Bond Market Development and Bank Risk-Taking: Evidence from Developing Markets

1. Introduction

Liquidity management is key to banks' successful operation. A shortage of liquidity is a major threat to the soundness of financial institutions and systematic financial stability. Both the 1997/98 Asian financial crisis and the global financial crisis (GFC) showed how the drying up of liquidity can challenge financial stability and harm the real economy when the financial sector, in particular banks, failed to function as a liquidity provider (Acharya and Mora 2015). During a crisis when liquidity is tight, banks face increased financial constraints and their own liquidity positions can worsen (Drehmann and Nikolaou 2013). Ivashina and Scharfstein (2010) show that, during the GFC, credit supply in the banking sector dropped significantly under liquidity pressure from credit-line drawdowns by existing borrowers and a run by short-term depositors. Cornett et al. (2011) document that banks with less liquid asset portfolios tend to reduce their credit supply and increase asset liquidity during financial crises, and only banks with stable funding sources continue lending activities. This evidence points to the importance of liquidity management instruments that can enhance bank resilience to liquidity shocks and contribute to a well-functioning financial system.

Liquidity risk reflects a maturity mismatch that is naturally embedded in banks' business model. Diamond and Rajan (2001) model bank business structure and show that banks create liquidity by financing long-term projects with short-term demand deposits. Their ability to transform illiquid loans into liquid deposits lies in their collection skills and demand deposit issuances. Diamond and Rajan (2005) further show that such a business structure exposes banks to a natural maturity mismatch between demand deposits and loan assets. The maturity mismatch arising from liquidity transformation and creation is the main reason for banks to hold liquidity reserves and for regulators to monitor bank liquidity risk.

The risk that liquidity demand cannot be met not only affects banks' continuous operation, it also heightens systemic financial instability. In the case of a systemic liquidity shortage, affected banks may become insolvent, which worsens the aggregate liquidity situation and in turn causes contagious bank failures (Hong, Huang, and Wu 2014). Imbierowicz and Rauch (2014) also suggest that liquidity risk contributes to bank failures independently from credit risk.

Following the lessons learned from the 1997/98 Asian financial crisis and the GFC, policy makers and regulators around the world adopted various measures to strengthen banks' balance sheets and improve their liquidity positions. For example, in the aftermath of the 1997/98 Asian financial crisis, ASEAN+3 governments recognized that currency and maturity mismatches were key contributors to the regional financial crisis.[9] They jointly launched the ASEAN Bond Markets Initiative in 2002 to develop bond markets as a long-term local currency (LCY) funding source to boost financial resilience. Similarly, after the GFC, the Basel Committee on Banking Supervision (BCBS) (2010) noted that during the "liquidity phase" of the GFC, many banks faced liquidity difficulties although they held a sufficient capital buffer. To strengthen sound liquidity management and supervision, BCBS introduced an international framework for liquidity risk management and monitoring in 2010.

Although bank liquidity risk has been identified as a major contributor to bank failures, especially in periods of turmoil (Imbierowicz and Rauch 2014), literature that articulates the factors affecting bank portfolio risk and liquidity risk is relatively sparse. A few studies have discussed the role of liability portfolio structure on bank risks and consistently found that a portfolio structure with a heightened maturity mismatch exposes banks to greater risks.

[9] ASEAN+3 refers to member economies of the Association of Southeast Asian Nations (ASEAN) plus the People's Republic of China; Japan; the Republic of Korea.

On the liability side, a greater reliability on deposits as a source of funding is related to heightened bank fragility. Acharya and Naqvi (2012) develop a model indicating that abundant deposits on a bank's balance sheet encourages it to underprice loan risks and increase risk-taking. Khan, Scheule, and Wu (2017) examine a sample of banks in the United States (US) and find that when banks rely more on deposits as funding sources to support bank loans (i.e., higher deposit-to-total-assets ratios), they tend to hold more risk-weighted assets and, thus, take more risk.

On the asset side, the illiquid nature of bank loans creates incentives for banks to convert illiquid assets on their balance sheets to liquid assets via refinancing such as loan sales and securitization. However, such refinancing is not found to reduce banks' risk. Wagner (2007) models loan sales as a means to increase asset liquidity but finds that loan sales and related credit derivatives may cause contagion among banks in crisis as the risks are only transferred among banks while remaining in system. Casu et al. (2011) examine the role of securitization on banks' credit risk-taking using a sample of US banks and find that securitization can have a negative or insignificant impact on bank credit risk, depending on the type of assets being securitized. They indicate that securitization is used by banks more as a financing tool rather than a risk management tool.

From an asset–liability perspective, Vazquez and Federico (2015) use a liquidity risk proxy that is similar to the net stable funding ratio (NSFR) required under Basel III to investigate the role of bank funding liquidity on bank failures. Using a sample of US and European banks, they find that a weaker funding structure, captured by a lower liquidity risk proxy and higher short-term funding ratio, is a significant contributor to bank failure during crisis.

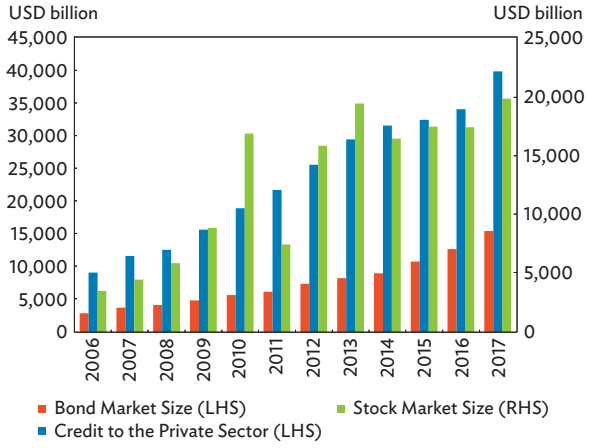
These studies point to the importance of stable funding other than deposits (Acharya and Naqvi 2012; Khan, Scheule, and Wu 2017) and liquid assets other than loans (Wagner 2007; Casu et al. 2011) in mitigating maturity mismatches and reducing liquidity risk in bank balance sheets. However, as a source of liquid assets and stable funding, the impact of bond market on bank risk-taking has not been discussed in the literature.

This study expands upon extant knowledge and provides the very first direct evidence on the role of bond market development in shaping bank portfolio structure and improving risk profile via investment and financing instruments that mitigate maturity mismatches in bank balance sheets. According to Diamond and Rajan (2001), "narrow banking" helps enhance financial stability by matching illiquid assets with longer-maturity liabilities and by reducing bank liquidity risk-taking. Bond markets provide alternative asset classes that can be used to reduce maturity mismatches and enhance liquidity management with government bonds serving as a liquid asset and corporate bonds serving as stable liability.

People may argue that capital market development challenges banks' role in liquidity creation, known as disintermediation. However, Berger and Bouwman (2009) show that banks' ability to create liquidity does not decline as the capital market evolves. **Figure 32** illustrates capital market development and bank credit growth in developing markets from 2006 to 2017. Capital market development, especially bond market development, does not hinder the expansion of bank credit to the private sector.

Motivated by the lack of discussion on bond market development and bank risk-taking, this study aims to understand the following research questions: First, does bond market development help increase bank stability by lowering banks' overall risk and strengthening their

Figure 32: Bond Markets, Bank Credit, and Equity Markets in Developing Markets



LHS = left-hand side, RHS = right-hand side, USD = Unites States dollar.
Note: This figure plots total bond market size and credit to the private sector among 26 global developing markets from 2006 to 2017.
Sources: Bank for International Settlements and World Federation of Exchanges.

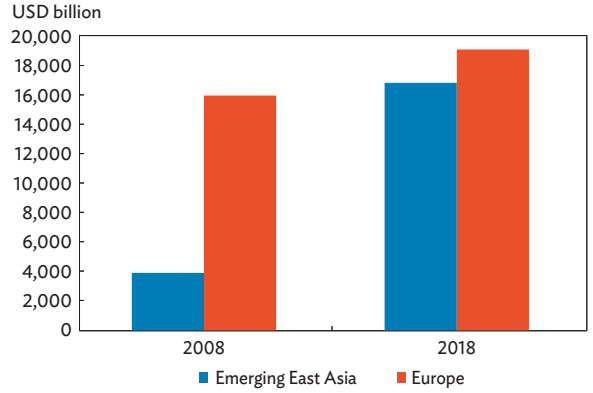
portfolio structures and liquidity positions? Second, do different bond market segments (i.e., government bonds and corporate bonds) influence risk-taking in different ways? Third, is the bond market's role in shaping bank risk-taking consistent across different bank sizes and levels of capital sufficiency? Finally, does bond market structure affect bank risk-taking?

This paper empirically examines the role of bond markets on bank risk-taking using a sample of 432 banks in 26 developing markets from 2006 to 2016. Focusing on bank risk-taking proxies, we find that bond market development significantly lowers risk in banks' asset and deposit portfolios, reduces bank liquidity risk exposure, and increases bank stability. Specifically, a 1% increase in bond market size is associated with 0.04%, 0.03%, and 0.05% decreases in banks' risky asset ratio, deposit ratio, and liquidity risk ratio (LRR), respectively. A 1% increase in bond market size is also related to 0.53% and 0.32% increases in banks' NSFR and ZSCORE, respectively.

Further investigation indicates that government bonds and corporate bonds work differently in contributing to banking sector stability. In particular, the government bond market serves as a source of liquid assets that increases liquidity in banks' asset portfolios without worsening banks' liquidity positions. Also, as an important liquid asset that generates yields, government bonds allow banks to expand their asset portfolios without facing risk and liquidity regulatory constraints. Meanwhile, corporate bonds serve as an alternative stable funding source that allows banks to mitigate maturity mismatches when taking on risky assets. In addition, corporate bonds are an alternative risky asset class that can increase the diversification of a bank's risky-asset portfolio. Overall, the findings imply that bond markets play a complementary role to the banking sector by offering liquid assets and stable liabilities, hence providing banks with more scope in risk management and liquidity creation while maintaining stability and resilience.

This paper is the first study that focuses on the impact of bond market development on banks' risk-taking. Bond markets offer alternative instruments to bank asset–liability management; however, no direct evidence has been produced supporting this perspective. This paper extends the current research by filling this void and focusing on bond market development, offering clear policy implications. The 1997/98 Asian financial crisis highlighted the importance of LCY bond markets in mitigating the currency and maturity mismatch problems in the financial system. Recent decades have witnessed the fast expansion of LCY bond markets worldwide, especially in emerging East Asia. After 2 decades of rapid development, the aggregate size of LCY bond markets in 2018 in ASEAN plus the People's Republic of China; Hong Kong, China; and the Republic of Korea is comparable to the amount of EUR-denominated bonds outstanding in the European bond market by 2018. (**Figure 33**)

Figure 33: Bond Market Development in Emerging East Asia



EUR = euro, USD = United States dollar.
Notes:
1. Emerging East Asia comprises the People's Republic of China; Hong Kong, China; Indonesia; the Republic of Korea; Malaysia; the Philippines; Singapore; Thailand; and Viet Nam.
2. This figure plots local currency bond market size of ASEAN plus the People's Republic of China; the Republic of Korea; and Hong Kong, China (ASEAN+3), against EUR-denominated bond market size for two periods. Over a period of 10 years, the local currency bond market has grown to a closer size of that in the EUR-denominated bond market in Europe.

