Bond market development, bank portfolio structure and liquidity risk:

Evidence from emerging markets

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Abstract

This paper investigates how bond market development will shape bank portfolio structures and liquidity risk exposure. Exploiting a bank-level dataset that covers 447 banks from 26 emerging markets during 2006 to 2017, we find that bond market development significantly reduces risks in banks' asset and deposit portfolios and strengthens bank liquidity position. In particular, government bond market serves as a source of liquid assets while corporate bond market works as alternative source of stable funding in contributing to bank stability and strengthening bank balance sheet. Moreover, larger bond market facilitates big and well-capitalized banks to take risk while maintain resilience to liquidity shocks. Overall, bond market development does not harm banking sector's role in liquidity creation, in the contrary, it offers banks greater scope in liquidity risk management. This study presents the first direct evidence to show how a well-functioning bond market enhances banking stability, offering policy implications that a diversified capital market complements banking sector as a good source of liquid assets, risk management tools and long-term equity and debt financing.

Key words: bond market development, liquidity risk, portfolio structure, financial stability

JEL code: G10, G18, G21, G28

1. Introduction

Liquidity management is one of the key areas in bank operation. Shortage of liquidity has been considered as an important threat to the soundness of financial institutions and systematic financial stability. The lessons from Asian Financial Crisis (AFC) and the Global Financial Crisis (GFC) both show how liquidity dry-up challenge the financial stability and harm real economy, as the financial sector in particular banks fail to function as the liquidity provider (Acharya and Mora, 2015). During crisis when market liquidity is tight, banks face more financial constraints and their own liquidity position can be worsened (Drehmann and Nikolaou, 2013). Ivashina and Scharfstein (2010) show that during GFC, banks credit supply dropped

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significantly facing 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 credit supply and increase asset liquidity during the financial crisis and only banks with stable funding sources remain lending activities. These evidences point to the importance of liquidity management instrument that can enhance bank resilience to liquidity shocks and contribute to a well-functioning financial system and economic growth.

Liquidity risk reflects maturity mismatch that is naturally embedded in bank business model. Diamond and Rajan (2001) model bank business structure and show that banks create liquidity by financing long-term project with short-term demand deposit, the ability that banks can transform illiquid loans into liquid deposits lies in their collection skills and demand deposit issuances. Diamond and Rajan (2005) further indicate that such a business structure exposes banks with 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 reserve and for regulators to monitor bank liquidity risk. Risk that liquidity demand cannot be met not only affects banks' continuous operation but also heightens systematic financial instability. Imbierowicz and Rauch (2014) suggest that bank liquidity risk and credit risk independently contribute to bank failure. In the case of a systematic liquidity shortage, affected banks may become insolvent which worsens the aggregated liquidity situation and in turn causes contagious bank failures (Hong et al, 2014).

Following the lessons learnt in AFC and GFC, policy makers and regulators around the world have taken actions to strengthen banks' balance sheets and improve banks' liquidity position. After the AFC, ASEAN+3 governments[2] recognized that currency mismatch and maturity mismatch are key contributors to the regional financial crisis. They jointly launched ASEAN Bond Markets Initiative (ABMI) to develop local currency bond market as a long-term local currency funding source to boost financial resilience. In the aftermath of GFC, the Basel Committee on Banking Supervision (BCBS) (2010a) points out that during the "liquidity phase" of the GFC, many banks face liquidity difficulties although they hold sufficient capital buffer. To

[2] ASEAN+3 indicates ASEAN economies plus the People's Republic of China; Hong Kong, China; Japan; the Republic of Korea.

strengthen sound liquidity management and supervision, BCBS introduced international framework for liquidity risk management and monitoring in 2010.

Understanding factors affecting bank portfolio structure and liquidity risk is important to strengthen financial resilience and contribute to economic development because bank liquidity risk is a major contributor to bank failures (Imbierowicz and Rauch, 2014), especially in turmoil period. A few studies have discussed the role of bank liability portfolio structure on bank risks and consistently found that a portfolio structure with heightened maturity mismatch exposes banks to greater risks. On the liability side, more deposits as funding sources are found to increase bank fragility. Acharya and Naqvi (2012) develop a model indicating that abundant deposit on banks' balance sheet would encourage banks to underprice loan risk and increase risk-taking. Khan et al (2017) examine a sample of US banks and find that when banks rely more on deposits as funding sources to support bank loans, i.e. having greater deposit to total asset ratio, banks tend to have more risk-weighted assets and greater bank risks. On the asset side, the illiquid nature of bank loans creates incentives for banks to reduce illiquid assets on the balance sheet to liquid assets via refinancing such as loan sales and securitization. However, such refinancing is not found to reduce bank risks. Wagner (2007) models the loan sales as a way to increase asset liquidity but finds that loan sales and related credit derivatives may cause contagion amongst banks in crisis as the risks are only transferred but remain in system. Casu et al (2011) examine a sample of US banks and find the role of securitization on banks' credit risk taking can be negative or insignificant depending on the type of assets being securitized. They indicate that securitization is used by banks more as a financing tool rather than risk management tool. Form an asset-liability perspective, Vazquez and Federico (2015) use Basel III type liquidity risk measures to investigate the role of bank funding liquidity on bank failure. Using a sample of US and European banks, they find that weaker funding structure, captured by lower Net Stable Funding Ratio (NSFR) and higher Short-Term Funding Ratio, are significant contributors to bank failure during crisis.

Existing literature mentioned above points to stable financing other than deposits (Acharya and Naqvi, 2012; Khan et al, 2017) and investment assets with better liquidity than loans (Wagner, 2007; Casu et al, 2011) as alternative instruments to help mitigate the maturity mismatch in bank balance sheet. The possible role of bond markets, especially government bonds as an important

source of liquid assets and corporate bonds as stable liabilities, on banks portfolio structure and liquidity risks has not been discussed in the literature. There is thus little evidence on the role of bond market development in shaping bank portfolio structure and benefiting liquidity risk management with investment and financing instruments that mitigate maturity mismatch in bank balance sheets.

