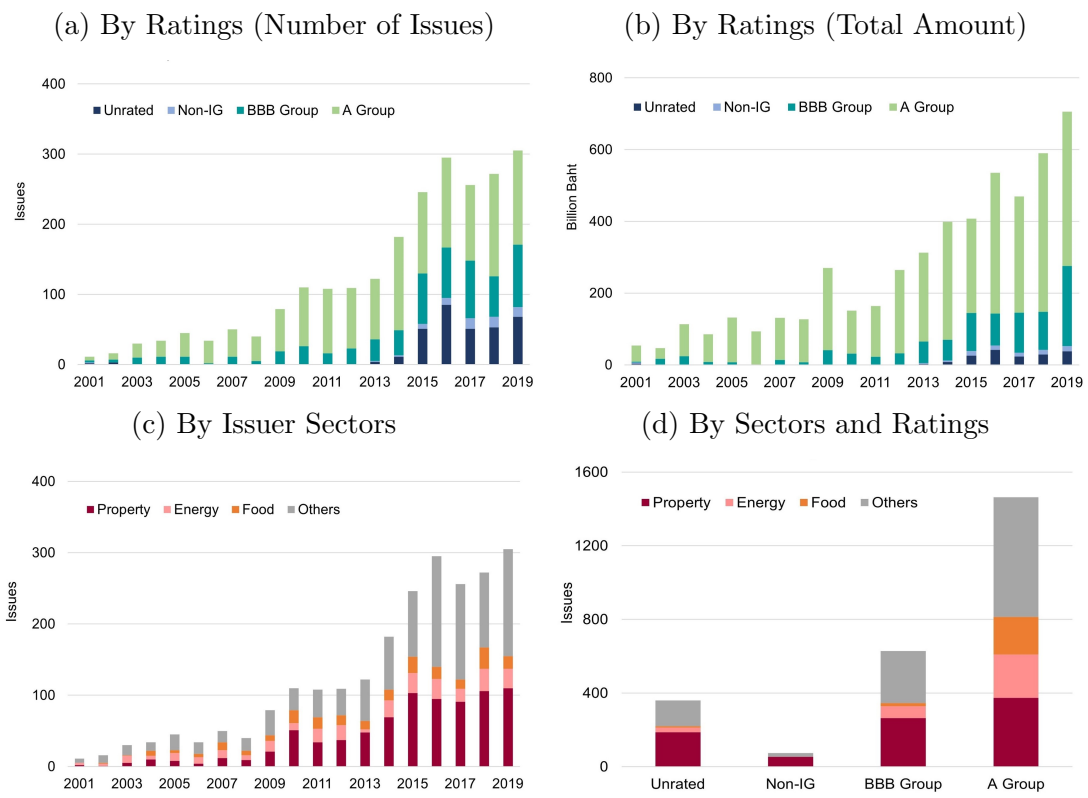
Tables A2 and A3 in the Appendix report data description and summary statistics for all variables used in the regression.

2.1 Stylized Facts

In this subsection, we show some stylized facts to provide background information on Thai corporate bond markets. As shown in Figure 1, bond markets have become a more popular source of financing for Thai businesses over times. From Figure 1 (a), we observe a marked increase in the number of corporate bond issuance, particularly during the second half of 2010s. This is consistent with the Bank of Thailand's private credit data, which shows that the ratio of debt securities outstanding to total private credit of non-financial corporations has risen from 10 percent in January 2011 to almost 30 percent in December 2020. Risky bonds, especially unrated ones, have also been in greater number over these periods. However, in terms of outstanding amount shown in Figure 1 (b), the A-group bonds still dominate the market, indicating the small issue size of risky bonds. Sectoral distribution of bonds can be seen from Figures 1 (c) and (d), where we specifically show three sectors with the largest number of bond issuance while the rest are grouped into gray bars. It is evident that bonds from the property sector outnumber those of other sectors, accounting for almost one-third of total issues and more than half of risky bonds. While the greater number of risky bonds raises the central bank's concerns over financial stability risks, it makes the corporate bond market an attractive investment and risk-taking destination by offering a menu of bonds with

[5]From July 2019, the Bank of Thailand requires custodians and brokers to report bond holdings for 27 bondholder types. However, such a change does not affect our 8-group bondholder classification.

Figure 1: Corporate Bond Issuance



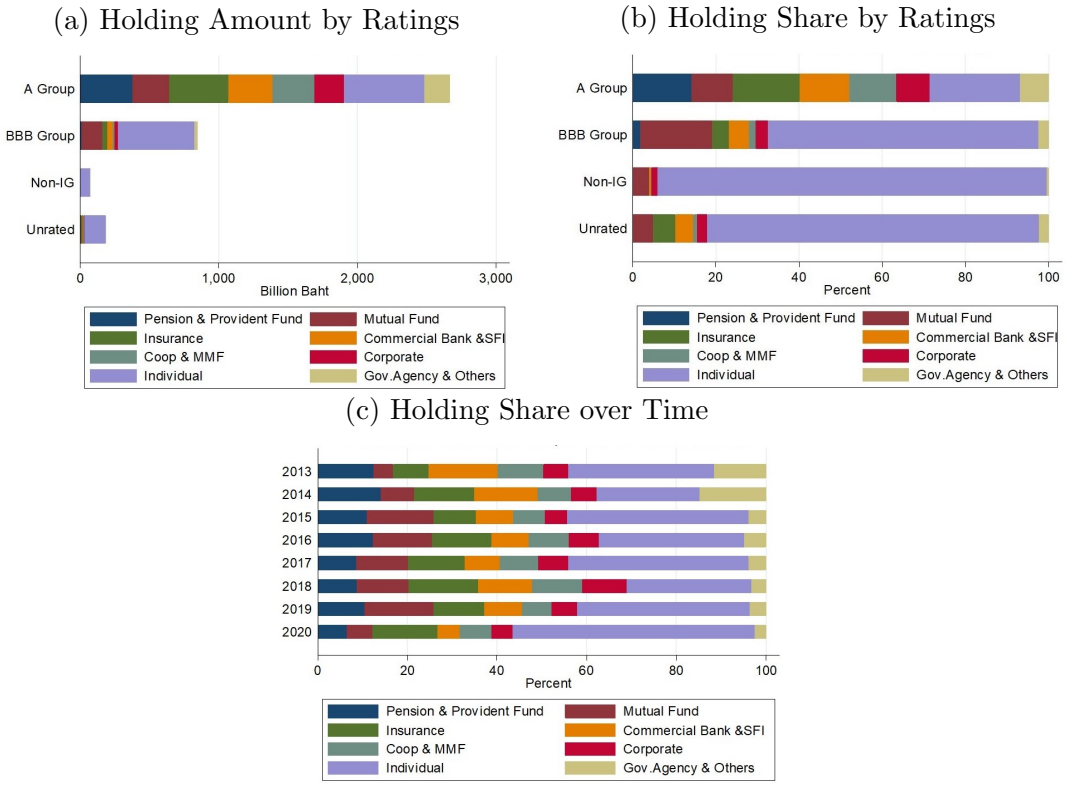
Note: Panels (a) and (b) show the number and the total amount of corporate bond issuance over time by bond risk ratings, respectively. Panel (c) shows the number of corporate bond issuance over time by issuer sectors. Panel (d) shows the number of corporate bond issuance by issuer sectors and ratings. Our sample includes only non-financial corporate bonds with fixed coupon, issued during periods 2001-2019.

differing risks and returns.

Turning to bond holding dataset, we observe that investment-grade bonds, especially A-group bonds, dominate portfolios of every bondholder group, likely explained by the abundance of bonds from this rating category (Figure 2 (a)). However, individuals, which are the largest holder of corporate bonds in Thailand, hold most of the risky bonds as shown in Figure 2 (b), indicating both their risk preference and the lack of institutional and regulatory constraints. In particular, they hold more than 80 percent of risky bond outstanding, whereas holdings of A-group bonds are more equally shared across bondholder groups. Moreover, Figure 2 (c) shows an increasing share of individuals' holding of corporate bonds over time.

Thanks to laws and regulations, certain bondholder groups are allowed to invest only in investment-grade corporate bonds. An example is insurance companies, which must conform to regulations imposed by the Office of Insurance Commission

Figure 2: Corporate Bond Holding across 8 Investor Groups



Note: Panels (a) and (b) show the outstanding amount and the percentage share of corporate bond holding across 8 bondholder groups by bond risk ratings, respectively. Panel (c) shows the percentage share of corporate bond holding across 8 bondholder groups over time. Our sample includes only non-financial corporate bonds with fixed coupon, issued during periods 2013-2020Q3.

(OIC).[6] Meanwhile, cooperatives and the social security funds face even stricter obligations to invest in corporate bonds with credit ratings no less than A-, according to announcements made by the National Cooperative Development Board and the Social Security Committee, respectively. It is to note that social security funds belongs to the 'government agency and others' group, which still records positive investment in risky bonds as the group covers a wide range of institutions, including non-profit organizations and nonresidents. In addition, the government pension funds also invest only in A-group bonds. Figures 2 (a) and (b) reflect well these regulatory constraints as shown in dark blue, green and light blue bars, which show zero or small holdings of risky bonds by these institutional investors.

[6]Without this obligation to invest in investment-grade bonds, investment in risky bonds may still be discouraged by the existence of capital requirements, as the required capital for holding junk and unrated bonds is much larger than that for investment-grade ones as is the case in the U.S. (Becker and Ivashina, 2015). The new risk-based capital framework just in place from 2019 even makes investment in risky bonds more costly.

3 Methods

We rely on multiple models and estimation techniques to tackle research questions of our interest. The first question concerns whether low interest rates lead to the greater issuance of risky bonds, as well as the lengthening of bond maturity. Second, we are interested in whether low interest rates result in compression of risk premium, especially for bonds with low creditworthiness. Third, we explore if any types of bond investors are prone to the search-for-yield behavior. We describe the methodology for each question in turn.

3.1 Interest Rates and Risky Bond Issuance

We consider the impact of monetary policy on the riskiness of newly-issued bonds along two dimensions: credit and maturity risks. For credit risks, since credit ratings are a category variable, we employ a multinomial logistic regression framework. By specifying A-group bonds as the base category, the model is as follows:

$$ln(\frac{p(rating_{i,t} = s)}{p(rating_{i,t} = A)}) = c + \beta r_t + \theta bond_{i,t} + \mu macro_t + \epsilon_{i,t}, \quad (1)$$

where $s \in \{BBB, non - IG, unrated\}$. $rating_{i,t}$ is credit rating of bond i, issued in quarter t. r_t is a measure of monetary policy, where we consider both the actual level of policy rate and the dummy variable indicating whether the policy rate in that period stays below its median. The coefficient β informs us the impact of monetary policy on the probability of issuing bonds from each risk category relative to A-group bonds.

We include several controls into the specification. $bond_{i,t}$ is a set of issue or bond-specific characteristics, including issue size, a dummy variable for callable and convertible bonds, a dummy variable for secured bonds as well as issue maturity. Macroeconomic conditions, $macro_t$, comprise GDP growth, stock market volatility and bank loan spread. The inclusion of stock market volatility and bank loan spread helps capture factors that may induce the substitution between bond and other sources of corporate financing. In particular, bank loan spread, defined as the difference between bank loan interest rates and the policy rate, measures the relative costs of bank loans compared to the bond market. Meanwhile, stock market volatility might affect companies' ability to raise funds in the stock market. $\epsilon_{i,t}$ is the error term.

These control variables should help address specific endogeneity concerns and help with identification. First, bond risk rating adjusts endogenously with the state of business cycles, which concurrently determines the level of policy rate.