Source: Authors' calculations based on Bloomberg LP data.

While LCY bond markets have mitigated currency mismatches and stabilized foreign exchange markets against external shocks (Park, Shin, and Tian 2018), little is known about how effective bond market development is in tackling maturity mismatches. This study therefore presents direct evidence of how bond market development benefits banking stability by mitigating maturity mismatches. The evidence is useful for regulators in supporting the development of a well-diversified and resilient financial sector, especially in emerging markets that heavily rely on bank loans as a major financing channel. Consistent with Berger and Bouwman (2009), this study shows that the role of the banking sector in liquidity creation is not weakened as capital markets develop; rather, banks benefit from bond

market development via the provision of liquid assets with yields, diversified risky asset pools, and a stable funding source.

The remainder of this study is organized as follows. Section 2 develops testable hypotheses based on theoretical frameworks. Section 3 describes the sample construction and research methods. Empirical evidence and extensional tests are presented and discussed in sections 4, 5, and 6. Section 7 concludes.

2. Theoretical Implications and Hypothesis Development

This paper is motivated by the existing bank management theoretical framework. As shown in the model of Diamond and Rajan (2001), banks create liquidity and supply credit using relatively short-term deposits to leverage long-term assets (loans). A maturity mismatch can cause funding constraints when there is liquidity stress, such as credit-line drawdowns and creditor withdrawals (Ivashina and Scharfstein 2010). A liquidity shortfall can lead to a fire sale of bank assets, rising external financing costs, or even bank failure.

In the bank management framework documented in Koch and MacDonald (2014) and Rose and Hudgins (2013), asset–liability management helps banks tackle possible liquidity constraints arising from maturity mismatch. More developed bond markets offer banks a wider range of asset choices in terms of diversity; and liquidity, return, and maturity in support of asset–liability management. More developed bond markets also feature reliable bond-pricing mechanisms and a better information environment, which reduces banks risk-taking in general.

Banks store liquidity in their asset portfolios to meet unexpected funding demands. Haan and Van den End (2013) developed a bank liquidity model where banks hold liquid assets to tackle liquidity pressure arising from loan makers and depositors, finding that most banks hold more than the required amount of liquid assets against liquid liabilities. Among the many liquid assets, government bonds in a well-developed bond market is a typical asset class that generates reasonable yields and carries good liquidity, compared to other liquid assets such as cash and reserve deposits at the central bank. Hence, a well-developed government bond market can effectively improve asset liquidity and shorten the maturity profile of banks' asset portfolios by mitigating maturity mismatches on their balance sheets. Moreover, while government bonds help improve the liquidity of asset portfolios, holding government bonds also allows banks to expand their loan portfolio without breaking regulatory liquidity requirements or losing too much revenue. In addition, holding government bonds does not introduce excess credit risk into the financial system that may be transferred to other banks when the bonds are sold, as in the case of loan sales and securitization, especially during crisis periods. Thus, a bigger and deeper bond market, especially a government bond market, offers commercial banks liquid assets to invest in, which lowers banks' risk-taking and liquidity risk.

In terms of liability portfolios, theoretical work by Acharya and Naqvi (2012) shows that when banks hold excess deposits, they tend to take more risk. Excess deposits make bank managers overconfident about their liquidity situation. In line with the principal–agent theory, bank managers take more risk by relaxing loan standards to gain more personal compensation. In addition, since deposits are covered by deposit insurance, which works like a put option, it induces moral hazard by encouraging banks to take excess risk (Khan, Scheule, and Wu 2017; Keeley 1990). Moreover, excess deposits, especially demand deposits, expose banks to greater liquidity pressure during periods of turmoil when depositors make withdrawals. Banks with more stable funding sources are less prone to such a liquidity run (Cornett et al. 2011). While deposits are largely determined by depositors' behavior, a corporate bond market offers banks instruments for active liability management in terms of the quantity and timing of liability. Banks can issue corporate bonds in planned amounts and at desired maturities to match asset portfolios. With predefined repayment cash flows, corporate bonds not only avoid moral hazard induced by deposit insurance, but also prevent liquidity runs in times of turmoil. Hence, corporate bonds serve as a stable funding source that helps reduce maturity mismatch and prevent excess risk-taking. In addition, corporate bonds themselves are also risky investment assets that offer diversification opportunities for a bank's risky asset portfolio. Given limited resources to conduct loan due diligence, investing in corporate bonds also fosters diversification of banks' risky assets in terms of geographic scope and sector diversification. When banks have more stable funding sources, they can hold more risky assets without

deteriorating their liquidity positions. Overall, a well-functioning bond market helps banks with a strengthened asset and liability structure, as well as more resilient liquidity positions. This study therefore develops the following two hypotheses:

> *Hypothesis 1: Larger bond markets improve banks' asset and liability portfolio structures, strengthen banks' liquidity positions, and reduce overall bank risk.*

> *Hypothesis 2: Larger government bond markets reduce risk in banks' asset portfolios and improve their liquidity positions. Larger corporate bond markets reduce banks' risk-taking and can facilitate risky asset holdings without heightening banks' risk exposure.*

3. Sample Construction and Empirical Design

Data Collection

Bank financial statement information has been collected from S&P Global Market Intelligence. Bond market development information was obtained from Bloomberg. Market-level macroeconomic attributes were collected from various sources, including World Development Indicators, International Country Risk Guide (ICRG), Bloomberg, and Bruegel. Bank-level data were matched with bond market development and macroeconomic variables. To get reasonable data coverage for each market, bond markets with data for fewer than three banks were excluded. The final sample is an annual panel data covering 26 developing markets worldwide from 2006 to 2016. The sample consists of 432 unique commercial banks and 2,794 bank-year observations.

Variable Construction

Bank Risk-Taking

According to Imbierowicz and Rauch (2014), there are two major types of bank risk that separately affect bank solvency risk—liquidity risk and credit risk; there is no significant reciprocal relationship between the two. This paper focuses on bank portfolio risk, liquidity risk, and overall risk—areas in which bond market development is very relevant.

Portfolio Risk

Asset portfolio risk. Asset portfolio structure directly relates to risks in bank assets. Basel II used the ratio of risk-weighted assets to total assets (RWA) to determine the minimum amount of capital that banks need to hold to reduce insolvency risk. RWA reflects the quality and structure of a bank's asset portfolio by assigning a risk weight to each asset class according to its inherent potential to default and the likely losses in case of default. In the empirical analysis, we use bank-reported RWA to capture risks embedded in the asset portfolio.

Liability portfolio risk. Liability portfolio structure matters for bank risk-taking. It has been documented that banks with excess deposits in their liability portfolio tend to relax loan standards and take more risk (Acharya and Naqvi 2012). Khan, Scheule, and Wu (2017) find that US banks with greater reliance on deposits take greater risks. Corporate bonds enhance banks' liability portfolios as active liability management instruments. Unlike demand deposits, corporate bonds have stable and predictable cash flows. In developed bond markets, banks can issue corporate bonds to obtain desired funding with predetermined cash flow patterns that better match asset portfolios. Unlike insurance-covered deposits that could induce moral hazard and excess risk-taking, debt funding introduces market monitoring to avoid excess risk-taking. In addition, corporate bonds themselves serve as an alternative pool of risky assets to invest in other than bank loans, which also offers diversification benefits to banks' asset portfolios. In our empirical analysis, the ratio of deposits to total assets (DEP) is used to reflect the liability portfolio risk of banks.[10]

Liquidity Risk

Funding stability. In the aftermath of the GFC, the Basel Committee introduced two liquidity risk measures under the Basel III framework to capture the liquidity position of a bank in terms of asset and liability portfolios (BCBS 2010a). The first measure is the NSFR, which reflects the level of funding liquidity and requires banks to fund their activities with sufficiently stable funding

[10] We also use the ratio of deposits to total liabilities as a proxy, which generates similarly results as DEP. We report the results estimated using DEP for brevity. Results generated using the ratio of deposits to total liabilities are available upon request.

sources over a medium- or long-term horizon (BCBS 2014). A higher NSFR indicates less reliance on short-term funding and a sound liquidity position. The other measure is the liquidity coverage ratio, which captures assets' liquidity and gauges whether banks hold enough high-quality liquid assets to cover short-term net cash flows.

Given that the granular information on assets and liabilities required to calculate these measures is very limited for banks in our sample of developing markets, we follow Vasquez and Federico (2015) and construct a proxy for the NSFR as the ratio between stability-weighted bank liabilities (L_i) and assets (A_i):

$$NSFR = \frac{\sum_i w_i L_i}{\sum_i w_i A_i} \quad (1)$$

where w_i is the weight reflecting relative stability of each balance sheet item, and $0 \le w_i \le 1$. Larger weights are assigned to assets that are less liquid and liabilities that are more stable funding sources. Thus, a higher NSFR indicates greater funding stability.

Liquidity risk-taking. Banks create liquidity via taking risks that arise from an inherent maturity mismatch in their balance sheets. Liquidity creation therefore describes the extent to which banks finance relatively illiquid assets with relatively liquid liabilities (Khan, Scheule, and Wu 2017). Liquidity creation is a widely used proxy for bank risk-taking in literature (Berger and Bouwman 2009; Berger and Bouwman 2013; Distinguin, Roulet, and Tarazi 2013; Horváth, Seidler, and Weill 2014; Khan, Scheule, and Wu 2017). Since bond market offers commercial banks with liquid assets as well as illiquid liabilities in the form of government and corporate bonds, a larger and more developed bond market could shape banks' liquidity risk-taking behavior. In the empirical analysis, we follow Berger and Bouwman (2009) to gauge a bank's LRR as the liquidity-creation-to-total-assets ratio in equation (2), where a higher LRR indicates greater liquidity risk in a bank's balance sheet:

$$\begin{aligned} \text{LRR} = ([&illiquid\ assets + liquid\ liabilities] \\ &- [liquid\ assets + illiquid\ liabilities] \\ &- equity) / 2 \times total\ assets \end{aligned} \quad (2)$$

Overall Risk

Z-score. A widely used Z-score is found in the literature to gauge overall bank risks (see, among others, Yeyati and Micco 2007; Laeven and Levine 2009; Fiordelisi and Mare 2014; Ramayandi, Rawat, and Tang 2014; Khan, Scheule, and Wu 2017). As a bond market helps improve banks' portfolio structure and enhance their liquidity management, it may also mitigate overall bank risk-taking. A Z-score comprehensively considers a bank's earnings performance (return on assets) as well as its earnings volatility and leverage, reflecting the distance of a bank from insolvency (Laeven and Levine 2009). A lower Z-score implies that a bank has a larger probability of insolvency. To capture overall bank risk, this study uses the natural logarithm of the Z-score constructed following the methodology in Fiordelisi and Mare (2014) and Yeyati and Micco (2007):

$$\ln\left(Z - score_{i,t}\right) = \ln\left(\frac{\mu(ROA_{c,t}) + CAR_{i,t}}{\sigma(ROA_{c,t})}\right) \quad (3)$$

where $\mu(ROA_{c,t})$ is the mean of all banks' return on assets (ROA) in market c at period t, while $\sigma(ROA_{c,t})$ is the standard deviation of the ROAs of all banks in market c at period t. CAR_{it} is the capital-to-asset ratio for bank i at period t. The Z-score captures the level of bank stability, with a higher Z-score indicating the greater soundness of a bank.