This study extends the extant knowledge and provides the very first direct evidence on the role of bond market in shaping bank portfolio structure and liquidity risk profiles. According to Diamond and Rajan (2001), "narrow banking" helps enhance financial stability by matching illiquid assets with longer maturity liabilities and reducing bank liquidity risk-taking. Bond market provides an alternative asset class that can be used to reduce maturity mismatch and enhance liquidity management with government bonds serving as liquid asset while corporate bonds serving as longer maturity liability. It is worth noting that people may argue that the development of capital markets would challenge banks' role of liquidity creation. However, Berger and Bouwman (2009) show that banks' role of creating liquidity has not declined as capital market evolves. Figure 1 shows the capital market development as well as bank credit growth in emerging Asia, it is also seen that capital market development especially bond market develop does not hinder the expansion of bank credit to the private sector.

(Figure 1 here)

Motivated by lack of discussion of bond market development on bank risks, this paper aims to understand the following research questions. First, whether bond market helps to lower bank liquidity risk and strengthen banks' portfolio structure? Second, which part of bond market is more influential in improving banks' portfolio structure and liquidity risk, government bond market and/or corporate bond market? Third, is bond market's role in shaping bank portfolio structure works for big and small banks in a similar way? How will capital buffer level affect the role of bond market on bank risk taking?

This paper empirically examines the role of bond market on bank funding structure and risk-taking using a sample of 447 banks in 26 emerging markets from 2006 to 2017. Focusing on bank portfolio structure and liquidity risk proxies, we find that bond market development significantly lowers risks in banks' asset and deposit portfolios and improves bank liquidity risk

exposure. Especially, 1% increase in bond market size is associated with 0.08% and 0.06% decrease in risky asset ratio and deposit ratio, respectively. The improvement in bank portfolio structures is reflected in strengthened liquidity positions. 1% increase in bond market size will increase bank net stable funding ratio by 0.81% while lower bank liquidity creation ratio by 0.06%. Further investigation indicates that government bond and corporate bond work differently in this benign role of bond market on bank stability. In particular, government bond market serves as a source of liquid asset that diversified bank asset portfolio, while corporate bond market contributes as an alternative stable funding source which allows banks to better match long term assets. However, bond market does not curb banking sector's role in liquidity creation. Evidence shows that availability of more liquid assets and stable funding encourages large and well-capitalized banks to take risk and create liquidity without necessarily impairing their liquidity risk positions. Our findings imply that bond market plays a supporting role to the banking sector via offering liquid assets and stable liabilities and provides banks with more scope in risk management and liquidity creation while maintaining bank stability and resilience.

This paper adds to the extant literature in the following two aspects. First, it is the first study that focuses on the role of bond market development on bank portfolio structure and liquidity risks. Bond market offers alternative instruments to bank asset-liability management and risk-taking decisions, however, no direct evidence has been produced about this mechanism. This paper extends the existing research by adding evidence with a new focus on bond market development. Second, while it is widely known that banks with different sizes and capital buffer levels adopt heterogeneous business strategy, profit models and risk profiles. This study sheds new lights on how different types of banks may tap bond market in a different way in their portfolio decisions and liquidity risk taking.

This paper offers clear policy implications. The Asian financial crisis highlighted the importance of local currency bond market in mitigating the currency and maturity mismatch problems in the financial system. Recent decades have witnessed fast expansion of local currency bond market worldwide, especially in Asia pacific region. After two decades of development, the size of emerging East Asian local currency bond market in ASEAN plus the People's Republic of China, Hong Kong, China and the Republic of Korea is getting similar to that of Euro-denominated bonds outstanding in the European bond market by 2018. (Figure 2) Park, Shin and Tian (2018)

examine the role of local currency bond market in mitigating currency mismatch in global emerging markets and show that local currency bond markets help emerging markets stabilize foreign exchange rates against external shocks. However, no direct evidence has been produced to assess the role of bond market development in tackling the maturity mismatch. This study therefore fills this void. This study presents the first direct evidence on how bond market development can benefit banking stability. This evidence is useful for regulators to plan a well-diversified and resilient financial sector, especially for some emerging markets that heavily rely on bank loans as sole financing channel. As shown in Figure 1 and documented in Berger and Bouwman (2009) as well as this study, banking sectors' role of creating liquidity is not affected as capital markets develops, instead, they can benefit from the development of capital markets as a source of liquid assets, risk management tools and long-term equity and debt financing.

(Figure 2 here)

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

2. Theoretical implication and hypothesis development

This paper is motivated by 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 up long-term loan assets. The maturity mismatch may cause funding constraints when there is liquidity stress, such as credit-line drawdowns and creditor withdrawals (Ivashina and Scharfstein, 2010). Liquidity shortfall would lead to fire sales of bank assets, rising external financing costs from capital markets, or even bank crisis.

In the bank management framework documented in Koch and MacDonald (2014) and Rose and Hudgins (2013), assets-liability management helps banks tackle with possible liquidity constraint arising from maturity mismatch. On the asset side, banks store liquidity in the asset portfolio to meet unexpected funding demands. Haan and van den End (2013) develop a bank liquidity model where banks hold liquidity assets to tackle liquidity pressure arising from loan makers and depositors and find that most banks hold more than required liquid assets against liquid liability.

Amongst the many liquid assets, government bond is a typical asset class that generates some yields while bears reasonable liquidity if the bond market is well developed. Hence, well developed bond market, in particular government bond market, can effectively improve liquidity and shorten the maturity of banks' asset portfolio, mitigating maturity mismatch on banks' balance sheet. At the same time, holding government bonds do not necessarily introduce excess credit risk that may be transferred to other banks when being sold, as in the case of loan sales and securitization. Thus, a greater and deeper bond market, especially government bond market, offers commercial banks an alternative class of liquid assets and lowers risk in their asset portfolio.