This may bias the coefficient on monetary policy for risky bond categories away from zero, making it more likely to overestimate the impact of low interest rates on issuance probability of these groups of bonds. Therefore, we use GDP growth to help capture the state of the economy. Second, the inclusion of bond characteristics should help mitigate the identification challenge that changes in bond credit risks may only reflect variations in the pool of borrowers, i.e., bond suppliers, as opposed to risk-taking incentives of bond investors. As suggested by Jiménez et al. (2014) in the context of bank risk-taking, if risky borrowers' demand for loans increases (more than from safe borrowers) and if banks' appetite for risk remains unaffected, lending standards will tend to tighten. Therefore, controlling for lending standards such as collateral, maturity and lending amount, should allow us to better identify the 'risk-taking' incentives emerged from lenders or investors.

Our choice of the dependent variable also benefits the identification of risk-taking as suggested by Dell'Ariccia et al. (2017), since the credit ratings should indicate ex-ante, forward-looking bond risks at times of bond issuance. Several bank risk-taking articles rely on ex-post risk measures, such as ex-post bank non-performing loans or individual loan default, which can be affected by various factors over the life of loans. Nevertheless, one major drawback of our risk measure is that firm risk rating may slowly adjust to changing information and not timely reflect firms' actual credit risks. The alternative to credit ratings is to compute an estimate of the firm's probability of default based on stock market information. However, using stock market data will restrict our observations to those bonds issued by listed companies. In addition, estimates of default probability may not be reliable due to several non-fundamental factors affecting stock prices.[7]

Next, to investigate how monetary policy influences bond maturity, we replace the dependent variable in the previous equation with bond maturity and rely on an OLS regression:

$$mat_{i,k,t} = c + \beta r_t + \theta bond_{i,k,t} + \mu macro_t + u_k + \epsilon_{i,k,t}, \tag{2}$$

where $mat_{i,k,t}$ is maturity of bond i, issued by firm k (expressed in the number of years and logarithmic form). We use the same set of controls as in the previous equation and add bond credit rating as another explanatory variable, as we should expect creditworthy firms to be able to issue bonds with longer maturity. We

[7]The bank risk-taking literature often uses heterogeneity among banks in credit-supply responses for identification. In particular, banks with worse agency problems tend to have stronger incentives to take on risks (Jiménez et al., 2014; Paligorova and Santos, 2017). However, our dataset does not permit us to adopt a similar strategy given the absence of detailed bond holding information.

also include term spread, defined as the difference between 5-year and 2-year Thai government bond yields, as a control, since expectations of future interest rates may lead issuers to alter bond maturity (Morris, 1976). Additionally, firm fixed effects (u_k) are included to account for each firm's preference for bond maturity. Our coefficient of interest β, therefore, identifies within-firm variations in bond maturity in responses to changes in the policy rate after controlling for both issue characteristics and macroeconomic conditions. We are interested in whether low interest rates are associated with the issuance of bonds with longer maturity, which may as well indicate greater risk-taking among investors.

3.2 Interest Rates and Pricing of Risks

Turning to our second agenda, we explore the impact of monetary policy on pricing of risks. This analysis will help to further identify the risk-taking incentives among bond investors. In particular, if we are to identify risk-taking incentives during periods of eased monetary policy, we would expect that bond investors require smaller risk premium on risky bonds (Ioannidou et al., 2015; Paligorova and Santos, 2017). We estimate the following specification via an OLS regression to validate this claim:

$$\begin{aligned} spread_{i,k,t} =& c + \sum_s \alpha^s rating^s_{i,k,t} + \beta r_t + \sum_s \rho^s (rating^s_{i,k,t} * r_t) \\ &+ \theta bond_{i,k,t} + \delta issuer_{k,t-1} + \mu macro_t + \epsilon_{i,k,t}, \end{aligned} \tag{3}$$

where $spread_{i,k,t}$ is the coupon rate of bond i over government bond yield of the same maturity, while $rating^s_{i,k,t}$ is a dummy variable indicating whether bond i falls into the credit rating category $s \in \{BBB, non-IG, unrated\}$. To differentiate risk pricing across different interest rate levels, we include the interaction term between bond credit ratings and our measure of monetary policy. The parameter ρ^s is key in identifying variations in risk premium or pricing for bonds from each risk category s across different levels of policy rate. Controlled variables related to issue characteristics and macroeconomic conditions are similar to those in Eq. 1. For robustness checks, we also include issuer characteristics ($issuer_{k,t}$), as they appear to influence bond riskiness and hence spread as suggested by Gilchrist and Zakrajšek (2012). These firm characteristics include firm size (dummy for large firms), profitability (return on assets) and leverage (the ratio of debt to assets).

The endogeneity of monetary policy and economic conditions could again pose a problem here and bias the parameter of our interest. In particular, during the bust periods, prices of risks could be higher for borrowers with lower creditworthiness

than for the creditworthy ones. Without properly accounting for the impact of business cycles on risk pricing across different types of bonds, the coefficients ρ^s for risky bonds will likely encounter an attenuation bias. Therefore, we include into the specification the interaction term between the risk rating categories and macroeconomic conditions, namely GDP growth, as another control variable.

While the estimation above allows us to show difference in risk premium across borrowers and interest-rate levels, we also leverage on the concept of excess bond premium (EBP) a la Gilchrist and Zakrajšek (2012) to compute time-varying risk premia. According to these authors, credit spread ($spread_{i,k,t}$) can be decomposed into two components: a systematic component that captures the default risk of the firms and a residual component called EBP. In other words, EBP is a residual component of bond spread that represents variations in the price of bearing exposure to corporate credit risk, above and beyond the compensation for expected defaults. This measure can, hence, be useful in tracking and detecting a compression in risk premium or evidence of risk underpricing over times, especially during the low-rate periods. Gilchrist and Zakrajšek (2012) show that EBP is a powerful predictor of economic activity and reflects changes in the effective risk-bearing capacity of the financial sector.

We rely on Eq. 3 above with the policy rate as the monetary-policy measure, but exclude all the interaction terms, so as to obtain such residuals, which are then averaged up to get the EBP: $EBP_t = \sum_{i,k} \epsilon_{i,k,t}$. An important deviation from the original version of EBP is that we use credit rating by rating agencies to account for a bond's probability of default while they employ the 'distance-to-default' framework developed in Merton (1974). Moreover, they compute EBP from prices of corporate bonds trading in the secondary market, whereas our paper considers the initial offerings in the primary market.

3.3 The Search-for-yield Behaviour

On the last question, we explore the search-for-yield incentives among different groups of bond investors. Specifically, we study how each bondholder group's demand for newly-issued bonds responds to bond coupon spread. Preference for bond is assumed to depend on a range of factors:

$$holding^j_{i,t} = f(spread_{i,t}, bonds_{i,t}, macro_t), \tag{4}$$

where $holding^j_{i,t}$ represents the share of each bondholder j's holding amount of newly-issued bond i issued in period t to its total non-financial corporate bond

portfolios in period t[8], which should reflect demand for bond i from each bondholder group. $spread_{i,t}$, the main independent variable, is as already defined above. For robustness checks, we replace bond spread with bond coupon rate as well as the spread between coupon rate of bond i and the median yields of all non-financial corporate bonds held by bondholder groups j at that time t. We estimate the equation above for each bondholder group, where positive values of the coefficient on bond spread would indicate the reach-for-yield incentives for that bondholder group j. We add controls for bond characteristics, including bond maturity, issue size and most importantly credit ratings, while macroeconomic controls include GDP growth and stock market volatility.

As argued by Becker and Ivashina (2015), the identification concern is that bond investors may have preferences for certain bond characteristics. If these features are correlated with yield, reaching-for-yield may be hard to distinguish from the investors' preferences. In the above specification, we control for bond maturity and offering amount. Institutional investors with long-term liabilities may prefer investing in longer-maturity bonds. Meanwhile, the issue size signals liquidity of the issue. Some bondholders may ignore small issues, which tend be rather illiquid, while others with longer holding periods may have greater tolerance for illiquidity. Apart from investor preference over these bond characteristics, regulatory constraints affect bond holding for certain investor groups as highlighted in Section 2.1, and impact the identification of search-for-yield incentives. In particular, zero or small holdings of risky bonds do not necessarily imply that investors do not have preference for high-yielding assets but that they encounter investment constraints. We account for this concern by including bond credit ratings as control variables and seeking to identify the reaching-for-yield incentives within bonds of a similar risk rating category[9] In addition, we also attempt to estimate the above specification using samples of investment-grade bonds, which should almost be free from laws and regulatory concerns.

To estimate the above equation, we rest on the zero-inflated beta regression described in Cook et al. (2008), since our dependent variables are in proportions and some observations are zero in part due to regulatory constraints above. This zero-inflated beta model, to be fitted by maximum likelihood, consists of two parts:

[8]Becker and Ivashina (2015) use the share of each bondholder j's holding amount of bond i to total issuance amount of bond i. This measurement is also used in our robustness check.

[9]This concern is also experienced by Becker and Ivashina (2015), since U.S. insurance companies face capital regulations. Czech and Roberts-Sklar (2017) and Choi and Kronlund (2018), meanwhile, differentiate reaching for yield into three different notions: reach for rating, reaching for maturity, and reaching for yield within a rating and maturity category. Our strategy identifies the latter component.

a logistic regression model for whether the proportion equals to zero and a beta model for proportions between 0 and 1. A structurally different model is desirable in our case, since factors causing bondholders not hold certain bonds may differ from those governing decisions on the holding amount.

4 Results

4.1 Interest Rates and Risky Bond Issuance

We first show results of whether low interest rates contribute to higher ex-ante risks of newly-issued bonds, both in terms of credit and maturity risks.

4.1.1 Bond Risk Ratings

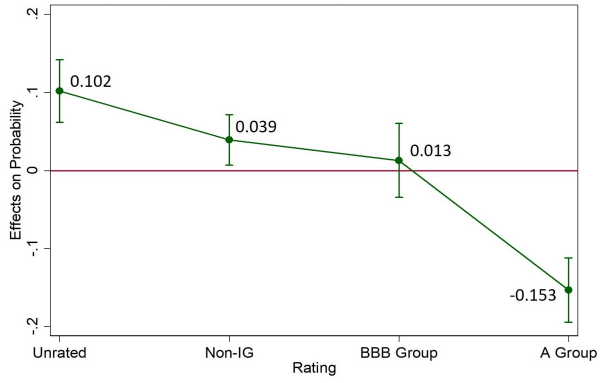
In the first risk dimension, we investigate whether there are more risky bonds, i.e. non-investment-grade and unrated bonds, issued when interest rates are low. We have seen in Section 2.1 that there are more corporate bonds issued in the second half of the 2010s, with a higher proportion of risky bonds. Can this be attributed to loose monetary policy? We use Equation 1 to evaluate the probabilities of bond issuance for each rating group using a multinomial logistic regression. The average marginal effects of a low interest rate on probabilities of issuance for the separate rating groups are summarized in Figure 3a.[10] Although we have used both measures of monetary policy, the Figure here only show results for low-rate dummy variables. The marginal-effect estimates using the level of policy rates can be found in the Appendix.

We find based on Figure 3a, which relies on the full sample, that the issuance probability of unrated and non-investment-grade bonds are significantly higher when rates are low, after issue characteristics and macroeconomic conditions are controlled for. In particular, whenever policy rates are below median, the probability of issuance of these bonds rises by 10.2 and 3.9 percent, respectively. This comes at the expense of A-group bonds, which encounter declining issuance probability by 15.3 percent. Therefore, similar to the case of bank lending activity (Dell'Ariccia et al. (2017)), low interest rates are associated with the greater issuance of risky bonds. This lends some support to the existence of risk taking channel of monetary policy outside the banking sector.