Bond Market Development

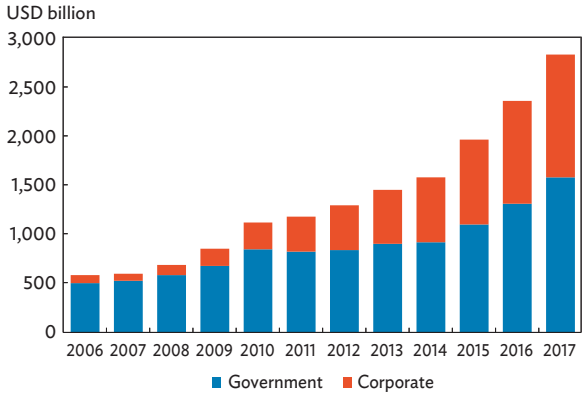
In our empirical study, bond market development is proxied by bond market size (Bond), which is measured as total bonds outstanding as a share of gross domestic product (GDP) for each market. To examine the different roles of government bonds and corporate bonds, we categorize bond markets into government and corporate segments, following the Bloomberg Industry Classification Standards (BICS) Level 1 classification, and calculate the outstanding amount of government bonds (GovB) and corporate bonds (CorpB) as a share of GDP. **Table 25** lists the average bond market size—government, corporate, and total—across 26 developing economies. **Figure 34** depicts our sample's aggregate bonds outstanding from 2006 to 2017, broken down into government and corporate bond segments.

Table 25: Bond Market Development in Developing Markets
(USD billion)

Market	Government	Corporate	Total
Argentina	252.3	27.7	279.9
Bangladesh	17.2	0.3	17.5
Brazil	1,250.3	641.6	1,892.0
Bulgaria	11.5	1.7	13.2
Chile	34.3	72.5	106.8
China, People's Rep. of	3,363.6	2,508.9	5,872.6
Colombia	99.8	56.1	155.9
Croatia	26.9	3.9	30.8
Hungary	113.5	19.8	133.3
India	1,162.3	344.0	1,506.4
Indonesia	186.1	46.5	232.7
Malaysia	183.5	161.3	344.8
Mexico	523.7	278.8	802.5
Pakistan	63.2	2.5	65.7
Panama	18.7	16.6	35.3
Peru	38.2	33.5	71.7
Philippines	116.3	35.1	151.3
Poland	270.2	23.9	294.0
Romania	57.7	2.0	59.7
Russian Federation	275.8	314.0	589.8
Serbia	15.5	0.4	15.9
Sri Lanka	38.4	3.5	41.9
Thailand	202.5	84.1	286.6
Turkey	295.3	33.5	328.8
Ukraine	45.3	11.1	56.3
Viet Nam	46.7	3.3	50.0

Source: Authors' calculations based on Bloomberg LP data.

Figure 34: Bond Market Development in Developing Markets



USD = United States dollar.
Source: Authors' calculations based on Bloomberg LP data.

Control Variables

To control for other widely acknowledged factors that also contribute to bank portfolio decision-making and risk-taking, we include variables at the bank and market levels in our analysis, following the path of existing studies such as Khan, Scheule, and Wu (2017); Vasquez and Federico (2015); Fu, Lin, and Molyneux (2014); and Konishi and Yasuda (2004). At the bank level, we include size, profitability, and capital sufficiency as major bank-specific attributes. At the market level, we control for banking industry concentration as well as macroeconomic conditions such as GDP growth, interest rates, exchange rate stability, and economic stability.

Bank-Specific Attributes

Size significantly affects banks' operational decisions because it shapes scale and scope economies. It is also related to access to capital markets. In the empirical analysis, bank size (Size) is defined as the natural logarithm of a bank's total assets. Bank profitability reflects the decision-making and risk-management quality of a bank's operation. Following Fu, Lin, and Molyneux (2014), we include bank ROA and net interest margin (NIM) to track the profitability of bank investment and lending activities. As a key dimension of bank regulation, capital buffer affects and reflects a bank's risk-taking decisions. Following Vasquez and Federico (2015), we construct the bank capital sufficiency ratio (CSR) as the ratio of Tier 1 capital to RWA.

Market-Level Attributes

The impact of banking sector concentration on bank stability has been widely documented yet remains controversial. The concentration-stability view suggests a positive impact of bank concentration on bank stability (Yeyati and Micco 2007, Berger and Bouwman 2009), while the concentration-fragility view argues for a negative impact of concentration on bank stability (Fu, Lin, and Molyneux 2014; Schaeck and Cihák 2014). Our study follows Fu, Lin, and Molyneux (2014) and uses concentration ratio (CR3) to measure banking sector concentration, which is defined as the ratio of loans held by the three largest banks to total loans held by the entire banking sector.

To account for macroeconomic conditions, this study includes GDP growth (GDPG) as a broad measure

of economic development that depicts the general soundness of real sector performance. The interest rate level determines the liquidity situation in the entire economic system. Lower interest rates encourage investment and bank risk-taking, and generate a lower default probability for existing loans (Ramayandi, Rawat, and Tang 2014). In our analysis, 1-year government bond yield (IR) is used to capture the benchmark interest rate level.

Exchange rate uncertainty affects banks' risk-taking behavior and impairs investment appetite. Excessive exchange rate volatility signals weakening economic and financial stability, and can induce a banking crisis in many countries (Lindgren, Garcia, and Saal 1996). In our empirical analysis, exchange rate volatility (FXV) is included and defined as the standard deviation of monthly real effective exchange rate changes during a single year. To capture overall market risk— such as governance, political, economic, and financial risk—the study also includes the natural logarithm of composite risk score constructed by ICRG. The ICRG composite risk score ranges from 0 to 100, with higher ratings suggesting greater soundness of a market.

Descriptive statistics of the key variables in the sample are reported in **Table 26**. To address outlier problems, bank-level variables are winsorized at three standard deviations around the mean. Extreme values for RWA are winsorized at the top 3%. Pearson's pairwise correlation coefficients between the variables are presented in **Table 27**. The low-to-moderate correlation among most of the control variables indicates that multicollinearity is not an issue in the analysis.

Table 26: Descriptive Statistics

	N	Mean	SD	Min	Max	Percentile				
						5th	10th	50th	90th	95th
Dependent Variables										
RWA	2,794	0.67	0.16	0.03	1.00	0.42	0.48	0.67	0.88	0.95
DEP	2,790	0.66	0.19	0.00	0.92	0.23	0.43	0.70	0.84	0.86
NSFR	2,794	0.75	0.59	0.00	10.14	0.17	0.26	0.62	1.31	1.53
LRR	2,794	0.15	0.18	−0.70	0.68	−0.18	−0.07	0.19	0.34	0.38
ZSCORE	2,789	2.59	0.75	−1.82	4.23	1.20	1.50	2.73	3.40	3.57
Key Independent Variables										
Bond	2,794	0.59	0.26	0.09	1.37	0.21	0.27	0.56	0.93	1.10
GovB	2,794	0.41	0.17	0.01	0.96	0.15	0.17	0.40	0.63	0.68
CorpB	2,794	0.18	0.14	0.00	0.67	0.01	0.03	0.15	0.38	0.47
Microeconomic Control Variables										
Size	2,794	16.49	1.61	11.68	21.39	13.52	14.41	16.48	18.32	19.23
CSR	2,794	0.13	0.05	0.02	0.52	0.08	0.08	0.12	0.18	0.21
ROA	2,794	0.01	0.01	−0.32	0.09	−0.01	0.00	0.01	0.02	0.03
NIM	2,794	0.04	0.02	−0.06	0.16	0.01	0.02	0.03	0.06	0.07
Macroeconomic Control Variables										
CR3	2,794	0.50	0.14	0.35	1.00	0.36	0.37	0.44	0.72	0.75
GDPG	2,794	0.05	0.03	−0.10	0.14	−0.02	0.01	0.05	0.09	0.10
ICRG	2,794	4.25	0.07	3.98	4.39	4.12	4.15	4.26	4.34	4.35
IR	2,794	0.06	0.06	0.00	1.06	0.01	0.02	0.04	0.10	0.12
FXV	2,794	0.02	0.01	0.00	0.14	0.01	0.01	0.01	0.03	0.04

Notes: This table lists summary statistics of the variables included in our models. Observations are bank-year combinations. The dependent variables are RWA, which is the risky-assets-to-total-assets ratio; DEP, which is the deposit-to-total-assets ratio; NSFR, which is the net stable funding ratio defined as the ratio between stability-weighted bank liabilities and assets; LRR, which is bank liquidity risk-taking as a share of total assets; and ZSCORE, which is the natural logarithm of Z-score. Bond is total bonds outstanding as a share of GDP. GovB is government bonds outstanding as a share of GDP. CorpB is corporate bonds outstanding as a share of GDP. Size is bank size measured using the natural logarithm of total assets. CSR is capital sufficiency ratio. ROA is return on assets. NIM is net interest margin. CR3 is loans held by top three largest banks to total loans held by all banks in an economy. GDPG is the gross domestic product growth of an economy. ICRG is the natural logarithm of composite risk score from the International Country Risk Guide. IR is interest rate measured by 1-year government bond yield. FXV is exchange rate volatility defined as the standard deviation of monthly real effective exchange rate changes within a year. The sample covers 432 banks from 26 developing markets for the period 2006–2016. Outliers for all other variables were winsorized at three standard deviations around the mean. Extreme values for RWA are winsorized at the top 3%.
Sources: Authors' calculations based on data from Bloomberg LP, S&P Global Market Intelligence, and World Bank *World Development Indicators*.