Hypothesis 1: Larger bond market, especially greater government bond market, helps to lower risks in banks' asset portfolio.

On the liability side, 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 the liquidity situation. In line with principle-agent theory, bank managers would more risk by relaxing loan standards for greater personal compensation. In additional, since deposits are covered by deposit insurance, which works similar to a put option, it will induce moral hazard by encouraging banks to take excess risk (Khan et al, 2017; Keeley, 1990). Moreover, excess deposits, especially demand deposits, expose banks to greater liquidity pressure during turmoil when depositors run for withdrawals. It is found that banks with more stable funding sources are less prone to such liquidity run (Cornett et al, 2011). While deposits are largely decided by depositors' behaviors, bond market offers banks instruments that can be used to actively manage liability portfolio in terms of quantity and timing. Banks can issue bonds in the corporate bond market with planned amount and desired maturity that match assets portfolio. With pre-defined repayment flows, corporate bonds not only avoid moral hazard induced by deposit insurance, but also prevent liquidity runs in turmoil. Hence, corporate bonds serve as a stable funding source that helps reduce maturity mismatch and prevent excess risk-taking. With a well-functioning bond market, banks tend to have better liability structure and more resilient liquidity positions.

Hypothesis 2: Larger bond market helps improve bank liability portfolio structure and reduce bank liquidity risk.

In the banking literature, bank size is an important factor that shape banks' business model. According to Koch and MacDonald (2014) and Rose and Hudgins (2013), large banks normally have more diversified asset portfolio in terms of geography, sector and asset classes, which helps diversify bank risk. Empirical evidence shows that larger bank size is associated with greater bank stability (Mercieca et al, 2007; Khan et al, 2017), lower assets volatility (Boyd and Runkle, 1993) and less earning volatility (De Haan and Poghosyan, 2012). Compare to smaller banks, larger banks generally have better access to global and domestic capital markets. As bond market develops, large banks can make better use of capital market to actively manage liability portfolio and the liquidity of assets portfolio, therefore are able to manage liquidity risks while creating liquidity. Berger and Bouwman (2009) investigate US banks' liquidity creation and show that bank liquidity creation has been increasing as capital market develops. More importantly, they find that large banks are the major contributor in liquidity creation. Since large banks have greater access to the bond market for debt financing, their finding implies the possible positive role of bond market in facilitating bank liquidity creation especially for large banks without necessarily inducing risk as longer term funding is matched with illiquid asset.

Hypothesis 3: Larger bond market helps larger banks to create liquidity by allowing they greater scope to improve portfolio structures.

Capital buffer level is one key attribute that affects a bank's solvency risk. The theoretical and empirical literature have been mixed regarding the association between capital and bank risks. In particular, a strand of studies argues that banks holding higher capital buffers tend to be less risky following a "skin in the game" logic (see amongst others, Berger and Bouwman, 2013; Demirgüç-Kunt et al., 2013; Tan and Floros, 2013; Lee and Hsieh, 2013; Anginer and Demirgüç-Kunt, 2014; Horváth et al, 2014). On the contrary, moral hazard induced by deposit insurance and the too-big-to fail phenomenon describes banks' excess risk taking to increase shareholder value at the expense of depositors and taxpayers. Thus, regulators require banks to hold capital to back risks, which means that higher capital ratio implies higher risk taking (See amongst others, Iannotta et al., 2007; Altunbas et al., 2007, etc.). Other studies do not find significant association between capital and bank risk taking (such as Bitar et al, 2018). Moreover, bank capital buffer has been documented to influence bank liquidity management. For example, Khan et al (2017) find that while banks with larger capital buffers are able to take more risk, they take less risk

when their liquidity position is weaker, for example, when they have greater deposits. Kim and Sohn (2017) further show that when large banks keeps sufficient liquid asset, capital will positively increase lending, especially during crisis period. Thus, when bond market is more developed, banks with higher capital buffer will take risk and create liquidity as they have more liquidity management instruments to tackle liquidity risks.

Hypothesis 4: Larger bond market facilitates capital-sufficient banks to create liquidity and taking risks.

3. Sample construction and Empirical design

3.1 Data collection

We collect bank financial statement information from S&P Global Market Intelligence. Bond market development information is obtained from Bloomberg. Market level macroeconomic attributes are collected from various sources, including World Development Indicators, International Country Risk Guide (ICRG), Bloomberg and Bruegel.[3] We match bank level data with bond market development and macroeconomic variables. To get a reasonable data coverage in each market, we exclude markets where less than three banks are recorded. The final sample is an annual panel data covering 26 emerging markets worldwide from 2006 to 2017. The sample consists of 447 unique commercial banks and 2,559 bank-year observations. To address outlier problems, bank-level variables with extreme values are winsorized at 3 standard deviations around the mean. Table 1 lists the number of banks in each of the markets in the sample.

(Table 1 here)

3.2 Variable Construction

3.2.1 Bank Risks

According to Imbierowicz and Rauch (2014), there are two major types of bank risks that separately affect bank solvency risk, being liquidity risk and credit risk, and there is no significant and reciprocal relationship between the two. In this paper, bond market development

[3] Data sources for all variables used in this study are listed in Appendix A.

is more related bank portfolio structure and liquidity risk, thus this study mainly focuses on these two aspects.

A. Portfolio structure

Asset portfolio structure

Asset portfolio structure directly relates to risks in bank assets. Basel II accords use risk-weighted assets to total assets ratio (RWA) to determine the minimum amount of capital that banks need to hold to reduce insolvency risk. RWA reflects quality and structure of bank asset portfolio by assigning risk weight to each asset class according to its inherent potential for default and the likely losses in case of default. Bond market offers fixed income assets such as government bonds and corporate bonds, that allows banks greater flexibility to management asset portfolio structure in terms of diversity, liquidity, return and maturity which reduces RWA. More developed and larger bond market can shape bank asset portfolio structure with more liquid and diversified bond supplies, reliable bond pricing dynamics and better information environment. In empirical studies, we use RWA to capture risks embedded in asset portfolio structure.