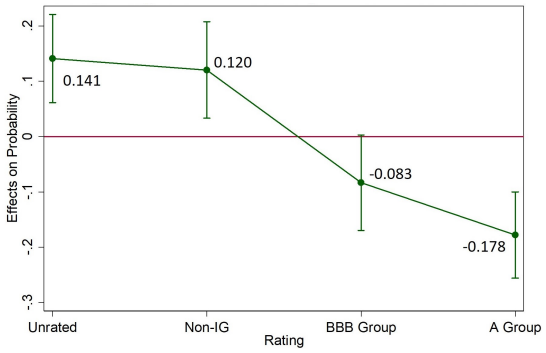
[10]The estimated coefficients from the multinomial logistic model are shown in Table B1 in the Appendix, which shows impact of each explanatory variable on probabilities relative to the base outcome

Figure 3: Effect of Low Interest Rate on Probability of Bond Issuance by Rating

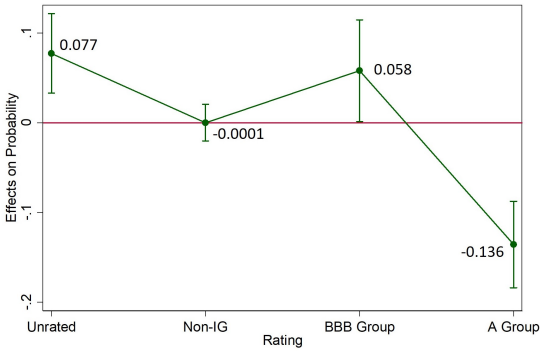
(a) Full Sample



(b) Property Sector



(c) Non-Property Sectors



Note: This figure shows the marginal effect of low interest rates on the issuance probability of bonds from different credit-rating groups. We derive marginal effects from estimates of a multinomial logistic regression, using (a) the full sample, (b) samples of bonds from the property sector, and (c) samples of bonds from the non-property sectors. Our measure of low rates is the dummy variable indicating whether the policy rate is below its median. All models include issue characteristics and macroeconomic variables as controls. Bands represent 95% confidence intervals. The sample periods are from 2001Q1-2020Q3.

After seeing the full-sample estimates, we analyze whether specific sectors are driving these results and face greater risk-taking incentives. Given the dominance of Thai corporate bond markets by the property sector, we divide the sample into property and non-property issuers, estimate the multinomial logistic regression seperately for each sub-sample and then plot the marginal probability of bond issuance.[11] We do not subdivide non-property bonds further as observations for each sector may not be sufficient to attain reliable estimates. As shown in in Figure 3b, in the property sector there is an even greater tendency to issue more non-investment grade and unrated bonds when rates are low. Although their issuance probabilities may

[11]The original coefficient estimates of the multinomial logistic regression are again produced in the Appendix in Table B1.

not be significantly different from full-sample results given large confidence bands, the estimates are much higher at 14.1 and 12.0 percent, respectively. Meanwhile, results for the non-property sectors shown in Figure 3c somewhat differ from the full-sample estimates, as they are more likely to issue BBB-rated and unrated bonds, whose issuance probabilities increase by 7.7 and 5.8 percent respectively. This is all at the expense of A-rated bonds. The result on BBB-rated non-property bonds is in line with the recent article by Acharya et al. (2022), which document a massive increase in bond issuance by BBB-rated firms propelled by the quantitative easing. Our results therefore point towards heterogeneity in risk-taking across sectors. Our full-sample results are more in line with those of the property sector than non-property ones.

The results here are robust to the measure of monetary policy. In Figure B1 in the Appendix, we analyze the case where we use the actual level of policy rate and obtain similar conclusions. Moreover, as discussed in Section 3, the identification of risk-taking rests upon controlling for issue characteristics and macroeconomic conditions. In Table B1, we show that issue characteristics matter greatly to probabilities of observing bonds of different risk ratings. Bonds with ratings below A typically have significantly shorter maturity and are smaller in their size with greater tendency to be callable, compared against A-group bonds. For unrated property-sector bonds, they also tend to be secured. However, we fail to find that the decline in GDP growth contributes to bonds becoming riskier.

4.1.2 Bond Maturity

In the second risk dimension, we examine whether maturity of the bonds issued are longer in length when rates are low, which may contribute to maturity and/or liquidity risks. We estimate a fixed-effect panel regression based on Eq. 2, where the results are shown in Table 1.

The first two columns show full-sample results using different measures of monetary policy. They yield equivalent results that firms lengthen their bond maturity when facing a low-rate regime. Given the way we define the two monetary-policy variables, the opposite signs on the coefficients do point towards the same conclusion. Based on the first column, as policy rates fall below median, bond maturity on average is lengthened by 9 percent. The evidence here, therefore, shows that there is also a positive association between low interest rates and bond maturity, again pointing towards a market that is willing to take more risks. Therefore, both credit and maturity risks heighten in times of low rates.

We are then interested in whether the relationship between monetary policy and

Table 1: Impact of Monetary Policy on Bond Maturity

Variable	Full Sample		A-group	BBB-group	NonIG	Unrated
Monetary Policy						
Low rate	0.0902***		0.0758*	0.0325	0.600***	0.438***
	(0.0309)		(0.0416)	(0.0404)	(0.0596)	(0.0859)
Policy rate		-0.0898***				
		(0.0228)				
Bond Characteristics						
BBB group	-0.183**	-0.173**				
	(0.0819)	(0.0817)				
Non-investment grade	-0.290***	-0.280***				
	(0.106)	(0.106)				
Unrated	-0.419***	-0.408***				
	(0.106)	(0.106)				
Issue size	0.0412**	0.0394**	0.0258	0.0602**	0.103	0.0470
	(0.0172)	(0.0173)	(0.0253)	(0.0264)	(0.0765)	(0.0429)
Callable	0.251***	0.243***	0.441***	0.257**	0.152	-0.125*
	(0.0697)	(0.0683)	(0.0999)	(0.117)	(0.110)	(0.0681)
Secured	-0.0881	-0.0727	-0.307**	0.263	-0.288**	0.146
	(0.0915)	(0.0929)	(0.138)	(0.208)	(0.126)	(0.0963)
Macro Conditions						
GDP growth	0.000294	0.00520*	-0.00321	0.00699	-0.00491	-0.00324
	(0.00286)	(0.00294)	(0.00364)	(0.00451)	(0.0104)	(0.00711)
SET volatility	0.00147	0.00241	-0.000859	0.00695	-0.0119	0.00257
	(0.00271)	(0.00271)	(0.00326)	(0.00562)	(0.0122)	(0.00594)
Spread2Y5Y	-0.0336	-0.0937**	-0.0284	-0.113**	-0.0511	0.217*
	(0.0373)	(0.0425)	(0.0535)	(0.0482)	(0.140)	(0.111)
Bank loan spread	-0.118***	-0.132***	-0.129**	-0.0233	-0.240	-0.131
	(0.0452)	(0.0474)	(0.0615)	(0.0760)	(0.188)	(0.132)
Constant	1.367***	1.626***	1.748***	0.591**	0.535	0.181
	(0.140)	(0.178)	(0.191)	(0.283)	(0.781)	(0.372)
Observations	2,526	2,526	1,463	629	74	360
Issuers	247	247	104	85	12	87
R^2	0.053	0.060	0.067	0.073	0.304	0.117
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Note: This table reports estimates from an OLS regression of bond maturity. The first two columns show full-sample results, using different measures of monetary policy. The last 4 columns are sub-sample results for each bond risk rating category. Issue characteristics, macroeconomic variables and issuer fixed effects are included as controls. Robust standard errors are shown in parentheses. The sample periods are from 2001Q1-2020Q3.

bond maturity is more pronounced for certain risk rating groups, especially risky ones. We estimate Equation 2 using subsamples of bonds with different risk ratings, where results are shown in columns 3-6. The results show that the initial full-sample results are driven by non-investment-grade and unrated bonds. That is, while all coefficients on low-rate dummy variable are positive, only these two groups find large estimates that are statistically significant at the 5-percent level. Hence, while we have already found that bonds of risky category are more in numbers when rates

are low, they tend to at the same time have longer maturity. However, it is note that the maturity for these groups of bonds may start off low. Therefore, such increases in bond maturity during low rates may not result in too large maturity and/or liquidity risks. The estimates of approximately 0.5 imply that bond maturity of these bonds will increase by 50 percent in low-rate periods. Given average maturity of risky bonds standing at around 2.5 years, that means low interest rates will induce 1.25-year higher in bond maturity.

Next, let us go through coefficients of the control variables, which are mostly as expected. For bond characteristics, we can conclude that bonds with riskier characteristics, judged by credit ratings, have shorter maturities. In particular, the maturity of unrated bonds tends to be shortest, followed by non-investment-grade bonds. Since the effective duration for callable bonds is shorter than fixed-term bonds with the same maturity date, their maturity can be slightly higher to compensate for the probability of the call option being exercised. Meanwhile, collateralized bonds tend to have shorter maturity, but only for some rating groups, possibly due to the fact that having collateral may indicate higher risks.

On the other hand, most macroeconomic variables are shown not to have any statistically significant effects. Only bank loans spread significantly matters for bond maturity for the full and A-group samples. We find that whenever bank loans are expensive, bond maturity is likely smaller. This may be due to the fact that bank loans are typically shorter in maturity than bonds. Therefore, as firms switch to tap funding from bond markets, this results in shorter bond maturity. In addition, we find that an increase in term spread, a proxy for expectations of future interest rate, reduces the maturity of newly-issued bonds. That is, bond investors are unwilling to commit to longer-term bonds when interest rates are expected to rise. Nevertheless, we do not find that GDP growth significantly impacts bond maturity, which contradicts with the results of Manuelli and Sánchez (2018).

Based on these findings, we can conclude that low interest rates induce greater issuance of bond with higher risks, both in terms of worse credit risk ratings and longer maturity. Recall that a crucial identification challenge of the risk-taking channel lies in the ability to disentangle bond demand from bond supply, the latter driven by incentives of bond issuers, not risk-taking incentives from bond investors. So far we have relied mainly on controlling for bond characteristics and economic conditions, for the identification of risk-taking. In the next subsection, we complement by examining how pricing of risks evolves as interest rates change.

4.2 Interest Rates and Pricing of Risks

4.2.1 Risk Pricing under Low vs. High Interest Rate

In this section, we explore how prices or return of bonds with differing risks change in response to shifts in monetary policy. To identify the risk-taking incentives, we expect to see the compression of risk premium, especially for risky bonds, under the low-rate environments. That is, risky firms can take advantage of an increase in the market's risk appetite during such environment by issuing more bonds at a reduced coupon rate. If risk premiums rise instead, this may indicate that increases in the issuance of risky bonds are driven more by bond suppliers. We estimate Eq. 3 using an OLS regression, where the results of this regression are shown in Tables 2 and 3.

We first show results for specification without any monetary policy interaction terms in the first two columns, while both measures of monetary policy are exploited. In the first column, which involves low-rate dummy variables, there is a positive association between the low-rate regime and heightened corporate bond spreads. Spreads are larger by 0.22 percentage point, whenever the policy rates stay below their median. This is against the prediction under the risk-taking channel that smaller risk premiums prevail during the periods of low interest rate. The second column, using the actual policy rate, points toward a similar conclusion as the decline in policy rates results in rising bond spreads.