Table 27: Pearson's Pairwise Correlation Coefficients

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	RWA	1.000																
2	DEP	−0.090	1.000															
3	NSFR	−0.243	−0.270	1.000														
4	LRR	0.354	0.524	−0.395	1.000													
5	ZSCORE	0.073	0.210	0.031	0.112	1.000												
6	Bond	−0.187	−0.147	−0.002	−0.186	0.146	1.000											
7	GovB	−0.208	−0.102	−0.057	−0.095	0.034	0.876	1.000										
8	CorpB	−0.099	−0.153	0.066	−0.233	0.233	0.814	0.434	1.000									
9	Size	−0.055	−0.011	0.190	0.024	0.235	0.211	0.121	0.248	1.000								
10	CSR	−0.127	−0.210	−0.060	−0.222	−0.005	−0.091	−0.043	−0.119	−0.406	1.000							
11	ROA	0.080	−0.001	0.036	0.010	0.326	−0.101	−0.126	−0.038	0.128	0.138	1.000						
12	NIM	0.319	−0.057	−0.191	0.243	−0.054	−0.208	−0.172	−0.181	−0.174	0.251	0.325	1.000					
13	CR3	0.179	−0.036	−0.039	0.182	−0.192	−0.325	−0.219	−0.343	−0.280	0.092	−0.119	0.131	1.000				
14	GDPG	−0.185	0.339	0.110	0.028	0.359	−0.115	−0.122	−0.067	0.284	−0.211	0.127	−0.173	−0.451	1.000			
15	ICRG	−0.209	0.105	0.108	−0.131	0.261	0.302	0.158	0.375	0.272	−0.149	0.035	−0.248	−0.314	0.401	1.000		
16	IR	0.109	−0.131	−0.036	0.037	−0.209	−0.048	0.035	−0.133	−0.123	0.076	−0.097	0.145	0.258	−0.382	−0.539	1.000	
17	FXV	0.177	−0.268	−0.038	−0.027	−0.383	0.031	0.011	0.045	−0.085	0.049	−0.122	0.154	0.185	−0.469	−0.385	0.678	1.000

Notes: This table presents the Pearson's correlation coefficients for each pair of variables. A total of 2,794 observations from 432 banks covering the period 2006–2016 were used in the calculations. RWA is bank risky-assets-to-total-assets ratio. DEP is bank deposit-to-total-assets ratio. NSFR is net stable funding ratio which is the ratio between stability-weighted bank liabilities and assets. LRR is bank liquidity risk-taking as a share of total assets. ZSCORE is the natural logarithm of Z-score. Bond is total bonds outstanding as a share of GDP. GovB is government bonds outstanding as a share of GDP. CorpB is corporate bonds outstanding as a share of GDP. Size is bank size measured using natural logarithm of total assets. CSR is capital sufficiency ratio. ROA is return on assets. NIM is net interest margin. CR3 is loans held by top three largest bank to total loans held by all banks in an economy. GDPG is the gross domestic product growth of an economy. ICRG is the natural logarithm of composite risk score from the International Country Risk Guide. IR is interest rate measured by 1-year government bond yield. FXV is exchange rate volatility defined as standard deviation of monthly real effective exchange rate changes within a year.
Sources: Authors' calculations based on data from Bloomberg LP, S&P Global Market Intelligence, and World Bank *World Development Indicators*.

Model Specification

To empirically test whether bond markets mitigate bank risk-taking, this study estimated the following baseline model specification:

$$Risk_{i,t} = \alpha_{i,t} + \phi Risk_{i,t-1} + \beta Bond_{i,t} + \gamma Controls_{i,t} + \phi Bank_i + \delta Year_t + \epsilon_{i,t}, \quad (4)$$

where $Risk_{i,t}$ is a vector of bank portfolio risk, liquidity risk, and overall risk measures for bank i at time t (i.e., RWA as a proxy for risks in banks' asset portfolio); DEP is a proxy for risk in banks' liability portfolio; NSFR is a proxy for banks' funding liquidity; LRR measures liquidity risk-taking; and ZSCORE is the natural logarithm of the Z-score to measure bank overall risk. $Risk_{i,t-1}$ is included to account for potential autocorrelation in risk measures. $Bond_{i,t}$ is a vector of bond market development variables for a particular market in which bank i registers at time t, including Bond, GovB, and CorpB as the ratios of aggregate bonds outstanding, government bonds outstanding, and corporate bonds outstanding to GDP, respectively. The vector $Control_{i,t}$ contains bank-level and market-level characteristics that are widely established in the literature to influence bank risk-taking, which includes bank size, profitability, capital sufficiency, banking sector concentration, GDP growth, interest rate level, exchange rate volatility, and composite market risk. $Bank_i$ is a vector of bank-specific fixed effects that account for time-invariant bank-specific heterogeneities, $Year_t$ is a vector of time fixed effects, and $\epsilon_{i,t}$ is the error term for bank i at time t. This baseline dynamic panel model specification is estimated using a panel fixed-effects regression.[11] Standard errors are clustered at the bank level.

[11] In order to choose between fixed and random effects, we conducted a (cluster) robust version of the Hausman test using a bootstrap procedure, as well as the Sargan–Hansen test of overidentifying restrictions that are robust to heteroscedasticity. The Sargan–Hansen test showed more consistent results for different model specifications. For all models, the Sargan–Hansen test favors fixed effects over random effects.

4. The Bond Market's Impact on Bank Risk-Taking

This section discusses the results of the analysis to understand how bond market development shapes bank portfolio risk, liquidity risk, and overall risk. The analysis focuses on five dependent variables: RWA, DEP, NSFR, LRR, and ZSCORE.

Table 28 reports the estimated results of the baseline model in equation (4) analyzing the impacts of bond market size (Bond) and related control variables on

Table 28: Bond Market Development, Bank Portfolio Structure, and Bank Risk-Taking

Variables	(1) RWA	(2) DEP	(3) NSFR	(4) LRR	(5) ZSCORE	(6) RWA	(7) DEP	(8) NSFR	(9) LRR	(10) ZSCORE
Bond						−0.0402*	−0.0335*	0.534***	−0.0488**	0.317*
						(−1.86)	(−1.90)	(5.53)	(−2.33)	(1.93)
RWA_{t-1}	0.528***					0.527***				
	(23.78)					(24.26)				
DEP_{t-1}		0.505***					0.502***			
		(12.81)					(12.65)			
$NSFR_{t-1}$			0.300**					0.291**		
			(2.09)					(2.03)		
LRR_{t-1}				0.504***					0.499***	
				(15.82)					(15.58)	
$ZSCORE_{t-1}$					0.169***					0.170***
					(6.07)					(6.03)
Size	−0.00526	−0.0686***	0.117***	−0.0463***	0.221***	−0.00476	−0.0685***	0.112***	−0.0461***	0.216***
	(−0.53)	(−8.57)	(3.68)	(−4.50)	(3.84)	(−0.48)	(−8.59)	(3.71)	(−4.48)	(3.66)
CSR	−0.683***	−0.196***	0.504	−0.539***	3.251***	−0.679***	−0.193***	0.447	−0.535***	3.209***
	(−8.51)	(−3.79)	(1.31)	(−6.18)	(9.08)	(−8.49)	(−3.68)	(1.16)	(−6.14)	(8.92)
ROA	0.256*	−0.298***	−1.280***	−0.289	10.21***	0.251*	−0.301***	−1.216***	−0.293	10.26***
	(1.71)	(−2.88)	(−3.06)	(−1.43)	(6.31)	(1.68)	(−2.85)	(−2.85)	(−1.41)	(6.21)
NIM	0.846***	−0.0604	−1.637**	0.900***	−0.102	0.833***	−0.0738	−1.465**	0.890***	−0.0182
	(2.81)	(−0.30)	(−2.45)	(3.11)	(−0.09)	(2.78)	(−0.36)	(−2.29)	(3.08)	(−0.02)
CR3	−0.207***	−0.0519	−0.0417	−0.228***	−1.408***	−0.213***	−0.0565	0.0390	−0.235***	−1.365***
	(−3.44)	(−1.17)	(−0.19)	(−4.41)	(−3.34)	(−3.56)	(−1.27)	(0.18)	(−4.64)	(−3.19)
GDPG	−0.00145	0.0882	−0.522*	0.289***	−0.592	−0.0191	0.0748	−0.300	0.269***	−0.433
	(−0.02)	(1.23)	(−1.68)	(3.48)	(−0.87)	(−0.20)	(1.06)	(−0.94)	(3.31)	(−0.59)
ICRG	−0.0758	0.163***	0.313	0.118*	−0.392	−0.112*	0.134***	0.792***	0.0761	−0.124
	(−1.28)	(3.48)	(1.07)	(1.86)	(−0.79)	(−1.82)	(2.81)	(2.84)	(1.13)	(−0.28)
IR	−0.0312	0.0886***	0.109	−0.0212	1.764***	−0.0280	0.0916***	0.0679	−0.0172	1.743***
	(−0.74)	(3.14)	(1.01)	(−0.61)	(8.87)	(−0.67)	(3.25)	(0.65)	(−0.49)	(8.86)
FXV	−0.498**	−0.371**	0.258	0.199	−9.277***	−0.470**	−0.350**	−0.100	0.236	−9.530***
	(−2.25)	(−2.37)	(0.31)	(1.00)	(−6.72)	(−2.09)	(−2.20)	(−0.12)	(1.18)	(−6.71)
Constant	0.899***	0.766***	−2.531*	0.439	1.103	1.071***	0.912***	−4.819***	0.648*	−0.165
	(3.03)	(3.20)	(−1.94)	(1.41)	(0.41)	(3.59)	(3.64)	(−3.69)	(1.94)	(−0.07)
Observations	2,794	2,790	2,794	2,794	2,789	2,794	2,790	2,794	2,794	2,789
Number of banks	432	432	432	432	432	432	432	432	432	432
Adjusted R^2	0.426	0.490	0.148	0.421	0.293	0.427	0.491	0.160	0.423	0.295
Year Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Bank Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Notes: This table reports parameter estimates of panel fixed-effects regressions of the baseline model. RWA is risky-assets-to-total-assets ratio. DEP is deposit-to-total-assets ratio. NSFR is net stable funding ratio defined as the ratio between stability-weighted bank liabilities and assets. LRR is liquidity risk-taking as a share of total assets. ZSCORE is the natural logarithm of Z-score. Bond is total bonds outstanding as a share of GDP. Size is bank size measured using the natural logarithm of total assets. CSR is capital sufficiency ratio. ROA is return on assets. NIM is net interest margin. CR3 is ratio of loans held by top three largest banks to total loans held by all banks in an economy. GDPG is gross domestic product growth of an economy. ICRG is the natural logarithm of composite risk score from the International Country Risk Guide. IR is interest rate measured by the 1-year government bond yield. FXV is exchange rate volatility defined as the standard deviation of monthly real effective exchange rate changes within a year. ***, **, * represent statistical significance at the 1%, 5%, and 10% level, respectively. t-statistics in parentheses are calculated from robust standard errors clustered at the bank level.
Sources: Authors' calculations.

bank portfolio structure and risk-taking. Specifications (1)–(5) show how various bank- and market-level control variables affect bank portfolio decisions and risks. It is All the lagged terms of portfolio structures and risks are significantly positively related to their current levels, indicating that banks' portfolio style and risk-taking behavior tend to be relatively stable and persistent.