Liability portfolio structure

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 et al (2017) also find that US banks with greater reliance on deposits as a funding source tend to take greater risks. Bond market helps balance bank liability portfolio with alternative funding instruments, i.e. corporate bonds. In better developed bond markets, it is easier for banks to issue corporate bonds to obtain funding with the desired amount and maturity. Unlike demand deposit, corporate bonds have preset cash flow patterns, thus corporate bond markets make banks' liability portfolio more stable and predictable. In addition, unlike the insurance-covered deposits that can induce moral hazard and excess bank risk taking,

debt funding introduces market monitoring to avoid excess risk taking. In empirical analysis, we use the ratio of deposits to total assets[4] (DEP) to reflect liability portfolio structure of banks.

B. Liquidity risk

Funding stability

In the aftermath of GFC, the Basel Committee introduced two liquidity risk measures under the Basel III framework (BCBS, 2010a) to capture the liquidity positions of a bank in terms of assets and liability portfolios. First measure is the Net Stable Funding Ratio (NSFR) which reflects the level of funding liquidity and requires banks to fund their activities with sufficiently stable funding sources over a mid-term or long-term horizon (BCBS, 2014). Higher NSFR indicates less reliance on short-term funding and sound liquidity position. The other measure is the liquidity coverage ratio which captures assets liquidity and gauge whether banks hold enough high-quality liquid assets or cover short term cash outflows. Given granular information on assets and liabilities required to calculate these measures is very limited for banks in our emerging market sample, we can only follow Vasquez and Federico (2015) and construct an approximate proxy for the NSFR as the ratio between stability-weighted bank liabilities (L_i) and assets (A_i):

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

where w_i is the weights reflecting relative stability of each balance sheet item, and $0 \leq w_i \leq 1$. Larger weights are assigned to assets which are less liquid and liabilities that are more stable sources of funding. The stylized balance sheet items and their stability weights used to calculate the NSFR are presented in Appendix 2.

Liquidity risk-taking

Banks create liquidity via taking risk that arise from an inherent maturity mismatch in their balance sheets. Liquidity creation therefore describes the extent to which banks finance relatively

[4] We also use the ratio of deposit to total liability as a proxy. Since the results generated by both proxies are very similar, given their high correlation of 0.986, we only report the results estimated using DEP for brevity. Results generated using DEL are available upon request.

illiquid assets with relatively liquid liabilities (Khan et. al, 2017). Liquidity creation is a widely used proxy for banks' liquidity risk-taking in literature (Berger and Bouwman 2009; Berger et al., 2013; Distinguin et al., 2013; Horváth et al., 2014; Khan et. al., 2017). Since bond market offers commercial banks with liquid assets as well as illiquid liabilities in the form of government and corporate bonds, greater bond market could mitigate bank liquidity risk. In empirical analysis, we follow Berger and Bouwman (2009)[5] to gauge bank liquidity creation and it as a share of total assets as follows:

$$\text{LCR} = \frac{(\textit{liquid assets} + \textit{liquid liabilities}) - (\textit{liquid assets} + \textit{liquid liabilities}) - \textit{equity}}{2 \times \text{total assets}}, \quad (2)$$

3.3.2 Bond Market Development

We use bond market size to proxy bond market development and define bank market development (Bond) as a market's total bond outstanding as a share of its current price GDP. To examine the different roles of government bonds and corporate bonds, we follow Bloomberg BICS Level 1 classification to categorize bonds into government and corporate, and calculate the outstanding amount of government bonds (GovB) and corporate bonds (CorpB) as a share of GDP, respectively. Table 2 lists the average bond market size across 26 emerging markets for government, corporate and total bond markets. Figure 3 depicts the aggregated bond market size with break down into government bond and corporate bond across years.

(Table 2 and Figure 3 here)

3.2.3 Control variables

To control for other widely acknowledge factors that also contribute to bank portfolio decision and risk taking, we follow the literature and include variables at the bank specific level as well as market level in our analysis (see amongst others, Khan, et. al., 2017; Vasquez and Federico, 2015; Fu, et al., 2014; Konishi and Yasuda, 2004). At the bank level, we include bank size, profitability and capital sufficiency as major bank-specific attributes. At the market level, we

[5] Classification of the balance sheet items as liquid or illiquid assets and liabilities in Appendix 3.

control for banking industry concentration as well as macroeconomic conditions, such as GDP growth, interest rate level, exchange rate stability and economic stability.

Bank specific attributes

Bank size significantly affects bank operation decisions with different levels of scale and scope economy as well as access to the capital markets. In empirical study, we measure bank size (SIZE) as the natural logarithm of bank total assets. Bank profitability reflects the decision making and risk management quality of bank operation. Following Fu et al. (2014), we include bank return on assets (ROA) and net interest margin (NIM) to track profitability of bank investment and lending activities. As key dimensions of bank regulation, capital buffer also affect bank risk taking. Following Vasquez and Federico (2015), we construct bank capital sufficiency ratio (CSR) as the ratio of Basel Tier 1 capital to risk-weighted assets.

Market level attributes

It has long been under debate how bank concentration influences bank stability. The literature split into concentration-stability view suggesting a positive role of bank concentration on bank stability (such as Yeyati and Micco, 2007; Berger et al., 2009) and a concentration-fragility view arguing for a negative impact of concentration on bank stability (for example, Fu et. al., 2014; Schaeck and Cihák, 2014). Due to data limits, we follow Fu et. al. (2014) and use loan concentration ratio of loans held by three largest banks to total loans in the banking industry (CR3) to measure banking sector concentration.