The coefficients for the control variables all have the expected signs. Using the 95-percent confidence level, we find that bonds with worse credit ratings, longer maturities, and with callable options all have larger interest rate spreads or higher risk premium. Again the finding of larger spreads for secured bonds implies that those bonds may be riskier initially. As for macroeconomic conditions, lower spreads can be found when the economy is strong and un-volatile, as measured by equity volatility. The negative correlation between spread and GDP growth is consistent with findings from Fama and French (1989).

The main result of our focus is the coefficients on the interaction term between monetary policy and credit ratings in columns 4 and 5. We find that the spread is higher for all risky bonds, from BBB to unrated, if the policy rate is low. That is, risks are priced higher and the investor is compensated more for risky bets in the bond market in such low-rate environment. According to the fourth column, issuers of non-investment-grade and unrated bonds have to pay higher premiums of around 1.8 and 0.9 percentage points during these periods, respectively, when compared against A-group bonds. With interaction terms the coefficients on monetary policy itself become insignificant, meaning that risk premiums for A-group

bonds in fact do not vary across interest rate level, while the results shown in the first two columns are driven mainly by risky bonds. These results contradict with behavior of banks, which tend to offer interest rate discounts to risky borrowers when rates are low (Ioannidou et al., 2015; Paligorova and Santos, 2017). They, on the other hand, indicate further risk aversion and greater risk pricing among bond investors during such periods, a different risk attitude from banks. Hence, we show that the risk-taking behaviour for corporate bond investors becomes less clear-cut once changes in risk pricing are considered. In other words, we cannot completely rule out the possibility that higher ex-ante risks during low rates found earlier may mainly be supply-driven, as firms issuing risky bonds attract investors by offering higher coupon rates.

On the control variable, the credit-rating interaction terms with GDP growth show that riskier bonds benefit the most when the economy is strong. These bonds are able to obtain relatively cheaper funding when the GDP is high when compared to the A-group bonds. This is consistent with the framework developed by Huang and Huang (2012), who find that credit risk accounts for a higher fraction of the corporate-treasury yield spread for bonds with worse credit ratings. However, these interaction terms are not statistically significant when we use actual policy rates as monetary policy measure.

In columns 6 and 7, for robustness checks, we include the issuers' characteristics as controls, as they are likely important determinants of interest rate spreads. Note, however, that the number of observations falls to some extent, as we focus on observations whose issuer characteristics are available. The results show that, as anticipated, profitable issuers are able to obtain lower spreads. Coefficients on issue size also become statistically significant, with large bond size leading to lower spreads. Given these controls, our main results on varying risk premiums for bonds with different risk ratings remain robust.

Since we have shown in the previous section that bond maturity is also effected by changes in monetary policy, we also consider how pricing of maturity risks evolve. We add interaction terms between our monetary policy measures and bond maturity into the specification. Results are shown in columns 8-13 in Table 3. Overall, the estimates for coefficients unrelated to maturity is robust. Again we fail to find robust evidence of premiums for maturity risks dropping during periods of low rates. In columns 8 and 9, we leave out the interaction terms between monetary policy and credit ratings that are key in the previous result table. The results suggest that during the low-rate environment, having longer maturities results in a statistically significant reduction in spread, which tends to support the risk-taking channel. However, as we include credit-rating and monetary-policy interaction terms back

into the specification (columns 10 and 11), the coefficients on maturity interaction terms are no longer significant. It may be that the significant estimates in columns 8 and 9 just pick up the correlation between bond maturity and credit ratings as suggested earlier in Table 1, as bonds with longer maturity are mostly from the A group and can afford lower spreads regardless of policy rate level. Meanwhile, estimated coefficients of the monetary policy-risk ratings interaction terms still point toward larger interest rate premiums for those risky bonds whilst rates are low. In columns 12 and 13, we further control for issuer characteristics, and still find no evidence of risk premium compression for both credit and maturity risks.

4.2.2 Excess Bond Premium

In this subsection, we leverage the excess bond premium (EBP) concept a la Gilchrist and Zakrajšek (2012), to represent the risk-bearing capacity of investors in the bond market and analyze risk-taking behaviors over time. To find EBP, we rely on residuals from the regression shown in column 3 in Table 2, which do not include any interaction terms. These residuals should, hence, capture time-varying risk premium incurred by firms of different risk categories. As the EBP is quite volatile, we show the results as 12-month moving average. Negative EBP indicates high risk-bearing capacity or appetite for risks, which if too large, may signal risk underpricing. Figure 4 shows the EBP for the full sample in dark blue and the investment-grade-bond sample in light blue.

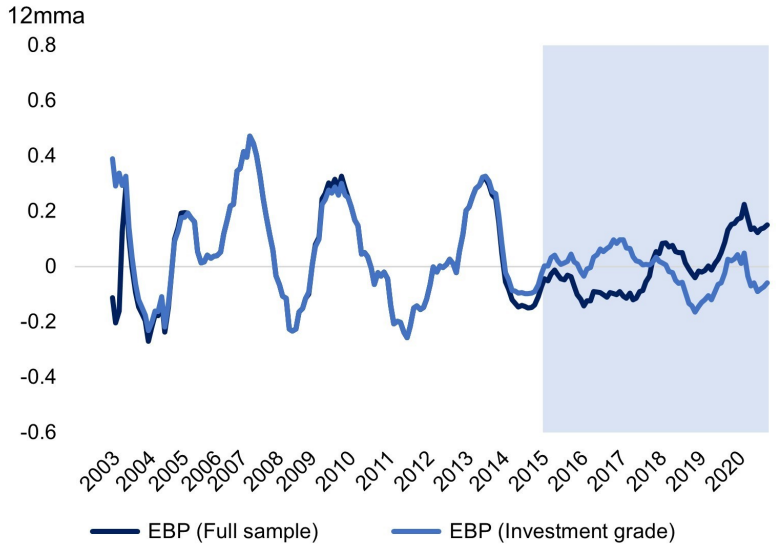
Looking at the full-sample result, we first note that the two highest peaks occur in 2006/2007 and 2009. This correlates to two turmoil events, the domestic coup in September 2006 and the global financial crisis, which may prompt investors to demand higher risk premium. The two peaks are followed by troughs, suggesting that investors are willing to take more risks in the aftermath of turmoils.

In Figure 4, we also plot this EBP for investment-grade bonds. The two lines roughly track each other before 2014, before diverging afterwards. This is owing limited issuance of risky bond before 2014. The shaded background represents the periods of prolonged low interest rate. Investors may be flocking to riskier bonds during this period early on, demanding more premium for safe investment grade bonds and less premium for other bonds in the market. This gives some credence to risk-taking behaviors. However, we see a reversal of this trend around 2017/2018. This possibly could be tied to the event surrounding the default from a large company, Energy Earth Public Company Limited, which likely caused investors to shift towards investments in safer assets. In 2020, we again see further divergence in excess bond premium between the whole market and the safest corporate bonds.

Despite the policy rate falling into its historical low, the uncertainty triggered by COVID-19 has made investors less risk tolerant and demanding more premium for the market as a whole, but also willing to take negative premium to hold safe bonds.

Although there is some evidence in 2015-2017 that points towards lower excess bond premiums in the corporate bond market and possibly risk-taking behaviors, shocks in 2018 and afterwards have altered that picture. The most recent data suggests that corporate bonds appear slightly underpriced since 2019, although not near the level of its highest two peaks in 2006/2007 and 2009. All in all, our measure of excess bond premium does not point to evidence of risk underpricing during low-rate periods, and hence not supportive to the existence of the risk-taking channel.

Figure 4: Excess Bond Premium



Note: The figure shows excess bond premium over time for the full sample (dark blue line) and for samples of investment-grade bonds (light blue line). We obtain excess bond premium of each bond as residuals from the spread equation 3 using the specification shown in Column 3 of Table 2. Data is shown as a 12-month moving average of excess bond premium of every bond in the sample, weighted equally. Shaded background represents the recent low-rate environment, where the Bank of Thailand cuts its policy rate to below 2 percent. The sample periods are from 2001Q1 to 2020Q3.

Table 2: Pricing of Risk Estimation: Only Credit Risks

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Credit rating							
BBB group	1.269***	1.272***	1.199***	1.179***	1.738***	1.118***	1.780***
	(0.0385)	(0.0381)	(0.0371)	(0.0733)	(0.0871)	(0.0728)	(0.0897)
Non-investment grade	2.960***	2.973***	2.893***	1.510*	4.953***	1.419*	4.945***
	(0.107)	(0.107)	(0.0786)	(0.880)	(0.779)	(0.838)	(0.751)
Unrated	2.660***	2.675***	2.702***	2.214***	3.524***	2.022***	4.646***
	(0.0883)	(0.0877)	(0.0586)	(0.297)	(0.386)	(0.308)	(0.360)
Monetary policy & interaction terms							
Low rate	0.229***			0.108***		0.0375	
	(0.0409)			(0.0351)		(0.0340)	
BBB X Low rate				0.259***		0.288***	
				(0.0716)		(0.0729)	
NonIG X Low rate				1.785**		1.839**	
				(0.880)		(0.841)	
Unrated X Low rate				0.861***		1.258***	
				(0.292)		(0.300)	
Policy rate		-0.123***	-0.0922***		-0.0572***		0.00307
		(0.0236)	(0.0242)		(0.0212)		(0.0229)
BBB X Policy rate					-0.239***		-0.290***
					(0.0463)		(0.0478)
NonIG X Policy rate					-1.372**		-1.389**
					(0.642)		(0.617)
Unrated X Policy rate					-0.415		-1.171***
					(0.294)		(0.286)
Bond characteristics							
Maturity	0.106***	0.104***	0.113***	0.118***	0.119***	0.128***	0.133***
	(0.0358)	(0.0357)	(0.0298)	(0.0358)	(0.0357)	(0.0290)	(0.0289)
Issue size	-0.0212	-0.0194	-0.0350**	-0.0157	-0.0177	-0.0256*	-0.0276*
	(0.0145)	(0.0146)	(0.0151)	(0.0143)	(0.0144)	(0.0144)	(0.0144)
Callable	0.631***	0.624***	0.337***	0.602***	0.598***	0.261***	0.254***
	(0.0681)	(0.0684)	(0.0585)	(0.0661)	(0.0673)	(0.0719)	(0.0743)
Secured	0.412***	0.408***	0.297***	0.364***	0.377***	0.273***	0.277***
	(0.0587)	(0.0595)	(0.0593)	(0.0578)	(0.0590)	(0.0668)	(0.0697)
Issuer characteristics							
Firm size			-0.0175			-0.0223	-0.0210
			(0.0377)			(0.0316)	(0.0316)
Return on assets			-0.0212***			-0.0256***	-0.0248***
			(0.00253)			(0.00249)	(0.00260)
Debt-to-asset ratio			-0.0126			-0.00348	-0.00801
			(0.0334)			(0.0470)	(0.0448)
Macroeconomic conditions							
GDP Growth	-0.0533***	-0.0504***	-0.0460***	-0.0444***	-0.0442***	-0.0364***	-0.0392***
	(0.00329)	(0.00363)	(0.00353)	(0.00309)	(0.00350)	(0.00298)	(0.00340)
BBB X GDP				-0.0188***	-0.00874	-0.0279***	-0.0146*
				(0.00716)	(0.00751)	(0.00757)	(0.00784)
NonIG X GDP				-0.0520***	0.0262	-0.0644***	0.0138
				(0.00991)	(0.0377)	(0.0112)	(0.0366)
Unrated X GDP				-0.0726***	-0.0435	-0.102***	-0.0289
				(0.0234)	(0.0285)	(0.0265)	(0.0293)
SET volatility	0.0103***	0.00613*	0.00635*	0.00615*	0.00226	0.00642**	0.00184
	(0.00364)	(0.00339)	(0.00326)	(0.00346)	(0.00317)	(0.00327)	(0.00305)
Bank loan spread	-0.0753	-0.0460	0.0108	-0.0176	-0.00734	0.0451	0.0690
	(0.0577)	(0.0566)	(0.0531)	(0.0521)	(0.0531)	(0.0532)	(0.0557)
Constant	1.170***	1.517***	1.622***	1.064***	1.292***	1.233***	1.280***
	(0.166)	(0.194)	(0.167)	(0.155)	(0.180)	(0.160)	(0.186)
Observations	2,526	2,526	2,046	2,526	2,526	2,046	2,046
R^2	0.742	0.741	0.769	0.753	0.751	0.790	0.789

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Note: This table reports estimates from an OLS regression. The dependent variable is the spread between a corporate bond's coupon rate and a yield of government bond of the same maturity. The main independent variables are the interaction terms between a measure of monetary policy and bond risk ratings. Issue and issuer characteristics, as well as macroeconomic variables are included as controls. Robust standard errors are shown in parentheses. The sample periods are from 2001Q1 to 2020Q3.