Compared to small banks, large banks tend to hold a smaller share of deposits in their liability portfolio and have a higher NSFR, lower LRR, and higher Z-score, confirming that large banks are more sound than smaller banks. As for capital buffer levels, in line with the widely documented evidence that well-capitalized banks are more prudent in risk-taking (Lee and Hsieh 2013; Lindquist 2004; Khan, Scheule, and Wu 2017), we find consistent results that a higher capital buffer level is significantly associated with lower asset risk, a smaller share of deposits in a bank's portfolio, less liquidity risk-taking, and a higher Z-score. Moreover, bank profitability signals a bank's decision-making and risk management quality. More profitable banks are in a better position to tackle asset and liquidity risks and hold more risky assets, while maintaining good risk management quality through less deposit-taking, a higher stable funding ratio, and a higher Z-score.

Among the market-level variables, banking sector concentration (CR3) has mixed impacts on bank risk-taking. A higher concentration is associated with less risky asset holdings and lower liquidity risk, but also with a lower Z-score; this could indicate that banks are liquidity-wise stable amid higher industry concentration, but concentration can also deteriorate credit risk, weighing down the Z-score. Macroeconomic variables also show significant impacts on bank portfolio decisions and risk-taking. When the economy is performing well—with higher GDP growth, higher interest rate levels, and a higher ICRG score—banks take more risks but remain sound, as shown in the associated lower net funding stability, more liquidity risk-taking, more deposit holdings, and higher Z-score. Consistently, when exchange rate volatility is high, which signals unstable macroeconomic and financial conditions, banks become more prudent and less stable, with lower risky asset ratios and lower deposit ratios in their portfolios as well as lower Z-scores, which together echo weak economic conditions. Overall, the control variables show intuitive and consistent evidence with the extant literature.

Specifications (6)–(10) of Table 28 include bond market size and report its impact on banks' RWA, DEP, NSFR, LRR, and Z-score, respectively. While the control variables' impacts remain largely consistent, the size of the bond market significantly reduces risk-taking, with fewer risky assets in banks' asset portfolios, lower deposit-to-liability portfolio ratios, and improved bank liquidity positions and overall stability. In particular, a 1% increase in bond market size will significantly reduce banks' RWA and DEP by 0.04% and 0.03%, respectively; a 1% increase is also associated with a 0.53% increase in banks' NSFR, a 0.05% decrease in LRR, and a 0.32% increase in ZSCORE. Overall, Table 28 indicates that a bond market improves banks' portfolio structure and reduces risk-taking in both asset and liability portfolios, highlighting the role of a bond market in improving bank stability.

To further investigate the different roles of corporate and government bond market development on banks' portfolio structure and risk-taking, **Table 29** separately reports the impacts of the two types of bond market segments.

A larger government bond market significantly reduces risks in banks' asset portfolios and improves banks' stable funding ratios. In particular, a 1% increase in government bond market size is associated with a 0.15% decrease in risky asset ratios and a 0.51% increase in NSFRs. This is intuitive and consistent with the role of government bonds as a liquid investment instrument for commercial banks, allowing them to improve liquidity in asset portfolios. Meanwhile, we find that a larger corporate bond market plays a significant role in lowering banking sector risk via lower deposit-to-liability portfolio ratios, less liquidity risk-taking, and higher overall stability. A 1% increase in corporate bond market size reduces the deposit ratio by 0.07%, which supports the hypothesis that corporate bond markets serve as a stable financing source for commercial banks other than deposits. As a stable funding source and alternative risky asset class, corporate bonds enable banks to hold more risky assets with potential diversification benefits while maintaining lower liquidity risk and overall soundness. In particular, a 1% increase in corporate bond market size is associated with a 0.14% increase in risky asset holdings in banks' asset portfolios; a 0.06% reduction in liquidity risk levels; and an increase in NSFRs and Z-scores of 0.57% and 1.00%, respectively.

Table 29: Impacts of Government and Corporate Bond Markets on Bank Risk-Taking

Variables	(1) RWA	(2) DEP	(3) NSFR	(4) LRR	(5) ZSCORE
GovB	−0.150***	−0.0104	0.510***	−0.0415	−0.117
	(−5.03)	(−0.44)	(5.42)	(−1.57)	(−0.36)
CorpB	0.136***	−0.0715***	0.574***	−0.0611*	1.004**
	(3.10)	(−2.63)	(3.79)	(−1.70)	(2.22)
RWA_{t-1}	0.506***				
	(22.30)				
DEP_{t-1}		0.498***			
		(12.57)			
$NSFR_{t-1}$			0.291**		
			(2.03)		
LRR_{t-1}				0.498***	
				(15.46)	
$ZSCORE_{t-1}$					0.171***
					(6.08)
Size	−0.0194*	−0.0655***	0.108***	−0.0451***	0.158**
	(−1.66)	(−7.82)	(3.52)	(−4.20)	(2.31)
CSR	−0.678***	−0.195***	0.449	−0.536***	3.258***
	(−8.38)	(−3.73)	(1.17)	(−6.14)	(9.18)
ROA	0.211	−0.291***	−1.224***	−0.290	10.09***
	(1.37)	(−2.77)	(−2.87)	(−1.40)	(6.02)
NIM	0.862***	−0.0756	−1.464**	0.891***	0.0629
	(2.73)	(−0.37)	(−2.30)	(3.09)	(0.06)
CR3	−0.139***	−0.0727	0.0562	−0.240***	−1.058***
	(−2.65)	(−1.57)	(0.26)	(−4.80)	(−2.73)
GDPG	0.0160	0.0690	−0.293	0.267***	−0.334
	(0.18)	(0.98)	(−0.92)	(3.29)	(−0.47)
ICRG	0.0119	0.106**	0.822***	0.0671	0.407
	(0.17)	(2.06)	(2.82)	(0.97)	(0.69)
IR	0.0198	0.0818***	0.0786	−0.0204	1.923***
	(0.46)	(3.01)	(0.74)	(−0.57)	(9.26)
FXV	−0.443**	−0.357**	−0.0942	0.235	−9.332***
	(−2.00)	(−2.24)	(−0.11)	(1.18)	(−6.41)
Constant	0.743**	0.996***	−4.902***	0.674**	−1.695
	(2.54)	(3.92)	(−3.68)	(2.02)	(−0.64)
Observations	2,794	2,790	2,794	2,794	2,789
Number of banks	432	432	432	432	432
Adjusted R^2	0.438	0.492	0.160	0.423	0.301
Year Fixed Effects	YES	YES	YES	YES	YES
Bank Fixed Effects	YES	YES	YES	YES	YES

Notes: This table reports parameter estimates of panel fixed-effects regressions of the baseline model. RWA is risky-assets-to-total-assets ratio. DEP is deposit-to-total-assets ratio. NSFR is net stable funding ratio defined as the ratio between stability-weighted bank liabilities and assets. LRR is liquidity risk-taking as a share of total assets. ZSCORE is the natural logarithm of Z-score. GovB is government bond outstanding as a share of GDP. CorpB is corporate bond outstanding as a share of GDP. Size is bank size measured using the natural logarithm of total assets. CSR is capital sufficiency ratio. ROA is return on assets. NIM is net interest margin. CR3 is the ratio of loans held by top three largest banks to total loans held by all banks in an economy. GDPG is the gross domestic product growth of an economy. ICRG is the natural logarithm of composite risk score from the International Country Risk Guide. IR is interest rate measured by 1-year government bond yield. FXV is exchange rate volatility defined as the standard deviation of monthly real effective exchange rate changes within a year. ***, **, * represent statistical significance at the 1%, 5%, and 10% level, respectively. t-statistics in parentheses are calculated from robust standard errors clustered at the bank level.
Sources: Authors' calculations.

Results for the roles of control variables are generally consistent with the results in Table 28. Better profitability and good economic performance are related with greater risk-taking, while larger bank size, higher capital sufficiency ratios, greater market concentration, and higher exchange rate risk will sour banks' risk appetite, leading to them hold fewer risky assets, take fewer deposits, and reduce risk-taking overall. Table 29 not only highlights the role of a government bond market as a source of liquid asset class, but also underscores the role of a corporate bond market as a good source of stable funding that allows banks to both take and mitigate risks.

Corporate bond markets may be biased toward larger banks with better access to capital markets and therefore may not be as relevant to smaller banks. The literature has extensively documented that banks of different size and with different capital buffer levels pursue heterogeneous business strategies, profit models, and risk profiles. It is thus interesting to know whether important bank attributes such as size and capital sufficiency affect the impact of bond markets on bank risk-taking. To uncover the answer, the next section conducts further investigation.

5. Extensional Test: The Role of Bond Market Development across Different Bank Attributes

The Role of Bond Market Development across Different Bank Sizes

In the literature, bank size is an important factor that shapes banks' business models and risk-taking strategies. Large banks enjoy greater scale and scope economies than small banks. They have a comparative advantage in capital markets for financing and advanced risk management technique under the Basel Accords (Hakenes and Schnabel 2011). According to Koch and MacDonald (2014) and Rose and Hudgins (2013), large banks normally have a more diversified asset portfolio in terms of geography, sector, and asset classes, as well as better access to capital markets, which helps reduce their risk. Empirical evidence shows that larger bank size is associated with greater stability (Mercieca, Schaeck, and Wolfe 2007; Khan, Scheule, and Wu 2017); less asset volatility (Boyd and Runkle 1993); and less earning volatility (De Haan and Poghosyan 2012).

As the bond market develops, large banks can make better use of the capital market to actively manage their asset and liability portfolios, thus better tackling liquidity risk while also creating liquidity. Given that bond market development shapes banks' portfolio structures and liquidity positions, it can affect different types of banks in different ways. To understand how the portfolio and liquidity risk-taking behavior of big and small banks is related to bond market development, we follow Khan, Scheule, and Wu (2017) and construct a dummy variable (BIG) which is equal to 1 if a bank's total assets fall in the largest quartile and 0 otherwise. **Table 30** reports the interaction term for BIG and bond market development.

Model specifications (1)–(5) of Table 30 show the impacts of total bond market size and the interaction between bond market size and BIG on bank risks. As seen in model specifications (3) and (4), bond market size significantly lowers bank liquidity risk regardless of bank size. Model specifications (2) and (5) reveal interesting findings as well. Bond market size has a significant impact on deposit ratios and Z-scores only when interacted with BIG. A 1% increase in bond market size will reduce deposit ratios by 0.04% more and increase ZSCORE by 0.27% more among big banks than small banks. This implies that large banks can benefit from bond market development through reduced liability portfolio risk and improved overall stability. This evidence also indicates that both large and small banks can tap the bond market to manage liquidity risks; however, large banks seem to be able to better utilize corporate bond markets for fund-raising and risk management.