At for macroeconomic condition, we include GDP growth (GDPG) as a broad measure of macroeconomic development that depicts the general soundness of the real sector performance. Lower interest rate encourages bank risk-taking with a lower default probability of existing loans (Ramayandi et al, 2014). To capture interest rate level and market liquidity condition, we include the one-year government bond yield (IR) as bench mark interest rate level. Exchange rate uncertainty also affect banks' risk-taking behavior and investment appetite. Excessive exchange rate volatility impairs economic and financial stability and induces banking crises in many countries (Lindgren et al. 1996). In empirical analysis, we construct exchange rate volatility (FXV) as the standard deviation of monthly real effective exchange rate changes during a year. To capture overall market risk, such as governance, political, economic and financial risk, we

also include the natural logarithm of composite International Country Risk Guide index (ICRG). The ICRG composite risk score ranges from 0 to 100, with higher ratings suggesting that a market is less risky.

Descriptive statistics for the key variables in the sample are reported in Table 3 and their definitions and data sources are listed in Appendix 1. Pearson's pairwise correlation coefficients between the variables presented in Table 4. The low to moderate correlation among most of our control variables indicate that multicollinearity is not an issue in our analysis.

[Tables 3 and 4 here]

3.3 Model specification

To empirically test whether bond market helps mitigate bank liquidity risk and improves portfolio structure, we estimated the following baseline model:

$$Bank_{i,t} = \alpha + \beta Bond_{i,t-1} + \gamma Controls_{i,t-1} + \delta_t + \varepsilon_{i,t}, \quad (3)$$

where $Bank_{i,t}$ is a vector of bank portfolio structure and liquidity risk measures for bank *i* at time *t*, i.e. risk-weighted assets to total assets ratio (RWA) as a proxy for banks' asset portfolio structure, deposits to total assets ratio (DEP) as a proxy for banks' liquidity portfolio structure, net stable funding ratio (NSFR) as a proxy for banks' funding liquidity, and liquidity creation to total assets ratio (LCR) to measure liquidity risk-taking. $Bond_{i,t-1}$ is a vector of bond market development variables for that market where bank *i* registers in at time *t-1*, including Bond, GovB and CorpB as the ratios of aggregate bond outstanding, government bond outstanding and corporate bond standing to current GDP, respectively. The vector $Controls_{i,t-1}$ contains bank-level and market-level characteristics that are widely established in 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. δ_t is a vector of time fixed effects, and $\varepsilon_{i,t}$ is the error term for bank *i* at time *t*.[6] The timing

[6] We did not control for bank fixed effect in all our regressions since we relatively have a small sample size and adding each bank effect in the models lowers degree of freedom because it entails estimation of more parameters resulting in a lack of power in the t-statistics.

applied is to ensure that the direction of causality goes from the explanatory variables to the dependent variable (Demsetz and Strahan, 1997; Stiroh, 2006). We estimate our baseline model using panel fixed effects models with clustered standard errors at the bank level.[7]

4. The role of bond market on bank portfolio structure and liquidity risk

This section discusses the results of the analysis that aims to understand how bond market development would shape bank portfolio structure and liquidity risk. We focus on four dependent variables, i.e. ratio of risk-weighted assets to total assets (RWA), ratio of deposit to total assets (DEP), stable funding ratio (NSFR) and liquidity creation ratio (LCR).

Table 5 reports the estimated results of baseline model specification (3) focusing on the impacts of bond market size (Bond) and related control variables on the four bank portfolio structure and liquidity risk variables. Specifications (1) - (4) show how various bank- and market- level control variables affect bank portfolio structure and liquidity risk levels. It is shown that larger banks tend to hold more risky assets in their asset portfolio but less deposits in their liability portfolio, which indicates that they adopt a more diversified funding structure. Despite taking more risky assets, large banks have higher net stable funding ratio and less liquidity creation ratio compared to small banks. As for capital buffer level, in line with the widely documented evidence that well-capitalized banks are more prudent in risk taking (Lee and Hsieh, 2013; Lindquist, 2004; Khan et al, 2017), we find consistent role that higher capital buffer level is significantly associated with lower asset risk in bank portfolio and lower liquidity risk taking. Moreover, bank profitability signals a bank's decision making and risk management quality. More profitable banks are at better position tackling asset and liquidity risks. In particular, banks with higher net interest margin (NIM) and ROA are consistently found to take greater asset risk, more liquidity creation and lower funding stability.

[7] In the presence of heteroscedasticity or serial correlation within panels, the traditional Hausman cannot be used to test which is the better fit model between fixed effects and random effects as the random-effects generalized least squares (RE-GLS) estimator is not fully efficient. In order choose between fixed and random effects, we perform two tests. First, we use a robust version of the Hausman test which implements a (cluster-) robust version of the Hausman specification test using a bootstrap procedure. Second, we use the Sargan–Hansen test of overidentifying restrictions which is robust to heteroscedasticity. The Sargan-Hansen test showed more consistent results for a repeated number of runs, thus, we choose the models which this test suggests to give a better fit. For all models, Sargan-Hansen test favors FE over RE.

Amongst the market level variables, consistent with Yeyati and Micco (2007) and Berger et al. (2009), banking sector concentration seems to play a stabilizing role as market concentration (CR3) is negatively associated with banks' risky asset holding as well as liquidity risk taking. Macroeconomic variables show significant impacts on bank portfolio decisions. When economic is performing well with higher GDP growth, higher interest rate and higher ICRG score, banks hold more deposits in their portfolios to support loans, which reduced their net funding stability and increases their liquidity risk taking. Consistently, when exchange rate volatility is high, banks become more prudent in a risk-off mode reducing risky assets ratio in their portfolios. Overall, the control variables show intuitive and consistent evidence with the extant literature.

[Table 5 here]

Specifications (5) - (8) of Table 5 include bond market size and report its impact on bank RWA, DEP, NSFR and LCR, respectively. It is shown that while the control variables' impacts remain largely consistent, the size of bond market significantly lowers the ratio of risky assets in banks' asset portfolio, reduces deposit ratio in liability portfolios and improves bank liquidity positions. In particular, 1% increase in bond market size will significantly reduce the shares of risk-adjusted asset and deposit in bank asset and liability portfolios by 0.08% and 0.06%, respectively. Meanwhile, 1% increase in bond market size is associated with 0.81% increase in bank net stable funding ratio and 0.06% decrease in bank liquidity creation ratio. Overall, Table 5 indicates that bond market improves bank liquidity risk and portfolio structure from both asset and liability sides, highlighting the role of government bond as a liquid investment vehicle and corporate bond as a long-term financing tool.