Table 3: Pricing of Risk Estimation: Both Credit and Maturity Risks

Variable	(8)	(9)	(10)	(11)	(12)	(13)
Credit rating						
BBB group	1.362***	1.358***	1.201***	1.696***	1.094***	1.763***
	(0.0498)	(0.0499)	(0.0742)	(0.0947)	(0.0745)	(0.0950)
Non-investment grade	3.133***	3.129***	1.550*	4.887***	1.377*	4.919***
	(0.108)	(0.110)	(0.895)	(0.790)	(0.832)	(0.761)
Unrated	2.941***	2.928***	2.274***	3.439***	1.960***	4.613***
	(0.141)	(0.142)	(0.313)	(0.403)	(0.321)	(0.375)
Monetary policy & interaction terms						
Low rate	0.530***		0.233**		-0.0979	
	(0.0872)		(0.104)		(0.100)	
BBB X Low rate			0.225***		0.328***	
			(0.0770)		(0.0773)	
NonIG X Low rate			1.729*		1.900**	
			(0.898)		(0.838)	
Unrated X Low rate			0.778**		1.345***	
			(0.321)		(0.323)	
Maturity X Low rate	-0.220***		-0.0811		0.0869	
	(0.0533)		(0.0650)		(0.0620)	
Policy rate		-0.257***		-0.132**		-0.0246
		(0.0533)		(0.0573)		(0.0577)
BBB X Policy rate				-0.219***		-0.282***
				(0.0494)		(0.0505)
NonIG X Policy rate				-1.337**		-1.375**
				(0.648)		(0.622)
Unrated X Policy rate				-0.371		-1.153***
				(0.302)		(0.294)
Maturity X Policy rate		0.102***		0.0498		0.0181
		(0.0316)		(0.0344)		(0.0327)
Bond characteristics						
Maturity	0.278***	-0.0670	0.176***	0.0280	0.0657	0.100
	(0.0398)	(0.0778)	(0.0468)	(0.0825)	(0.0533)	(0.0666)
Issue size	-0.0214	-0.0196	-0.0159	-0.0174	-0.0258*	-0.0276*
	(0.0143)	(0.0144)	(0.0143)	(0.0144)	(0.0144)	(0.0144)
Callable	0.596***	0.591***	0.601***	0.597***	0.261***	0.255***
	(0.0682)	(0.0686)	(0.0660)	(0.0673)	(0.0716)	(0.0743)
Secured	0.374***	0.380***	0.363***	0.378***	0.278***	0.276***
	(0.0583)	(0.0595)	(0.0578)	(0.0591)	(0.0662)	(0.0696)
Issuer characteristics						
Firm size					-0.0187	-0.0214
					(0.0316)	(0.0316)
Return on assets					-0.0255***	-0.0249***
					(0.00252)	(0.00262)
Debt-to-asset ratio					-0.00404	-0.00779
					(0.0465)	(0.0451)
Macroeconomic conditions						
GDP Growth	-0.0432***	-0.0418***	-0.0444***	-0.0446***	-0.0362***	-0.0394***
	(0.00308)	(0.00349)	(0.00307)	(0.00348)	(0.00301)	(0.00339)
BBB X GDP	-0.0206***	-0.0191***	-0.0186***	-0.00814	-0.0283***	-0.0143*
	(0.00708)	(0.00705)	(0.00714)	(0.00750)	(0.00758)	(0.00784)
NonIG X GDP	-0.0504***	-0.0454***	-0.0516***	0.0269	-0.0650***	0.0140
	(0.00927)	(0.00942)	(0.00989)	(0.0378)	(0.0113)	(0.0366)
Unrated X GDP	-0.0701***	-0.0616***	-0.0724***	-0.0429	-0.102***	-0.0288
	(0.0229)	(0.0226)	(0.0234)	(0.0285)	(0.0266)	(0.0293)
SET volatility	0.00695**	0.00253	0.00605*	0.00202	0.00651**	0.00178
	(0.00352)	(0.00325)	(0.00346)	(0.00317)	(0.00329)	(0.00304)
Bank loan spread	-0.0321	-0.000898	-0.0142	-0.00178	0.0409	0.0709
	(0.0565)	(0.0555)	(0.0524)	(0.0534)	(0.0540)	(0.0558)
Constant	0.832***	1.646***	0.970***	1.418***	1.337***	1.328***
	(0.162)	(0.216)	(0.162)	(0.207)	(0.184)	(0.202)
Observations	2,526	2,526	2,526	2,526	2,046	2,046
R^2	0.749	0.747	0.753	0.751	0.790	0.789

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Note: This table reports estimates from an OLS regression. The dependent variable is the spread between a corporate bond's coupon rate and a yield of government bond of the same maturity. The main independent variables are the interaction terms between a measure of monetary policy and bond maturity. Issue and issuer characteristics, as well as macroeconomic variables are included as controls. Robust standard errors are shown in parentheses. The sample periods are from 2001Q1 to 2020Q3.

4.3 The Search-for-Yield Behaviour

Last, we explore whether any bond investor types are prone to the search-for-yield behavior, by leveraging the debt securities holding database. Before proceeding to regressions, we show some stylized facts on yields obtained by different groups of bondholders.

4.3.1 Weighted-average Yield

We have already seen in Figure 1 that individuals proportionally hold more risky bonds than any other types of investors. In Figure 5, we compute weighted-average yields of non-financial corporate bond portfolio held by each bondholder groups during 2013-2020. It is unsurprising that this group of investors obtains the highest yields, over 4 percent per annum. The group with the second highest yields are the 'government agencies plus others'. It is important to note here that this 'government agencies plus others' group includes nonresidents, which may be willing to afford high risks.

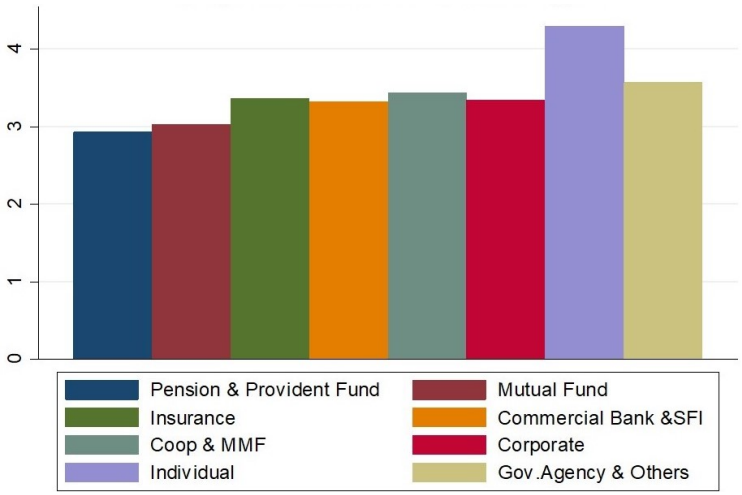
On the other hand, the groups with the lowest yields are pension and provident funds, as well as mutual funds. As mentioned earlier, the difference in the weighted-average yields across groups may be due in part to law and regulations that prevent certain groups of investors from investing in risky bonds, but also in part due to those groups' own risk preferences. Meanwhile, corporates, banks and other institutional investors including insurance companies and cooperatives obtain moderate yields.[12]

In Figure 6, we attempt to see whether the aggregate trends still hold if we focus on bonds in the same ratings group, especially safe bonds that are less subjected to investment restrictions. The results show that individuals remain the yield-chasing agent even within these group of bonds. Within A-group bonds, individuals, as well as cooperatives and MMF, obtain the highest yields. For the BBB-rating group, the two investor groups with the highest yields are individuals and government agencies plus others. Meanwhile, pension and provident funds, as well as mutual funds, are always bondholder groups that hold the low-yield bond portfolio even within the safe category of bonds.

Figure 7 compares weighted-average yields across time periods. We subdivide the sample into two 4-year periods: 2013-2016 and 2017-2020Q3. All bondholders face declining returns in the later period, consistent with the level of policy rate.

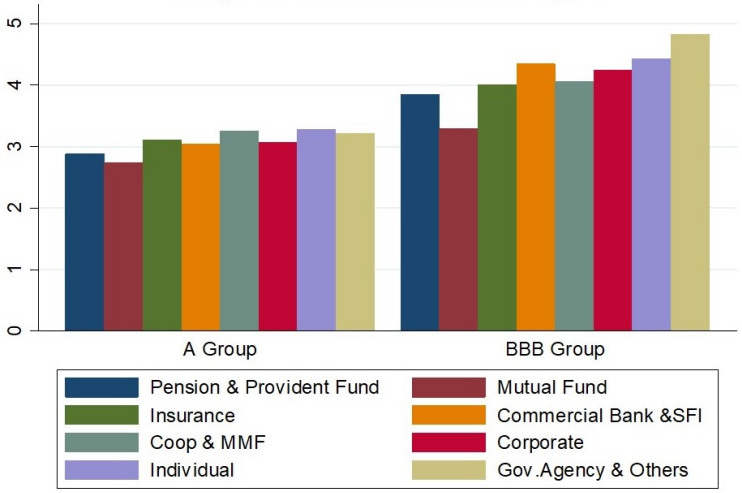
[12]Cooperatives belong to the group that also includes money market funds. It would have been interesting to separate these two entities since their business models and operations are so different, but we are not able to do so given data availability.

Figure 5: Weighted-Average Yield (%) by Bondholder Group



Note: The figure reports a value-weighted average yield of Thai non-financial corporate bond holdings across 8 bondholder groups. The sample periods are from 2013Q1 to 2020Q3.

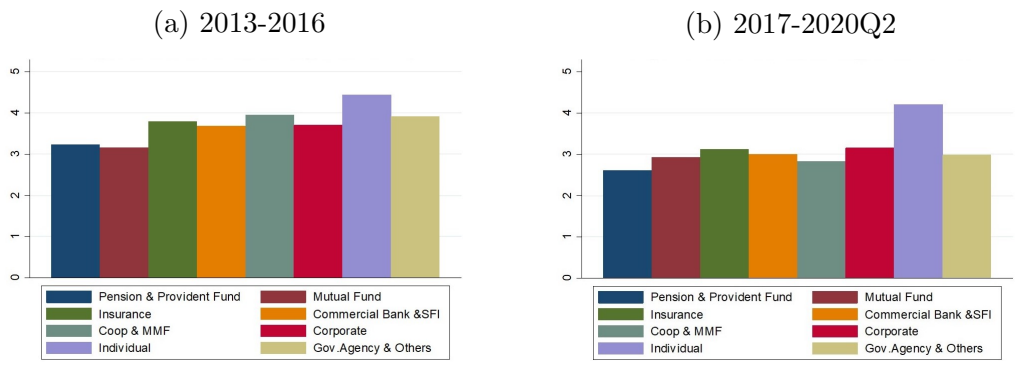
Figure 6: Weighted-Average Yield (%) by Rating and Bondholder Group



Note: The figure reports a value-weighted average yield of Thai non-financial corporate bond holdings across 8 bondholder groups, broken down into two investment-grade bond risk rating categories: A and BBB group. The sample periods are from 2013Q1 to 2020Q3.