Columns (6)–(10) report evidence on the individual roles of government and corporate bond market segments, as well as their interaction with BIG. Government bond markets reduce asset risk and improve net funding ratios for all banks. They allow large banks to increase liquidity (LRR) while still improving overall stability (ZSCORE) due to better access to capital markets and improved risk management. In addition, a larger government bond market allows banks to take more deposits due to increased liquidity in their asset portfolios.

Turning to corporate bond markets, the results are consistent with Table 29. Corporate bonds serve as a stable funding source contributing to overall bank stability regardless of bank size. A 1% increase in corporate bond market size is linked to a 0.16% reduction in bank deposit ratios, an 0.11% decrease in bank liquidity risks, a 0.79% increase in NSFRs, and a 1.46% increase in ZSCORE. While larger corporate bond markets play a stabilizing role for banks, they do not negatively impact banks' risky assets holdings. Larger corporate bond markets allow banks to take risk without weakening their risk profile. Interestingly, large banks have lower risky asset ratios, which may be largely related to their competitive advantage in risk management.

The results for control variables are largely consistent with those documented in the previous section. A more concentrated market environment and a volatile exchange rate make banks prudent, while better macroeconomic performance encourages banks to take

Table 30: The Role of Bond Market Development across Different Bank Sizes

Variables	(1) RWA	(2) DEP	(3) NSFR	(4) LRR	(5) ZSCORE	(6) RWA	(7) DEP	(8) NSFR	(9) LRR	(10) ZSCORE
Bond	−0.0371	−0.0191	0.563***	−0.0473**	0.240					
	(−1.56)	(−0.98)	(5.43)	(−2.14)	(1.23)					
BIGxBond	−0.00867	−0.0385**	−0.0405	−0.00698	0.274**					
	(−0.48)	(−2.25)	(−0.63)	(−0.35)	(1.97)					
GovB						−0.143***	0.0596***	0.436***	−0.0197	−0.576
						(−4.27)	(2.30)	(4.22)	(−0.67)	(−1.50)
BIGxGovB						0.0253	−0.0372	−0.0991	0.0580*	0.860**
						(0.74)	(−1.48)	(−0.96)	(1.72)	(2.01)
CorpB						0.134***	−0.157***	0.793***	−0.113***	1.458***
						(3.58)	(−4.72)	(4.38)	(−2.73)	(3.40)
BIGxCorpB						−0.0682**	−0.0201	−0.0298	−0.0552	−0.448
						(−2.08)	(−0.63)	(−0.21)	(−1.47)	(−1.41)
BIG	0.00297	0.00412	0.0290	−0.00790	−0.184**	−0.000816	0.000373	0.0504	−0.0261	−0.297**
	(0.21)	(0.32)	(0.66)	(−0.49)	(−2.01)	(−0.05)	(0.03)	(1.03)	(−1.52)	(−2.10)
RWA_{t-1}	0.525***					0.503***				
	(23.68)					(22.36)				
DEP_{t-1}		0.574***					0.551***			
		(14.33)					(13.57)			
$NSFR_{t-1}$			0.293**					0.292**		
			(2.03)					(2.03)		
LRR_{t-1}				0.527***					0.513***	
				(17.90)					(16.87)	
$ZSCORE_{t-1}$					0.184***					0.179***
					(6.46)					(6.62)
CSR	−0.672***	−0.0899*	0.265	−0.455***	2.809***	−0.647***	−0.114**	0.311	−0.470***	3.075***
	(−8.70)	(−1.81)	(0.70)	(−5.10)	(8.25)	(−8.32)	(−2.33)	(0.81)	(−5.28)	(8.82)
ROA	0.232	−0.594***	−0.718*	−0.491**	11.18***	0.142	−0.519***	−0.850**	−0.450**	10.55***
	(1.63)	(−4.76)	(−1.67)	(−2.30)	(7.16)	(0.96)	(−4.23)	(−2.00)	(−2.12)	(6.32)
NIM	0.853***	0.184	−1.875***	1.008***	−0.986	0.933***	0.139	−1.787***	1.004***	−0.514
	(2.80)	(0.86)	(−2.87)	(3.68)	(−0.86)	(2.96)	(0.63)	(−2.78)	(3.67)	(−0.45)
CR3	−0.209***	0.0258	−0.168	−0.167***	−1.658***	−0.124**	−0.0440	−0.0425	−0.204***	−1.031***
	(−3.50)	(0.63)	(−0.85)	(−3.23)	(−3.80)	(−2.32)	(−1.00)	(−0.21)	(−3.99)	(−2.60)
GDPG	−0.00864	0.200***	−0.568*	0.365***	−0.806	0.0461	0.163***	−0.479	0.337***	−0.588
	(−0.10)	(2.77)	(−1.94)	(4.29)	(−1.01)	(0.52)	(2.34)	(−1.59)	(4.04)	(−0.77)
ICRG	−0.112*	0.133**	0.767***	0.0825	−0.202	−0.00423	0.0368	0.947***	0.0217	0.596
	(−1.82)	(2.59)	(2.69)	(1.24)	(−0.46)	(−0.06)	(0.67)	(3.22)	(0.32)	(1.01)
IR	−0.0299	0.0722**	0.0753	−0.0246	1.838***	0.0135	0.0410	0.128	−0.0366	2.142***
	(−0.71)	(2.55)	(0.70)	(−0.68)	(9.40)	(0.31)	(1.50)	(1.15)	(−0.99)	(10.51)
FXV	−0.434**	0.167	−1.010	0.561***	−11.32***	−0.328	0.0671	−0.795	0.490***	−10.60***
	(−2.03)	(1.04)	(−1.17)	(3.03)	(−8.72)	(−1.53)	(0.42)	(−0.93)	(2.61)	(−7.15)
Constant	0.990***	−0.303	−2.789**	−0.171	3.881**	0.489*	0.173	−3.645***	0.118	0.0778
	(3.64)	(−1.35)	(−2.20)	(−0.58)	(2.08)	(1.71)	(0.71)	(−2.79)	(0.39)	(0.03)
Observations	2,794	2,790	2,794	2,794	2,789	2,794	2,790	2,794	2,794	2,789
Number of banks	432	432	432	432	432	432	432	432	432	432
Adjusted R^2	0.427	0.441	0.154	0.406	0.285	0.436	0.451	0.155	0.409	0.300
Year Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Bank Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Notes: This table reports parameter estimates of fixed-effects regressions of models including the interaction of bank size with total bond market in model specifications (1) to (5), and government and corporate bond markets in model specifications (6) to (10). RWA is risky-assets-to-total-assets ratio. DEP is deposit-to-total-assets ratio. NSFR is net stable funding ratio defined as the ratio between stability-weighted bank liabilities and assets. LRR is liquidity risk-taking as a share of total assets. ZSCORE is the natural logarithm of Z-score. Bond is total bond outstanding as a share of GDP. GovB is government bond outstanding as a share of GDP. CorpB is corporate bond outstanding as a share of GDP. BIG represents a dummy variable denoting the top 25% of banks based on size of total assets. CSR is capital sufficiency ratio. ROA is return on assets. NIM is net interest margin. CR3 is the ratio of loans held by top three largest banks to total loans held by all banks in an economy. GDPG is the gross domestic product growth of an economy. ICRG is the natural logarithm of composite risk score from the International Country Risk Guide. IR is interest rate measured by 1-year government bond yield. FXV is exchange rate volatility defined as the standard deviation of monthly real effective exchange rate changes within a year. ***, **, * represent statistical significance at the 1%, 5%, and 10% level, respectively. t-statistics in parentheses are calculated from robust standard errors clustered at the bank level.
Sources: Authors' calculations.

more risk. Overall, bond market development is found to reduce bank risk-taking regardless of bank size. Yet, government bond markets and corporate bond markets work differently in shaping banks' risk-taking. Corporate bonds serve as a source of stable funding that contribute to bank stability without repressing liquidity creation for large banks.

The Role of Bond Market Development across Different Capital Buffer Levels

The capital buffer is another key attribute that affects a bank's solvency risk and risk-taking behavior. The theoretical and empirical literature has been mixed regarding the association between capital and bank risk. A strand of studies argues that banks holding higher capital buffers tend to be less risky, following a "skin in the game" logic (Berger and Bouwman 2013; Demirgüç-Kunt, Detragiache, and Merrouche 2013; Tan and Floros 2013; Lee and Hsieh 2013; Horváth, Seidler, and Weill 2014). In contrast, moral hazard induced by deposit insurance and the "too big to fail" phenomenon describes banks' excessive risk-taking to increase shareholder value at the cost of depositors and taxpayers. Thus, when banks are required to hold capital to back risks, a higher capital ratio would mean greater risk-taking (Iannotta, Nocera, and Sironi 2007; Altunbas et al. 2007). Other studies do not find significant association between capital and bank risk-taking (Bitar, Pukthuanthong, and Walker 2018).

The role of capital buffer on bank risk is also related to a bank's portfolio structure. Khan, Scheule, and Wu (2017) argue that while banks with larger capital buffers are able to take more risk, they take less risk when their liquidity position is weaker (e.g., when they have greater deposits). Kim and Sohn (2017) further show that when large banks keep sufficient liquidity in their asset portfolios, capital will positively increase lending, especially during crisis periods. It is therefore interesting to learn whether banks with different capital buffer levels utilize bond markets differently, in terms of risk-taking strategy and liquidity creation, if presented with more liquidity management instruments to tackle liquidity risks.

This section examines whether bond market development affects bank risk-taking across various capital buffer levels. In the spirit of Khan, Scheule, and Wu (2017), we construct a dummy variable (CAP) which equals 1 if the capital sufficiency ratio falls in the highest quartile and 0 otherwise. Greater capital sufficiency indicates that banks are well-capitalized and relatively safer. **Table 31** reports the results of how capital buffers affect the association between a bond market and bank risk-taking by including both the CAP and an interaction term between bond market and CAP in the analysis.

Columns (1)–(5) of Table 31 show estimated results for the aggregated bond market and its interaction with CAP. Consistent with the results in Table 28, regardless of capital buffer levels, bond market development helps banks mitigate risk. A 1% increase in bond market size will reduce the respective banking sector's risky asset ratio, deposit ratio, and LRR by 0.04%, 0.04% and 0.05%, respectively, and increase stable funding ratio and Z-score by 0.53% and 0.39%, respectively. At the same time, a larger bond market encourages banks that hold more capital to take risk, as signified by a 0.28% reduction in the Z-score when the aggregate bond market is interacted with CAP.