To further investigate the different roles of corporate bond market and government bond market development on bank portfolio structure and liquidity risk taking, Table 6 reports the separate impacts of each type of bond markets on bank portfolio structure and liquidity risk. First, evidence on control variables reveal similar information as in Table 5. Larger size, better profitability and good economic performance are all associated with higher liquidity risk, more risky assets and lower stable funding ratio, while higher capital sufficiency ratio, greater market concentration and higher exchange risk risk will reduce bank risk appetite by holding less risky asset, less deposit and reduce liquidity creation. Moreover, evidence shows that larger government bond market significantly reduces bank risky asset as well improve bank stable

funding ratio. In particular, 1% increase in government bond market size is associated with 0.18% lower risky asset ratio and 0.69% increase in net stable funding ratio. It is worth noting that government bond market does not affect liability portfolio structure captured by deposit ratio. This is intuitive and consistent with the role of government bond market as a liquid investment instrument to commercial banks, allowing banks to improve liquidity in asset portfolio but does affect bank liability portfolio much. Consistently, we find that larger corporate bond market plays a significantly role in lowering bank' deposit ratio with 1% increase in corporate bond market driving down deposit ratio by 0.25%. This finding supports the hypothesis that corporate bond market serves as long-term financing tools to commercial banks other than deposits. With more stable funding from the corporate bond market, banks are able to take more risky assets while still have good liquidity positions. As shown in Table 6, 1% increase in corporate bond market is associated with 0.09% more risky asset ratio in banks balance sheet but are still able to improve banks net funding ratio by 0.99% and reduce bank liquidity risk taking by 0.24%. Table 6 not only highlights the role of government bond market as a source liquid asset to invest, but also underscores the role of corporate bond market a good source of stable funding which allows banks to take risk as well as mitigate associated liquidity risk.

[Table 6 here]

People may argue that corporate bond market may be more biased towards large banks that have better access to capital market, whether corporate bond market is not relevant for small banks? Will important bank attributes such as size and capital sufficiency affect the role of bond market on bank risk taking? To uncover this question, we conduct further examination in the next section.

5. The role of bond market across bank sizes and capital ratios

The banking literature has extensively documented that bank size and capital sufficiency significantly shape bank risk taking decisions. Large banks enjoy greater economy scale and scope compared to small banks. They have comparative advantage in capital markets for financing, risk management and investment under the Basel Capital Accord. (Hakenes and Schnabel, 2011) Well-capitalized banks are normally prudent, taking less risk. (Lee and Hsieh, 2013)

Given that bond market development may affect different types of banks in different ways, it is interesting to understanding how bank size and capital buffer level would influence the role of bond market developed on bank portfolio structure and liquidity risk taking. To examine the risk-taking behavior of big and small banks, we follow Khan et al (2017) and construct a dummy variable, BIG, which equals to 1 if a bank's total assets ranks the top quartile, or 0 otherwise. Table 7 reports the interactive term for BIG and bond market development.

[Table 7 here]

Model specifications (1) to (4) of Table 7 shows results on the impacts of total bond market and an interaction term between bond market size and bank size, while model specifications (5) to (8) show results for separate types of bond markets and their interaction with bank size. As seen in column (1) and column (3), the coefficients on bond market size are significant while those on the interactive term are insignificant. This evidence indicates that greater bond market helps to lower risky in asset portfolio and improve funding stability, regardless of bank size. Moreover, column (2) reveals interest finding. Bond market size shows insignificant impact on deposit ratio but a negative and significant impacts on the interaction term between deposit ratio and BIG. This evidence suggests that 1% increase in bond market will reduce deposit ratio of big banks by 0.08% compared to small banks, affirming that corporate bond market is more used by large banks for liquidity risk management.

Columns (5) and (8) reveal detailed evidence on separate roles of government bonds and corporate bonds. It can be seen that 1% increase in government bond market will reduce asset risk by 0.22% regardless of bank sizes. Interestingly, as banks have more liquid assets to invest, they are able to take more deposit. However, when combined with the effect of corporate bonds, the net impact of bond market is still to lower deposit especially for large banks as shown in column (2), indicating that it is largely small banks that take more deposit. In addition, consistent with our hypothesis 3, greater government bond market, while improves net funding ratio for small banks, lowered net funding ratio and increase liquidity creation for big banks by allowing them to take more risk with more liquid investment assets. Turning to corporate bond market, consistent with the role of corporate bond market as a source of long-term funding source, 1% increase in corporate bond market is linked to a 0.16% increase in risky asset as well as a 1.17% increase in net stable funding ratio, indicating that the long-term funding provided by corporate

bond market fosters bank asset risk taking while still improves bank liquidity risk. This can be further shown in column (6), where a 1% increase in corporate bond market reduce deposit ratio for small banks by 0.31% and lower deposit ratio by 0.1% for big banks. This evidence suggests that corporate bond market as a long-term funding source is not biased towards big banks. Small banks still benefit from issuing corporate bonds for liquidity risk management. Results in column (8) reaffirms this finding. 1% increase in corporate bond market lower small banks' liquidity creation ratio by 0.25% and lower that for big banks by 0.11%.

The results for control variables are largely consistent with those documented in earlier section. In particular, higher capital sufficiency and more concentrated market environment make banks prudent by taking less risk in asset portfolio and reduce liquidity creation; while higher profitability and better macroeconomic performance encourage banks to take more risk in asset portfolio, create more liquidity, and adopt less stable funding structure.