The Bank of Thailand started its easing cycle in 2011 that ended in 2014. The rate, apart from a single hike in 2018, has remained low ever since and dropped lower in 2019-2020 due to the US-China trade war and COVID-19. However, individuals stands out with its ability to maintain similar yields across the two time periods, as they are able to maintain yields above 4 percent in both sample periods. It may be the case that they shift their risk preferences or attempt to search for yield in order to maintain this level of return.

Figure 7: Weighted Average Yield (%) across 2 Time Periods



Note: The Figure reports a value-weighted average yield of Thai non-financial corporate bond holdings across 8 bondholder types, using two different time periods: (a) between 2013-2016 and (b) between 2017-2020Q3.

4.3.2 Search-for-yield Estimates

In this section, we use the aforementioned zero inflated beta model to analyze how bond yield influences investment decisions of each bondholder group. We focus only on the coefficients of the beta model that is applied when bond holding proportions are not zero.

The results are shown in Table 4. There is strong evidence that individuals have riskier preferences and are prone to search-for-yield behaviors. Not only do they underweight bonds in the A ratings group and overweight bonds with longer maturities, they also seek for bonds with higher spreads conditional on bonds having similar risk ratings and maturity. A one-percentage-point increase in bond spread leads to a higher holding weight of that individual bond by 0.03 percentage point as a proportion of all their non-financial corporate bond portfolio. The estimate appears to be small, when compared with the standard deviation of the dependent variable. However, this is unsurprising since we consider marginal investment in an individual bond out of the existing diversified bond portfolios. Similar findings on the search-for-yield incentives are also found for cooperatives and MMF, with an even large size of coefficients of 0.06. The search-for-yield incentives found for cooperatives echo concerns of the IMF and the Bank of Thailand over possible weaknesses for credit cooperatives due to a buildup of risky assets and that their supervision and regulation could be strengthened to be on par with other types of financial institutions (IMF Staff, 2019; Bank of Thailand, 2021). On the other hand, other bondholder groups allocate more of their portfolios to bonds with lower spreads. That is, we fail to find positive estimates for certain institutional investors that are earlier found to engage in the search-for-yield behaviors in the U.S., including insurance companies.

With regard to controls, we show that pension and provident funds are the most conservative investors, allocating more of their portfolios to bonds in the A ratings group and also with lower spread. This is consistent with regulatory constraints facing them. Corporates also tend to invest in A-group bonds. Meanwhile, insurance companies, individuals, and cooperatives and MMF are three groups that have preference for longer-dated bonds. Insurances have longer durations on the liability side of their balance sheets and thus having to buy longer-maturity bonds.[13]

Since law and regulations may constrain certain investor groups' ability to hold non-investment-grade bonds, it is relevant to also look specifically at investment-grade bonds. This helps with the identification of search-for-yield incentives. The results, displayed in Table 5, are in line with those of the full sample. The same two groups, individuals and cooperatives & MMF are the ones that allocate more of their holdings into bonds with higher spreads.

We implement several robustness checks by using alternative measures of the bond holding and yields. First, in line with Becker and Ivashina (2015), the dependent variable is replaced by the percentage of the bonds held compared to the bond's own issue size. They compare bond acquisitions of each holder type to those of other groups of investors. According to Table B2 in the Appendix, we again find that individuals and cooperatives and MMF exhibit the 'search for yield' behavior. Individuals, in particular, would hold roughly 9.5-percentage-point more of the bond if the spread is increased by one percentage point. Meanwhile, cooperatives and MMF will increase holdings by around 2.3 percentage points. The coefficient on bond spread for the government agency and others group now becomes positive, but not significant at 5 percent level. Position-taking by these three holder groups comes at the expense of other groups, which reduce holdings of these higher-yielding bonds.[14]

[13]The coefficients on issue size here are all positive, almost by construction: a low-issue-sized bond, even when an investor is fully invested in them, just isn't able to represent a large proportion of that investor's portfolio.

[14]It is to note that if we limit our sample to key institutional investors, namely, insurance companies, pension funds and mutual funds as in Becker and Ivashina (2015), we similarly find that insurance companies have relatively higher tolerance for risks. Results are available upon request.

Table 4: Searching for Yield Estimation: Full Sample

Variable	Pension & Provident Fund	Mutual Fund	Insurance	Bank & SFI	Coop & MMF	Corporate	Individual	Gov. Agency & Others
Spread	-0.0729***	-0.0520***	-0.0240***	-0.0666***	0.0613***	0.00297	0.0268***	-0.0268**
	(0.0133)	(0.0125)	(0.00862)	(0.0207)	(0.0184)	(0.00750)	(0.00525)	(0.0134)
A group	0.00158***	-0.000368	-0.000553**	0.000733	0.000544	0.00100***	-0.00170***	0.000392
	(0.000492)	(0.000412)	(0.000265)	(0.000762)	(0.000755)	(0.000291)	(0.000241)	(0.000513)
BBB group	0.000645	0.000300	-0.000476*	-0.000104	0.000745	7.59e-05	7.82e-05	-0.000503
	(0.000480)	(0.000337)	(0.000261)	(0.000589)	(0.000608)	(0.000199)	(0.000153)	(0.000377)
Maturity	-0.00128***	-0.00141***	0.00127***	0.000126	0.00216***	-0.000135	0.000250***	0.000127
	(0.000151)	(0.000175)	(9.47e-05)	(0.000236)	(0.000181)	(9.23e-05)	(8.02e-05)	(0.000163)
Issue size	0.000826***	0.000939***	0.000409***	0.000818***	0.000813***	0.000922***	0.000901***	0.000933***
	(7.28e-05)	(8.14e-05)	(4.95e-05)	(0.000109)	(8.87e-05)	(5.53e-05)	(5.12e-05)	(9.13e-05)
GDP growth	0.0106***	0.0106***	0.00421***	0.0186***	0.0155***	0.0117***	0.00562***	0.0120***
	(0.00291)	(0.00308)	(0.00158)	(0.00452)	(0.00301)	(0.00179)	(0.00151)	(0.00294)
SET volatility	0.0120***	0.00763***	0.00378***	0.0100***	0.00614***	0.00820***	0.00227**	0.0116***
	(0.00202)	(0.00219)	(0.00130)	(0.00315)	(0.00226)	(0.00127)	(0.00105)	(0.00231)
Observations	1,858	1,858	1,858	1,858	1,858	1,858	1,858	1,858

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Note: This table reports marginal effects from estimating a zero-inflated beta model to study search-for-yield behavior for 8 different bond investor groups. The dependent variable ($holding^{j}_{i,t}$) is the share of each bondholder group j's holding amount of a newly-issued bond i to agent j's total non-financial corporate bond portfolios in period t. A spread between a coupon rate of that bond i and a yield of government bond of the same maturity represents a measure of bond yield. All models include issue characteristics and macroeconomic variables as controls. Here we only show results of beta regression that is applied when $0 < holding^{j}_{i,t} < 1$. Standard errors are shown in parentheses. The sample periods are from 2013Q1 to 2020Q3.

Table 5: Searching for Yield Estimation: Only Investment-Grade Bonds

Variable	Pension & Provident Fund	Mutual Fund	Insurance	Bank & SFI	Coop & MMF	Corporate	Individual	Gov.Agency & Others
Spread	-0.156***	-0.112***	-0.0462***	-0.126***	0.122***	0.00253	0.0754***	-0.0604***
	(0.0248)	(0.0228)	(0.0141)	(0.0360)	(0.0273)	(0.0127)	(0.00957)	(0.0203)
BBB group	-0.000306	0.00139***	0.000360	-0.000201	-0.000529	-0.00106***	0.00101***	-0.000556
	(0.000388)	(0.000337)	(0.000248)	(0.000627)	(0.000515)	(0.000251)	(0.000207)	(0.000392)
Maturity	-0.00134***	-0.00145***	0.00159***	0.000457	0.00231***	-0.000133	3.81e-05	0.000273
	(0.000187)	(0.000199)	(0.000133)	(0.000297)	(0.000213)	(0.000126)	(0.000106)	(0.000205)
Issue Size	0.00104***	0.00109***	0.000486***	0.000947***	0.000971***	0.00117***	0.00102***	0.00118***
	(8.87e-05)	(9.04e-05)	(5.96e-05)	(0.000133)	(0.000104)	(7.47e-05)	(7.09e-05)	(0.000115)
GDP growth	0.00925***	0.00940***	0.00436**	0.0206***	0.0202***	0.0155***	0.00880***	0.0144***
	(0.00358)	(0.00352)	(0.00189)	(0.00548)	(0.00361)	(0.00239)	(0.00194)	(0.00362)
SET volatility	0.0144***	0.00928***	0.00477***	0.0120***	0.00688***	0.0109***	0.00323**	0.0155***
	(0.00241)	(0.00243)	(0.00156)	(0.00377)	(0.00263)	(0.00173)	(0.00139)	(0.00290)
Observations	1,430	1,430	1,430	1,430	1,430	1,430	1,430	1,430

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Note: This table reports marginal effects from estimating a zero-inflated beta model to study search-for-yield behavior for 8 different bond investor groups. We limit our sample to only investment-grade bonds. The dependent variable ($holding^{j}_{i,t}$) is the share of each bondholder group j's holding amount of a newly-issued bond i to agent j's total non-financial corporate bond portfolios in period t. A spread between a coupon rate of that bond i and a yield of government bond of the same maturity represents a measure of bond yield. All models include issue characteristics and macroeconomic variables as controls. Here we only show results of beta regression that is applied when $0 < holding^{j}_{i,t} < 1$. Standard errors are shown in parentheses. The sample periods are from 2013Q1 to 2020Q3.

In Tables B3 and B4 we vary the main independent variable, changing from the spread over government bonds, to the coupon rate and its difference from the median coupon rate of all bonds in the portfolio. Individuals and cooperatives and MMF are again more likely to search for yields compared to other investors. Whenever the coupon rate is employed as yield measure, insurance companies, commercial banks, corporates and government agencies also appear to significantly respond to and take advantage of higher bond yields. All in all, our findings suggest that individuals and cooperatives and MMF are the only two bond investor groups that have tendencies to 'search-for-yield', whereas other institutional and retail investors do not appear to have such incentives. Compared to previous studies, this paper suggests novel bond investor types that may be prone to risk-taking in this market.

5 Conclusion

This paper examines the risk-taking channel of monetary policy in the context of Thai corporate bond market, and shows that the evidence is less clear-cut. We find evidence that low interest rates are associated with the greater issuance of bonds of low creditworthiness, in support of the risk-taking channel of monetary policy. Bond maturity is also lengthened when rates are low. However, examining the pricing of risks, we observe during periods of low interest rates that bond spreads for risky bonds are even higher. The finding contrasts with the finding of bank risk-taking literature, which points to a compression of risk premium during those periods. This suggests that banks themselves have incentives to take greater risks on their portfolio, while in bond markets greater risky bond issuance during the low-rate environment may be more driven by suppliers of bonds, rather than by risk-taking incentives or demand from bond investors. Therefore, this paper points towards the heterogeneity in risk-taking behaviour between banks and bond investors.