Columns (6)–(10) reveal the results for the separate impacts of government and corporate bond markets and their interaction with CAP. Government bonds improve asset risks as well as the net funding ratio regardless of the capital buffer level. When the government bond market is larger, more capitalized banks tend to take more deposits given that they have more liquid assets for investment. Corporate bonds reduce deposit-taking, improve bank liquidity, and reduce overall risk, while allowing for more risky asset holdings without impairing bank stability, regardless of capital buffer levels. More capitalized banks tend to utilize corporate bond markets to strengthen their liability portfolios. This evidence suggests that larger government bond markets allow well-capitalized banks to take more deposits by providing more liquid assets to invest in, while corporate bonds are being utilized more by well-capitalized banks to manage risks in their liability portfolio.

Control variables report consistent evidence with better economic performance positively contributing to bank risk-taking, while greater market concentration and heightened exchange rate risk negatively affects bank risk-taking. Overall, the evidence in Table 31 suggests that the bond market's role in mitigating banks' risk-taking is not much affected by different capital buffer levels.

Table 31: The Role of Bond Market Development across Different Capital Buffer Levels

Variables	(1) RWA	(2) DEP	(3) NSFR	(4) LRR	(5) ZSCORE	(6) RWA	(7) DEP	(8) NSFR	(9) LRR	(10) ZSCORE
Bond	−0.0414*	−0.0379**	0.530***	−0.0488**	0.394**					
	(−1.92)	(−2.12)	(5.37)	(−2.28)	(2.40)					
CAPxBond	0.00004	0.0146	0.0337	−0.00867	−0.281**					
	(0.00)	(1.26)	(0.85)	(−0.57)	(−2.20)					
GovB						−0.152***	−0.0356	0.486***	−0.0346	−0.0437
						(−4.78)	(−1.55)	(5.16)	(−1.21)	(−0.15)
CAPxGovB						0.0181	0.0691***	0.0756	−0.0273	−0.197
						(0.59)	(3.34)	(1.03)	(−0.93)	(−0.54)
CorpB						0.129***	−0.0587**	0.588***	−0.0667*	1.060**
						(2.97)	(−2.06)	(3.75)	(−1.81)	(2.39)
CAPxCorpB						−0.0184	−0.0609**	−0.0212	0.0162	−0.366
						(−0.51)	(−2.17)	(−0.17)	(0.49)	(−1.04)
CAP	−0.0394***	−0.0127	0.00977	−0.0210**	0.269***	−0.0426***	−0.0233***	0.00185	−0.0175	0.255**
	(−3.91)	(−1.55)	(0.38)	(−2.11)	(3.17)	(−3.64)	(−2.82)	(0.06)	(−1.51)	(2.10)
RWA_{t-1}	0.541***					0.522***				
	(23.72)					(22.35)				
DEP_{t-1}		0.502***					0.496***			
		(12.48)					(12.53)			
$NSFR_{t-1}$			0.291**					0.291**		
			(2.02)					(2.02)		
LRR_{t-1}				0.511***					0.510***	
				(15.66)					(15.49)	
$ZSCORE_{t-1}$					0.172***					0.174***
					(6.06)					(6.09)
Size	0.00250	−0.0644***	0.108***	−0.0384***	0.151***	−0.0113	−0.0628***	0.104***	−0.0372***	0.0957
	(0.25)	(−7.98)	(3.29)	(−3.70)	(2.62)	(−0.97)	(−7.42)	(3.05)	(−3.43)	(1.39)
ROA	0.106	−0.358***	−1.117**	−0.429**	11.16***	0.0640	−0.354***	−1.132**	−0.424**	11.01***
	(0.83)	(−3.16)	(−2.32)	(−2.08)	(6.41)	(0.50)	(−3.20)	(−2.36)	(−2.04)	(6.26)
NIM	0.766***	−0.0870	−1.419**	0.821***	0.0305	0.795***	−0.0882	−1.416**	0.823***	0.108
	(2.64)	(−0.43)	(−2.28)	(2.97)	(0.03)	(2.61)	(−0.43)	(−2.27)	(2.97)	(0.10)
CR3	−0.205***	−0.0577	0.0316	−0.230***	−1.356***	−0.136**	−0.0722	0.0526	−0.236***	−1.068***
	(−3.27)	(−1.28)	(0.15)	(−4.45)	(−3.24)	(−2.42)	(−1.57)	(0.25)	(−4.57)	(−2.82)
GDPG	0.00688	0.0932	−0.316	0.296***	−0.622	0.0446	0.0979	−0.299	0.291***	−0.507
	(0.07)	(1.34)	(−0.93)	(3.49)	(−0.85)	(0.48)	(1.45)	(−0.89)	(3.42)	(−0.69)
ICRG	−0.160**	0.112**	0.829***	0.0257	0.166	−0.0439	0.0843	0.862***	0.0172	0.663
	(−2.41)	(2.33)	(2.68)	(0.36)	(0.38)	(−0.59)	(1.61)	(2.70)	(0.23)	(1.13)
IR	−0.0385	0.0847***	0.0683	−0.0254	1.897***	0.00579	0.0748***	0.0801	−0.0284	2.064***
	(−0.93)	(2.98)	(0.68)	(−0.82)	(7.74)	(0.14)	(2.71)	(0.77)	(−0.89)	(8.20)
FXV	−0.398*	−0.303*	−0.120	0.289	−10.35***	−0.367	−0.311**	−0.111	0.289	−10.15***
	(−1.71)	(−1.94)	(−0.15)	(1.47)	(−7.36)	(−1.60)	(−2.01)	(−0.14)	(1.46)	(−7.02)
Constant	1.081***	0.922***	−4.875***	0.685*	−0.103	0.777**	1.035***	−4.952***	0.704**	−1.510
	(3.35)	(3.56)	(−3.66)	(1.96)	(−0.04)	(2.41)	(3.93)	(−3.67)	(2.00)	(−0.57)
Observations	2,794	2,790	2,794	2,794	2,789	2,794	2,790	2,794	2,794	2,789
Number of banks	432	432	432	432	432	432	432	432	432	432
Adjusted R^2	0.398	0.485	0.159	0.399	0.267	0.407	0.488	0.159	0.399	0.271
Year Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Bank Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Notes: This table reports parameter estimates of fixed-effects regressions of models including the interaction of capital buffer with total bond market in model specifications (1) to (5), and government and corporate bond markets in model specifications (6) to (10). RWA is risky-assets-to-total-assets ratio. DEP is deposit-to-total-assets ratio. NSFR is net stable funding ratio defined as the ratio between stability-weighted bank liabilities and assets. LRR is liquidity risk-taking as a share of total assets. ZSCORE is the natural logarithm of Z-score. Bond is total bond outstanding as a share of GDP. GovB is government bond outstanding as a share of GDP. CorpB is corporate bond outstanding as a share of GDP. CAP represents a dummy variable denoting the top 25% of banks with high capital buffer based on the level of their capital sufficiency ratio. CSR is capital sufficiency ratio. ROA is return on assets. NIM is net interest margin. CR3 is the ratio of loans held by top three largest banks to total loans held by all banks in an economy. GDPG is the gross domestic product growth of an economy. ICRG is the natural logarithm of composite risk score from the International Country Risk Guide. IR is interest rate measured by 1-year government bond yield. FXV is exchange rate volatility defined as the standard deviation of monthly real effective exchange rate changes within a year. ***, **, * represent statistical significance at the 1%, 5%, and 10% level, respectively. t-statistics in parentheses are calculated from robust standard errors clustered at the bank level.
Sources: Authors' calculations.

6. The Role of Bond Market Structure: Is the Bond Market a Friend or Foe?

Previous evidence has shown that government and corporate bond markets help strengthen banks' portfolio structure and mitigate risk-taking via different mechanisms. While government and corporate bonds improve liquidity risk positions, their impacts on risk-taking in asset portfolios are different. Government bonds reduce risk in asset portfolios by adding low-risk liquid assets, while corporate bonds encourage risk-taking without impairing bank stability. One can also argue that corporate bonds may serve as a potential competitor for bank loans by providing direct financing to borrowing companies, which could repress bank liquidity creation.

To further reveal the role of corporate bond markets in bank risk-taking, this section investigates how bond market structure, such as corporate bonds' share of the total bond market and bank-issued bonds share of total corporate bonds, is related to bank portfolio decisions and risk-taking. In our empirical test, the share of corporate bonds in the total bond market is included in the analysis after controlling for the size of the bond market to test the potential competitor effect of corporate bonds. As government bonds mainly support liquidity in asset portfolios, a larger government bond market will encourage more loans without deteriorating bank liquidity status. However, if a corporate bond market is relatively big, its role as a source of stable funding and alternative risky assets, as well as a potential competitor to bank loans, will be more pronounced. This test will demonstrate the role of the relative size of a corporate bond market to total bond market size on bank risk-taking. The results are reported in **Table 32**.

Results in Table 32 suggests that while overall bond market development reduces bank risk-taking—via reduced assets and liability portfolio risks, reduced liquidity risk, and strengthened banking sector stability—a larger corporate bond market (as a share of the total market) increases banks' risky asset holdings without weakening their liquidity positions. A 1% increase in the corporate bond markets' share of total bonds outstanding is associated with an 0.08% increase in RWA, a 0.05% decrease in the LRR, and an 0.84% decrease in ZSCORE. As banks take on more risky assets, it can be confirmed that a corporate bond market does not crowd out liquidity creation in the banking sector. However, as liquidity risk improves and overall Z-scores fall, this may indicate the potential for competition from the corporate bond market for quality loan makers. As corporate bonds serve as an alternative direct financing option for both banks and their clients, a more developed corporate bond market can also pressure banks to take risks as clients may otherwise turn to the bond market for direct financing.

Interestingly, while a larger bond market is shown to reduce bank deposit-taking, a larger corporate bond market (as a share of the total bond market) is not significantly related to bank deposit-taking. This may indicate that how banks utilize the corporate bond market matters. More bank-issued bonds not only provide more stable funding but also indicate less disintermediation. To further investigate the role of the corporate bond market in bank risk-taking, another test is conducted to examine whether the share of bank-issued corporate bonds affects the impact of bond markets on bank risk-taking. Empirically, the share of bank-issued corporate bonds to total corporate bonds is included in the analysis after controlling for the size of the corporate bond market. The results are reported in **Table 33**.

The reported impacts in Table 33 of corporate bond market size on bank portfolio decisions and liquidity risk are consistent with the results in Table 29. Larger corporate bond markets, on the whole, facilitate banks' risky asset holdings while reducing risk-taking and deposit-taking, enhancing liquidity positions, and increasing overall stability. Bank-issued corporate bonds further lower deposit-taking and enhance Z-scores. A 1% increase in bank-issued bonds as a share of total corporate bonds is associated with a 0.08% decrease in the deposit ratio and a 0.31% increase in ZSCORE. This evidence indicates that bank bonds serve as an alternative stable funding source and contribute to bank stability. The bank-issued bond share is not significantly related to bank asset risk, while banks' risky asset holdings increase as the size of the overall corporate bond market expands. This evidence suggests that more nonbank corporate bond issuance may encourage banks to take on additional risky assets. However, as banks also utilize corporate bond markets to obtain stable funding, their liquidity risks and overall risks are not heightened.