Overall, bond market development is found to reduce asset risk and lower bank liquidity risk regardless of bank size. Government bond market and corporate bond market work differently in shaping banks' portfolio structure and liquidity risk taking. In particular, evidence suggests corporate bonds serve as a source of stable funding that facilitate larger banks to reduce deposit taking and lower liquidity risk.

As a key attribute affecting bank insolvency risk, capital buffer have been widely employed in the banking literature to examine bank stability. In spirit of Khan et al (2017), we construct a dummy variable, CAP, that equals to 1 if bank capital sufficiency ratio ranked as top quartile, or 0 otherwise[8]. Higher capital sufficiency indicates that banks are well-capitalized and relatively safer. To investigate how capital level will affect the association between bond market and bank portfolio structure and liquidity risk, we include an interactive term between bond market and CAP in the analysis. Table 8 reports the results of bond market development on banks with different levels of capital.

[Table 8 here]

[8] We also repeat the analysis following Khan et. al. (2017) and use capital sufficiency ratio (also called capital buffer) to understand the interactive role of bond market and capital level. The implication of the results are similar to those generated using CAP. For brevity, we only report the results using CAP, the results using capital buffer is available upon request.

Columns (1) and (4) of Table 8 show estimated results for aggregated bond market and its interaction with CAP. It is shown that 1% increase in bond market will reduce the risky asset ratio, deposit ratio and liquidity creation ratio by 0.008%, 0.07% and 0.07% respectively, while increase stable funding ratio by 0.83%, regardless of bank capital levels. Columns (5) and (8) reveals detailed results for separate impacts of government and corporate bond markets and their interaction terms with CAP. The results for government bonds and its interaction with CAP suggests that larger government bond market significantly reduces risky asset ratio and increase net stable funding ratio regardless of capital buffer levels. Interestingly, we note that well-capitalized banks tend to tend more deposit when government bond market is large. This is consistent with our hypothesis 4 in that with more liquidity risk management assets, well-capitalized banks can take additional risk as they have more scope in investing liquid assets. Moreover, the results for corporate bond market is largely consistent with that in Table 6 indicating that large corporate bond markets improved banks' liability portfolio structure by reducing deposit ratio, which allows banks to hold more risky assets without worsening liquidity conditions. In particular, large corporate bond market is associated with better liquidity conditions with higher net funding ratio and lower liquidity creation ratio. These impacts of corporate bonds are not affected by capital buffer levels. This evidence also supports Berger and Bouwman (2009) that bank liquidity creation is not curbed as capital market evolves. In the contrary, as bond market develops, banks have more risk management instruments which allows them to create more liquidity. Moreover, control variables also report consistent evidence with better profitability and better economic performance positively contributed to bank risk taking, while greater market concentration and higher exchange rate risk levels negatively associated to bank risk taking.

Overall, evidence in Table 8 suggests that bond market's role in mitigating bank asset risk and liquidity risk are robust across different levels of capital buffers. Well-capitalized banks are able to take risk by accepting more deposit as larger government bond market offer more liquid assets to hold. Evidence shows that corporate bond market helps banks to lower deposit taking and increase investment in risky asset without impairing their liquidity situation, regardless of capital levels.

6. Conclusion and discussion

This paper examines the role of bond market development on banks' portfolio structure and liquidity risk. We find evidence that bond market plays a significantly role in lowering risks in bank balance sheet as well as reducing bank liquidity risk. In the asset portfolio, we reveal that in a market where bond market is larger, banks' risk adjusted assets ratio is lower, due to the availability of more liquid investment instruments, especially government bonds. In the liability portfolio, greater bond market is found to reduce bank deposit ratio which in turn lowers bank risks according to Acharya and Naqvi (2012). The availability of long-term financing tools such as corporate bonds is shown to contribute to this lower deposit taking. Thus, bond markets help banking sector to improve their portfolio structures by diversifying assets class in asset portfolio and providing alternative stable funding in liability portfolio.

The role of bond market in strengthening bank portfolio structure is also reflected in stronger bank liquidity indicators. Large bond market is associated with higher net liquidity funding ratio and lower liquidity creation ratio. A breakdown of bond market into government and corporate bond market further indicates that while government bonds mainly function via improving bank liquidity, corporate bond market function as an alternative stable financing channel that allow banks to take more risky assets without impairing their liquidity status. Our results for control variables are consistent with the literature (see amongst others, Yeyati and Micco, 2007; Berger et al., 2009; Lee and Hsieh, 2013; Lindquist, 2004; Khan et al, 2017, etc). Large banks size, higher profitability and good economic performance are found to be positively associated with bank risk taking. Meanwhile, banks are found to be prudent and risk-off when they hold higher capital buffer, banking sector is more concentrated, and the macroeconomic risk is heightened.

We also examine how bank size and capital buffer level will influence the role of bond market on bank risk taking. By including an interactive term between bond market development and a large size dummy, we find that while greater bond market still helps banks to reduce asset risk and liquidity risk, it allows large bank to reduce deposit taking as big banks can better tap bond market for financing. Similarly, the interaction between bond market and a high capital buffer dummy suggests that the role of bond market in lowering risks in banks' portfolios and liquidity positions is not affected by the level of capital buffer level, with the exception that well-capitalized banks will take risk by increasing deposit ratio when government bond market is larger. As larger government bond market provides more liquid investment instruments, their

deposit taking will not increase liquidity risk. Overall, we find evidence that bond market development does not discourage banks from taking risks. In the contrary, by offer more liquid assets and stable funding sources, bond market helps large and safer banks to take risk without harming their liquidity position.

In sum, our results support the view that bond market play a complementary role to the banking sector by improving the structure of their portfolios and reducing their liquidity risk exposure. These findings show that government bond market supplies liquidity in bank asset portfolio while corporate bond market serves as a stable funding source in bank liability portfolio. A well-developed bond market will facilitate banks to better function as liquidity creators without necessarily impairing their liquidity creation, especially for bigger banks and well capitalized banks. This study sheds new evidence on how bond market development can contribute to banking stability. Such evidence is helpful to regulators to design financial sector development roadmap and regulatory framework to foster a well-functioned and well-diversified financial sector that better contributes to economic development.