Our results further show that, rather than institutional investors, retail individual investors reach for yield in corporate bond investment by investing both in risky bonds and in highest-yielding bonds within the same risk-rating category. Meanwhile, the only institutional investors that engage in reaching-for-yield are saving cooperatives and MMF, which subject to regulatory constraints search for high-yield bonds within A-rated risk category.

The findings lend important policy implications for the central banks whose mandates cover both price and financial stability like the Bank of Thailand. First, this paper points toward rather mild evidence of risk-taking among corporate bond investors during the low-rate environment, as bond risks are not underpriced and the

search-for-yield evidence is only limited to a few investor groups. Financial-stability implications of low-for-long policy rates in corporate bond markets are therefore not much a concern, when compared against their impact on bank profitability and risks (Ratanavararak and Ananchotikul, 2018). It is also hard to tell that whether the increased risk-taking among bond investors is optimal or not, especially in Thailand, where the participation of risky borrowers and bonds has been initially low. However, the rate-setting committee may have to place an awareness on risk-taking on bonds from certain sectors like the property sector that may be subjected to greater risk-taking.

Second, the finding that the search-for-yield behavior is found for individuals or retail investors highlights roles of improved market conduct. Ex-post defaults of corporate bond may affect savings, consumption and welfare of each individual. For those individuals that are not well-protected by public safety nets, improved market conduct could help prevent reckless investment and potential risk-underpricing. The impact on individuals, however, depends on their existing wealth. The fact that individuals have to be considered 'high net worth' to be eligible to invest in non-investment grade bonds helps alleviate this concern to some extent. They are also less likely to contribute to systemic financial-stability risks or spillovers to other parts of the economy.

Last, for financial stability concerns, regulators should take a close look at co-operatives, as they are holding riskier bond portfolios and they act as key financial intermediaries for the 'underbanked' population in Thailand. Since saving cooperatives and MMFs are outside the regulatory perimeter of the central bank, relevant regulatory agencies ought to ensure sufficient surveillance and, if necessary, impose regulatory measures to avoid excessive risk-taking. A portfolio of these institutional investors is likely less diversified than bank loans portfolio, rendering them susceptible to bond default in some future states though asset risks are well-priced.

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Appendix

A Debt Securities Holding Dataset

Until June 2019, the dataset shows debt securities' holding amount across 24 types of bondholders. In Table A1, we categorize these 24 holder types into 8 groups, in line with the classification used in the Thai Bond Market Association (ThaiBMA)'s website. From July 2019, the Bank of Thailand requires custodians and brokers to report bond holdings for 27 holder types. Other depository financial institution is further classified into 3 types: money market mutual fund, credit foncier company, and thrift and credit cooperatives and credit unions. Other non-financial corporation now consists of cooperatives other than thrift and credit cooperatives and credit unions, and other resident juristic.

Table A1: Classification of Bond Investors

8 Bondholder Groups	24 Bondholder Types
[1] Pension & provident funds	Civil servant pension fund Provident fund
[2] Mutual funds (except money market mutual fund: MMF)	Non-financial market mutual fund
[3] Insurances	Insurance company Life insurance company
[4] Commercial banks & specialized financial institutions (SFI)	Domestically-registered commercial bank Branches of foreign bank Specialized financial institution Finance company Securities company Other financial institution
[5] Other depository financial institutions	Other depository financial institution (e.g., cooperatives and MMF)
[6] Corporates	Other non-financial corporation
[7] Individuals	Residents
[8] Government agencies & others	The Bank of Thailand Non-profit organization serving government Social security office Local government Public non-financial corporation Non-profit organization serving household Nonresidents as non-financial corporations Nonresidents as individuals Nonresident as financial institutions Other nonresidents

Note: Recently, the ThaiBMA further classifies 'government agencies and others' into 3 groups: nonresidents, non-profit organizations and government agencies.

Table A2: Description and Source of Data

Variable	Description	Source
Policy rate	Quarterly average of 1-day bilateral repurchase rate (in percent per annum)	Bank of Thailand and authors' calculation
Low rate	= 1 if the policy rate is below median during periods 2001-2020Q3; = 0 otherwise	Bank of Thailand and authors' calculation
Maturity	Bond maturity (in number of years)	ThaiBMA
Issue size	Bond issue size (in million baht)	ThaiBMA
Spread	The difference between a bond coupon rate and a yield of government bond of the same maturity (in percent per annum)	ThaiBMA and authors' calculation
Coupon rate	Bond coupon rate (in percent per annum)	ThaiBMA
Callable	= 1 if a bond is callable and/or convertible; = 0 otherwise	ThaiBMA
Secured	= 1 if a bond is secured; = 0 otherwise	ThaiBMA
A group	= 1 if a bond is rated A- or above; = 0 otherwise	ThaiBMA, Bloomberg, TRIS rating website
BBB group	= 1 if a bond is rated BBB-, BBB or BBB+; = 0 otherwise	
Non-investment grade (NonIG)	= 1 if a bond is rated BB+ or below; = 0 otherwise	
Unrated	= 1 if a bond is unrated; = 0 otherwise	
Rating	∈ {A group, BBB group, Non-investment grade, Unrated}	
Total assets	An issuing firm's total assets (in billion baht)	Bloomberg, SETSMART
Firm size	= 1 if assets of an issuing firm rank above the 75th percentile of all firms; = 0 otherwise	
Return on assets	An issuing firm's return on total assets (in percent)	
Debt-to-asset ratio	An issuing firm's ratio of debt to total assets (in percent)	
GDP growth	A year-on-year growth rate of quarterly Thai nominal GDP (in percent)	NESDC
SET volatility	SET (Stock Exchange of Thailand) total return index volatility over past 260 trading days (in percent)	Bloomberg
Spread2Y5Y	The difference between yields of 5-year and 2-year government bond, based on quarterly average of daily data (in percent per annum)	ThaiBMA
Bank loan spread	The difference between new bank loan rates and the policy rate (in percent per annum)	Bank of Thailand and authors' calculation
Holding	The ratio of an holding amount of a particular corporate bond by a certain bondholder group to its total non-financial corporate bond portfolios (in percent)	Debt Securities Holding Database

Table A3: Summary Statistics

Variable	Obs	Mean	SD	Min	Median	Max
Maturity	2526	4.47	2.91	0.76	3.01	16.01
Issue size (million baht)	2526	2,143	3,134	10	1,058	43,895
Spread	2526	1.93	1.35	-1.58	1.48	7
Coupon rate	2526	4.28	1.23	0.7	4.17	8.5
Callable bonds	224					
Secured bonds	278					
Rating						
- A group	1,463					
- BBB group	629					
- Non-investment grade	74					
- Unrated	360					
Issuers' total assets (billion baht)	2046	96,000	130,000	11	41,000	750,000
Issuers' return on assets	2046	7.21	5.75	-30.57	6.72	39.28
Issuers' debt-to-asset ratio	2046	0.62	0.43	0	0.61	18.84
Policy rate	2526	1.81	0.76	0.5	2	5
GDP growth	2526	4.48	5.05	-14.49	5.04	21.7
SET volatility	2526	16.39	6.6	6.55	14.56	36.27
Spread2Y5Y	2526	0.45	0.29	0.02	0.4	1.54
Bank loan spread	2526	2.67	0.38	1.93	2.65	4.46
Holding						
- Pension and provident funds	1,858	0.125	0.363	0.000	0.000	4.758
- Mutual funds (except MMF)	1,858	0.142	0.413	0.000	0.000	6.094
- Insurances	1,858	0.106	0.343	0.000	0.000	6.203
- Commercial banks & SFI	1,858	0.217	0.577	0.000	0.000	8.284
- Cooperatives & MMF	1,858	0.139	0.480	0.000	0.000	12.768
- Corporates	1,858	0.138	0.511	0.000	0.016	15.651
- Individuals	1,858	0.145	0.420	0.000	0.029	6.935
- Government agencies & others	1,858	0.179	0.607	0.000	0.003	13.769

Note: This table reports summary statistics of the cleaned dataset. Please refer to the variable description in Table A2. The sample periods are from 2001 to 2020Q3. The exception is the bond holding variable, whose sample periods only run from 2013 to 2020Q3.

B Tables and Figures

Interest Rate and Risky Bond Issuance (Section 4.1.1)

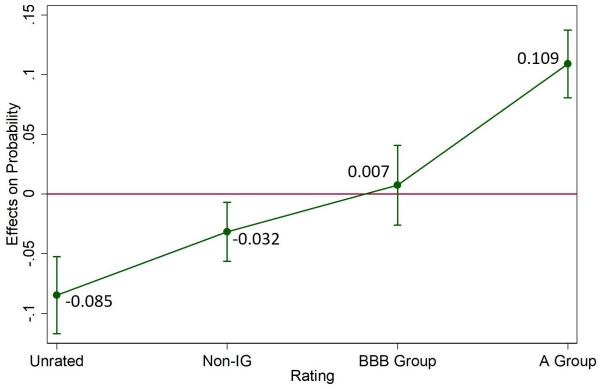
Table B1: Multinomial Logistic Regression Results on Bond Credit Rating

	(a) Full Sample			(b) Property Sector			(c) Non-Property Sector		
Variable	Unrated	Non-IG	BBB group	Unrated	Non-IG	BBB group	Unrated	Non-IG	BBB group
Low rate	2.267***	2.328***	0.770***	2.140***	2.963***	0.428*	2.433***	1.221	0.983***
	(0.332)	(0.598)	(0.155)	(0.451)	(0.819)	(0.238)	(0.525)	(0.922)	(0.216)
Maturity	-3.797***	-2.532***	-2.070***	-3.374***	-2.322***	-1.635***	-4.281***	-2.974***	-2.253***
	(0.222)	(0.284)	(0.131)	(0.354)	(0.436)	(0.236)	(0.318)	(0.514)	(0.164)
Issue size	-1.329***	-0.600***	-0.475***	-1.157***	-0.207	-0.523***	-1.480***	-0.895***	-0.425***
	(0.0926)	(0.123)	(0.0572)	(0.148)	(0.181)	(0.104)	(0.131)	(0.224)	(0.0726)
Callable	2.877***	2.394***	2.229***	1.457**	1.926***	-0.231	3.557***	3.209***	2.769***
	(0.334)	(0.433)	(0.225)	(0.642)	(0.707)	(0.652)	(0.439)	(0.651)	(0.254)
Secured	1.017***	-0.00931	-0.674***	2.043***	-0.775	0.222	0.143	0.626	-0.933***
	(0.280)	(0.454)	(0.224)	(0.446)	(0.797)	(0.389)	(0.425)	(0.639)	(0.286)
GDP growth	-0.0201	-0.103***	-0.00222	-0.0229	-0.0921*	0.00810	-0.00316	-0.145*	-0.00409
	(0.0235)	(0.0388)	(0.0128)	(0.0331)	(0.0472)	(0.0201)	(0.0365)	(0.0764)	(0.0174)
SET volatility	-0.0627**	-0.0705*	-0.0218	-0.0788**	-0.0716	-0.0450**	-0.0611	-0.0992	-0.00888
	(0.0246)	(0.0394)	(0.0142)	(0.0331)	(0.0456)	(0.0209)	(0.0380)	(0.0771)	(0.0200)
Bank loan spread	-0.0727	-1.379*	0.208	-0.919	-1.590*	0.481	1.035	-0.777	0.0939
	(0.434)	(0.719)	(0.225)	(0.627)	(0.876)	(0.350)	(0.648)	(1.355)	(0.304)
Constant	10.58***	7.473***	4.473***	12.02***	5.286**	4.309***	8.328***	8.684**	4.125***
	(1.085)	(1.872)	(0.577)	(1.709)	(2.490)	(1.013)	(1.520)	(3.462)	(0.747)
Observations	2,526	2,526	2,526	881	881	881	1,645	1,645	1,645
Pseudo-R:	0.325	0.325	0.325	0.251	0.251	0.251	0.389	0.389	0.389
Log-Likelihood:	-1780	-1780	-1780	-808.2	-808.2	-808.2	-902	-902	-902
Chi-squared	1713	1713	1713	542.8	542.8	542.8	1148	1148	1148
Prob Wald:	0	0	0	0	0	0	0	0	0