The results revealed in Tables 32 and 33 confirm the view that corporate bonds do not crowd out banks' loan

Table 32: Relative Size of a Corporate Bond Market on Bank Risk-Taking

Variables	(1) RWA	(2) DEP	(3) NSFR	(4) LRR	(5) ZSCORE
Bond	−0.0420*	−0.0333*	0.534***	−0.0485**	0.339**
	(−1.93)	(−1.89)	(5.57)	(−2.30)	(2.10)
CorpB%	0.0825**	−0.0120	0.00428	−0.0462**	−0.841*
	(2.58)	(−0.68)	(0.07)	(−1.98)	(−1.84)
RWA_{t-1}	0.523***				
	(23.78)				
DEP_{t-1}		0.501***			
		(12.63)			
$NSFR_{t-1}$			0.291**		
			(2.03)		
LRR_{t-1}				0.494***	
				(15.18)	
$ZSCORE_{t-1}$					0.168***
					(5.98)
Size	−0.0105	−0.0677***	0.111***	−0.0432***	0.275***
	(−0.97)	(−8.27)	(3.76)	(−4.21)	(3.78)
CSR	−0.673***	−0.194***	0.447	−0.541***	3.119***
	(−8.42)	(−3.70)	(1.16)	(−6.20)	(8.22)
ROA	0.239	−0.298***	−1.216***	−0.285	10.39***
	(1.59)	(−2.83)	(−2.85)	(−1.38)	(6.28)
NIM	0.833***	−0.0735	−1.465**	0.901***	−0.0199
	(2.72)	(−0.36)	(−2.29)	(3.13)	(−0.02)
CR3	−0.180***	−0.0614	0.0408	−0.254***	−1.718***
	(−3.25)	(−1.35)	(0.19)	(−5.02)	(−3.40)
GDPG	−0.00535	0.0732	−0.299	0.264***	−0.554
	(−0.06)	(1.04)	(−0.93)	(3.25)	(−0.75)
ICRG	−0.0690	0.128***	0.794***	0.0515	−0.582
	(−1.07)	(2.63)	(2.88)	(0.76)	(−1.13)
IR	−0.0175	0.0901***	0.0685	−0.0228	1.641***
	(−0.42)	(3.23)	(0.64)	(−0.64)	(7.91)
FXV	−0.437*	−0.355**	−0.0985	0.223	−9.944***
	(−1.96)	(−2.23)	(−0.12)	(1.11)	(−6.65)
Constant	0.937***	0.934***	−4.827***	0.733**	1.334
	(3.19)	(3.74)	(−3.71)	(2.17)	(0.51)
Observations	2,794	2,790	2,794	2,794	2,789
Number of banks	432	432	432	432	432
Adjusted R^2	0.430	0.491	0.160	0.424	0.307
Year Fixed Effects	YES	YES	YES	YES	YES
Bank Fixed Effects	YES	YES	YES	YES	YES

Notes: This table reports parameter estimates of panel fixed-effects regressions of the baseline models including the share of corporate bonds to total bonds. RWA is risky-assets-to-total-assets ratio. DEP is deposit-to-total-assets ratio. NSFR is net stable funding ratio defined as the ratio between stability-weighted bank liabilities and assets. LRR is liquidity risk-taking as a share of total assets. ZSCORE is the natural logarithm of Z-score. Bond is total bond outstanding as a share of GDP. CorpB% is share of corporate bond to total bond outstanding. Size is bank size measured using the natural logarithm of total assets. CSR is capital sufficiency ratio. ROA is return on assets. NIM is net interest margin. CR3 is the ratio of loans held by the top three largest banks to total loans held by all banks in an economy. GDPG is the gross domestic product growth of an economy. ICRG is the natural logarithm of composite risk score from the International Country Risk Guide. IR is interest rate measured by 1-year government bond yield. FXV is exchange rate volatility defined as the standard deviation of monthly real effective exchange rate changes within a year. ***, **, * represent statistical significance at the 1%, 5%, and 10% level, respectively. t-statistics in parentheses are calculated from robust standard errors clustered at the bank level.
Sources: Authors' calculations.

Table 33: Bank Bonds' Market Share on Bank Risk-Taking

Variables	(1) RWA	(2) DEP	(3) NSFR	(4) LRR	(5) ZSCORE
CorpB	0.103**	– 0.0659**	0.667***	– 0.0744**	0.940**
	(2.55)	(– 2.26)	(4.12)	(– 2.09)	(2.25)
BankB%	0.00965	– 0.0805***	0.00770	0.0308	0.309**
	(0.42)	(– 4.67)	(0.12)	(1.43)	(2.13)
RWA_{t-1}	0.521***				
	(22.06)				
DEP_{t-1}		0.485***			
		(12.52)			
$NSFR_{t-1}$			0.295**		
			(2.06)		
LRR_{t-1}				0.493***	
				(15.30)	
$ZSCORE_{t-1}$					0.167***
					(6.10)
Size	– 0.0109	– 0.0669***	0.0790***	– 0.0428***	0.168**
	(– 0.97)	(– 8.46)	(2.75)	(– 4.16)	(2.52)
CSR	– 0.682***	– 0.229***	0.500	– 0.529***	3.364***
	(– 8.30)	(– 4.66)	(1.28)	(– 5.94)	(9.17)
ROA	0.236	– 0.271***	– 1.293***	– 0.294	10.04***
	(1.56)	(– 2.70)	(– 3.16)	(– 1.44)	(6.07)
NIM	0.884***	– 0.156	– 1.545**	0.937***	0.413
	(2.79)	(– 0.77)	(– 2.38)	(3.18)	(0.36)
CR3	– 0.174***	– 0.0826*	0.173	– 0.248***	– 1.059***
	(– 3.02)	(– 1.74)	(0.75)	(– 4.91)	(– 2.87)
GDPG	0.0149	0.187***	– 0.349	0.228**	– 0.782
	(0.15)	(2.67)	(– 1.01)	(2.50)	(– 1.07)
ICRG	0.00565	0.0774	0.839***	0.0771	0.547
	(0.08)	(1.50)	(2.80)	(1.08)	(0.97)
IR	– 0.0159	0.0768***	0.202*	– 0.0294	1.897***
	(– 0.38)	(2.69)	(1.74)	(– 0.84)	(9.81)
FXV	– 0.529**	– 0.334**	0.149	0.201	– 9.515***
	(– 2.40)	(– 2.16)	(0.18)	(1.01)	(– 7.19)
Constant	0.602**	1.170***	– 4.442***	0.582*	– 2.539
	(1.99)	(4.64)	(– 3.22)	(1.72)	(– 0.91)
Observations	2,788	2,784	2,788	2,788	2,783
Number of banks	432	432	432	432	432
Adjusted R^2	0.428	0.497	0.153	0.423	0.301
Time Fixed Effects	YES	YES	YES	YES	YES
Bank Fixed Effects	YES	YES	YES	YES	YES

Notes: This table reports parameter estimates of fixed-effects regressions of the corporate bond models including the share of bank bonds to total bonds. RWA is bank risky-assets-to-total-assets ratio. DEP is deposit-to-total-assets ratio. NSFR is net stable funding ratio defined as the ratio between stability-weighted bank liabilities and assets. LRR is liquidity risk-taking as a share of total assets. ZSCORE is the natural logarithm of Z-score. CorpB is corporate bond outstanding as a share of GDP. BankB% is share of bank-issued bonds to total corporate bonds. Size is bank size measured using natural logarithm of total assets. CSR is capital sufficiency ratio. ROA is return on assets. NIM is net interest margin. CR3 is the ratio of loans held by top three largest bank to total loans held by all banks in an economy. GDPG is gross domestic product growth of an economy. ICRG is the natural logarithm of composite risk score from the International Country Risk Guide. IR is interest rate measured by 1-year government bond yield. FXV is exchange rate volatility defined as the standard deviation of monthly real effective exchange rate changes during a year. ***, **, * represent statistical significance at the 1%, 5%, and 10% level, respectively. t-statistics in parentheses are calculated from robust standard errors at the bank level.
Sources: Authors' calculations.

business, rather they help mitigate risks in bank portfolios and liquidity positions by providing an additional source of stable funding. In general, a corporate bond market is more a friend than foe of the banking sector, but banks also need to prepare for the challenge of disintermediation, especially from quality clients.

7. Conclusion and Discussion

This paper examines the role of bond market development on banks' risk-taking. There is evidence that bond markets play a significant role in mitigating risks in banks' balance sheets and reducing banks' risk exposure. With regard to bank asset portfolios, a larger bond market is associated with less risky asset holdings; while for liability portfolios, a larger bond market is associated with lower deposit ratios. Larger bond markets are also found to strengthen banks' liquidity positions and mitigate overall risk.

Government bonds and corporate bonds function differently in shaping banks' risk-taking. While government bonds serve as liquid assets, corporate bonds function as a stable funding source for active liability management as well as an alternative risky asset class that offers diversification benefits.

The impact of the bond market on risk-taking in the banking sector is related to bank size and capital buffer levels. In particular, bond markets help larger and more cautious banks take risk without impairing their liquidity position. In addition, corporate bonds generally supplement rather than substitute for bank loans. Larger corporate bond markets support banks to expand loans without introducing excess liquidity risk, while also offering diversified risky assets to invest in. More bank-issued corporate bonds also help improve banking sector stability.

In sum, this study supports the view that bond markets play a complementary role to the banking sector by improving the structure of banks' portfolios and reducing their risk exposure. Compared to cash and central bank reserve deposits, liquid and yield-generating government bonds are an important asset class for banks, especially when banks need to expand loan portfolios to meet liquidity requirements such as the liquidity coverage ratio. Government bond holdings enable banks to make loans while maintaining sound liquidity in their asset portfolios. However, under extreme circumstances, such as when government bond yields are high enough to offer a wide margin, banks may prefer to hold government bonds over loans, which would dampen bank loan creation. Corporate bonds offer stable funding and mitigate maturity mismatches. Furthermore, evidence shows that corporate bonds are not a substitute for bank loans. As an important corporate bond issuer class, banks can utilize corporate bond markets to take more risk and make loans while maintaining sound liquidity positions.

This study provides new evidence on how bond market development can contribute to banking sector stability. The findings also have important policy implications. First, bond markets complement the banking sector. Banks' role in creating liquidity is not weakened as the capital market develops, rather banks benefit from the capital market as a source of liquid assets, risk management tools, and stable funding for capital and debt financing. Second, a balanced bond market structure matters. The government and corporate bond market segments each improve banking stability in different ways while also fostering risky asset holdings via different mechanisms. Such evidence is helpful to regulators and policy makers in designing a financial sector development road map and regulatory framework to foster a well-functioning and well-balanced financial sector that better contributes to economic development.

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