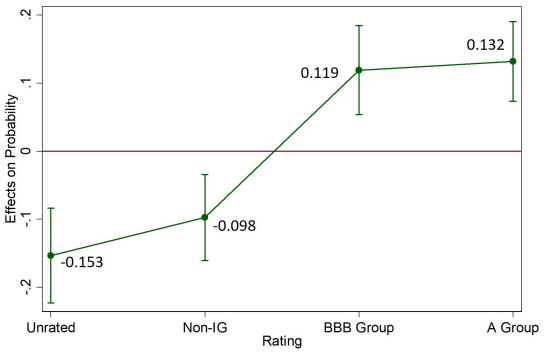
Note: This table reports estimates of multinomial logistic regression to predict a bond's risk rating, where the A group is the base outcome, using (a) the full sample, (b) samples of bonds from the property sector, and (c) samples of bonds from the non-property sectors. Our measure of monetary policy is the dummy variable indicating whether the policy rate is below its median. All models include issue characteristics and macroeconomic variables as controls. Standard errors are reported in parentheses. ***,**,* denote 1%, 5% and 10% significant level, respectively. The sample periods are from 2001Q1-2020Q3.

Figure B1: Effect on the Probability of Bond Issuance by Rating after a 1-percentage-point Rise in the Policy Rate

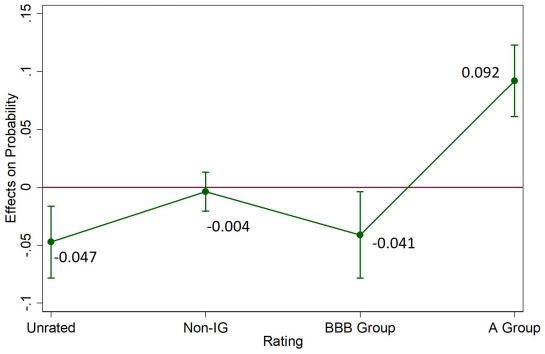
(a) Full Sample



(b) Property Sector



(c) Non-Property Sectors



Note: This figure shows the marginal effects of a 1-percentage point increase in the policy rate on the issuance probability of bonds from different credit-rating groups. We derive marginal effects from estimates of a multinomial logistic regression, using (a) the full sample, (b) samples of bonds from the property sector, and (c) samples of bonds from the non-property sectors. Our measure of monetary policy is the actual policy rate. All models include issue characteristics and macroeconomic variables as controls. Bands represent 95% confidence intervals. The sample periods are from 2001Q1-2020Q3.

The Search-for-yield Behavior: Robustness Checks (Section 4.3.2)

Table B2: Use of Share to Bond Issue Size as Dependent Variable

Variables	Pension & Provident Fund	Mutual Fund	Insurance	Bank & SFI	Coop & MMF	Corporate	Individual	Gov.Agency & Others
Spread	-4.783***	-4.772***	-2.059**	-2.824***	2.279**	-0.341	9.534***	0.327*
	(1.088)	(1.257)	(1.027)	(0.978)	(1.118)	(0.299)	(0.982)	(0.197)
A group	0.182***	-0.0159	-0.0265	0.0696*	-0.00352	0.0337***	-0.219***	0.00680
	(0.0395)	(0.0438)	(0.0369)	(0.0366)	(0.0444)	(0.0114)	(0.0366)	(0.00756)
BBB group	0.0781**	0.0387	-0.0166	0.0289	0.0187	0.00587	0.0240	0.00129
	(0.0337)	(0.0342)	(0.0315)	(0.0271)	(0.0351)	(0.00767)	(0.0242)	(0.00523)
Maturity	-0.114***	-0.0909***	0.133***	-0.00472	0.147***	0.00204	0.0169	0.00424*
	(0.0116)	(0.0135)	(0.0103)	(0.0113)	(0.0107)	(0.00397)	(0.0129)	(0.00227)
Issue size	-0.00870*	-0.0114*	-0.0236***	-0.0363***	-0.0243***	-0.00559***	0.0158**	-0.00597***
	(0.00510)	(0.00614)	(0.00559)	(0.00553)	(0.00534)	(0.00206)	(0.00683)	(0.00130)
GDP growth	0.103	-0.327	-0.530***	0.299	0.326*	-0.00859	0.380*	0.0917**
	(0.206)	(0.234)	(0.179)	(0.207)	(0.180)	(0.0703)	(0.228)	(0.0409)
SET volatility	0.446***	-0.306*	-0.209	0.127	-0.0768	-0.0484	-0.0632	0.0891***
	(0.145)	(0.172)	(0.149)	(0.150)	(0.142)	(0.0518)	(0.175)	(0.0302)
Observations	1,858	1,858	1,858	1,858	1,858	1,858	1,858	1,858

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Note: This table reports marginal effects from estimating a zero-inflated beta model to study search-for-yield behavior for 8 different bond investor groups. The dependent variable ($holding^{j}_{i,t}$) is the share of each bondholder group j's holding amount of a newly-issued bond i to that bond's issue size. A spread between a coupon rate of that bond and a yield of government bond of the same maturity represents a measure of bond yield. All models include issue characteristics and macroeconomic variables as controls. Here we only show results of beta regression that is applied when $0 < holding^{j}_{i,t} < 1$. Standard errors are shown in parentheses. The sample periods are from 2013Q1 to 2020Q3.

Table B3: Use of Coupon Rate as Yield Measure

Variables	Pension & Provident Fund	Mutual fund	Insurance	Bank & SFI	Coop & MMF	Corporate	Individual	Gov.Agency & Others
Coupon Rate	-0.0130	-0.000455	0.0194***	0.0346**	0.0597***	0.0460***	0.0257***	0.0467***
	(0.0109)	(0.0115)	(0.00706)	(0.0166)	(0.0110)	(0.00569)	(0.00449)	(0.0112)
A group	0.00292***	0.000810*	0.000211	0.00381***	0.000634	0.00240***	-0.00180***	0.00273***
	(0.000569)	(0.000445)	(0.000308)	(0.000709)	(0.000578)	(0.000246)	(0.000210)	(0.000469)
BBB group	0.00120**	0.000866**	-0.000320	0.00150**	0.000613	0.000816***	2.42e-05	0.000727**
	(0.000535)	(0.000369)	(0.000292)	(0.000594)	(0.000517)	(0.000181)	(0.000138)	(0.000360)
Maturity	-0.00146***	-0.00161***	0.00109***	-0.000368	0.00173***	-0.000495***	0.000151*	-0.000331*
	(0.000181)	(0.000208)	(0.000107)	(0.000262)	(0.000189)	(9.60e-05)	(8.39e-05)	(0.000178)
Issue size	0.000826***	0.000977***	0.000426***	0.000807***	0.000797***	0.000972***	0.000899***	0.000974***
	(7.70e-05)	(8.63e-05)	(5.19e-05)	(0.000110)	(8.45e-05)	(5.34e-05)	(5.10e-05)	(9.03e-05)
GDP growth	0.0161***	0.0141***	0.00400**	0.0204***	0.00708***	0.0105***	0.00285**	0.0115***
	(0.00300)	(0.00320)	(0.00168)	(0.00456)	(0.00272)	(0.00163)	(0.00141)	(0.00285)
SET volatility	0.0134***	0.00785***	0.00254*	0.00827**	0.00106	0.00701***	0.00118	0.00954***
	(0.00221)	(0.00238)	(0.00142)	(0.00329)	(0.00227)	(0.00122)	(0.00105)	(0.00231)
Observations	1,858	1,858	1,858	1,858	1,858	1,858	1,858	1,858

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Note: This table reports marginal effects from estimating a zero-inflated beta model to study search-for-yield behavior for 8 different bond investor groups. The dependent variable ($holding^{j}_{i,t}$) is the share of each bondholder group j's holding amount of a newly-issued bond i to agent j's total non-financial corporate bond portfolios in period t. A coupon rate represents a measure of bond yield. All models include issue characteristics and macroeconomic variables as controls. Here we only show results of beta regression that is applied when $0 < holding^{j}_{i,t} < 1$. Standard errors are shown in parentheses. The sample periods are from 2013Q1 to 2020Q3.

Table B4: Use of Spread Relative to Median Yield as Yield Measure

Variables	Pension & Provident Fund	Mutual fund	Insurance	Bank & SFI	Coop & MMF	Corporate	Individual	Gov.Agency & Others
Δ from median	-0.0207*	-0.203	0.00940	-0.0183	0.0497***	0.0316***	0.0226***	0.00533
	(0.0123)	(0.0124)	(0.00786)	(0.0175)	(0.0127)	(0.00606)	(0.00454)	(0.00533)
A group	0.00272***	0.00272***	-1.48e-05	0.00219***	0.000265	0.00196***	-0.00189***	0.00142***
	(0.000579)	(0.000585)	(0.000307)	(0.000728)	(0.000622)	(0.000259)	(0.000215)	(0.000468)
BBB group	0.00109**	0.00110**	-0.000411	0.000596	0.000584	0.000580***	-2.10e-05	2.87e-05
	(0.000534)	(0.000536)	(0.000287)	(0.000598)	(0.000552)	(0.000187)	(0.000142)	(0.000364)
Maturity	-0.00141***	-0.00141***	0.00115***	4.54e-05	0.00186***	-0.000378***	0.000182**	4.16e-06
	(0.000181)	(0.000183)	(0.000110)	(0.000265)	(0.000197)	(9.88e-05)	(8.37e-05)	(0.000179)
Issue Size	0.000826***	0.000827***	0.000420***	0.000808***	0.000793***	0.000946***	0.000890***	0.000935***
	(7.61e-05)	(7.64e-05)	(5.18e-05)	(0.000110)	(8.74e-05)	(5.43e-05)	(5.09e-05)	(9.12e-05)
GDP growth	0.0142***	0.0147***	0.00534***	0.0209***	0.0124***	0.0129***	0.00403***	0.0139***
	(0.00306)	(0.00300)	(0.00164)	(0.00456)	(0.00271)	(0.00169)	(0.00143)	(0.00291)
SET volatility	0.0123***	0.0127***	0.00345**	0.00972***	0.00504**	0.00858***	0.00188*	0.0116***
	(0.00217)	(0.00216)	(0.00136)	(0.00320)	(0.00219)	(0.00124)	(0.00105)	(0.00231)
Observations	1,858	1,858	1,858	1,858	1,858	1,858	1,858	1,858

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Note: This table reports marginal effects from estimating a zero-inflated beta model to study search-for-yield behavior for 8 different bond investor groups. The dependent variable ($holding^{j}_{i,t}$) is the share of each bondholder group j's holding amount of a newly-issued bond i to agent j's total non-financial corporate bond portfolios in period t. A coupon rate relative to the median yield of agent j's portfolios at that time t represents a measure of bond yield. All models include issue characteristics and macroeconomic variables as controls. Here we only show results of beta regression that is applied when $0 < holding^{j}_{i,t} < 1$. Standard errors are shown in parentheses. The sample periods are from 2013Q1 to 2020Q3.