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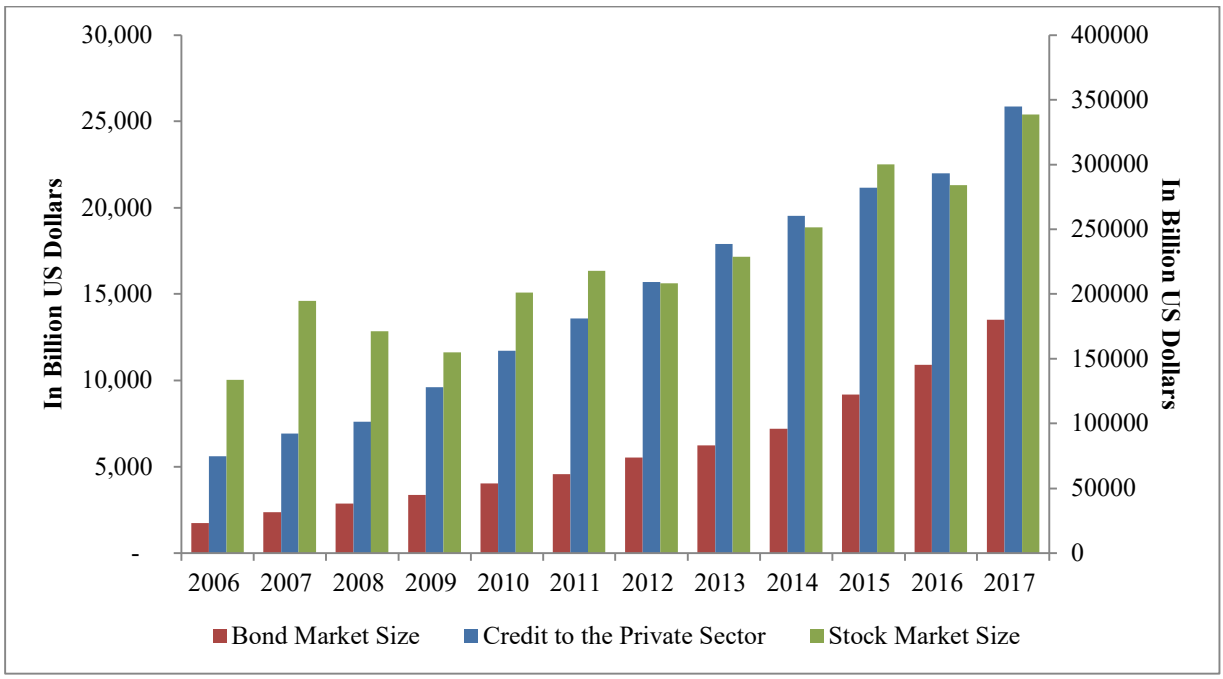
Figure 1. Bond Market Size and Credit to the Private Sector, Emerging Asian Markets
This figure plots total bond market size and credit to the private sector among emerging Asian markets from 2006 to 2017. Due to unavailability of data, the stock and bond market sizes represent data for developing markets across Asia and the Pacific, while credit to the private sector only covers data for 8 emerging Asian markets, namely, People's Republic of China; Hong Kong, China; Indonesia; India, Republic of Korea; Malaysia; Singapore; and Thailand. Over a period of 12 years, credit to the private sector continues to expand as emerging Asia's capital market develops.



Data source:

Figure 2. Bond Market Development in Asean+3 during 2008 to 2018 period

This figure plots local currency bond market size of emerging East Asia against Euro-denominated bond market size for two periods. Over a period of 10 years, the local currency bond market of emerging East Asia has grown to a closer size of that in the Euro-denominated bond market in Europe.

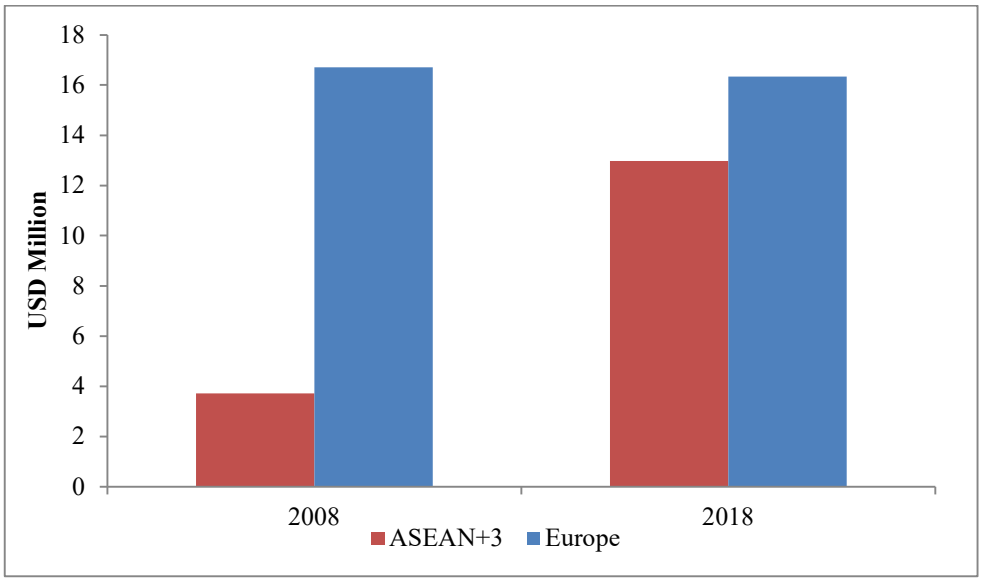


Figure 3. Bond Market Development in Emerging Asian Markets
This figure plots government and corporate bond market sizes of 26 emerging Asian markets from 2006 to 2017. Data is collected from Bloomberg LP.

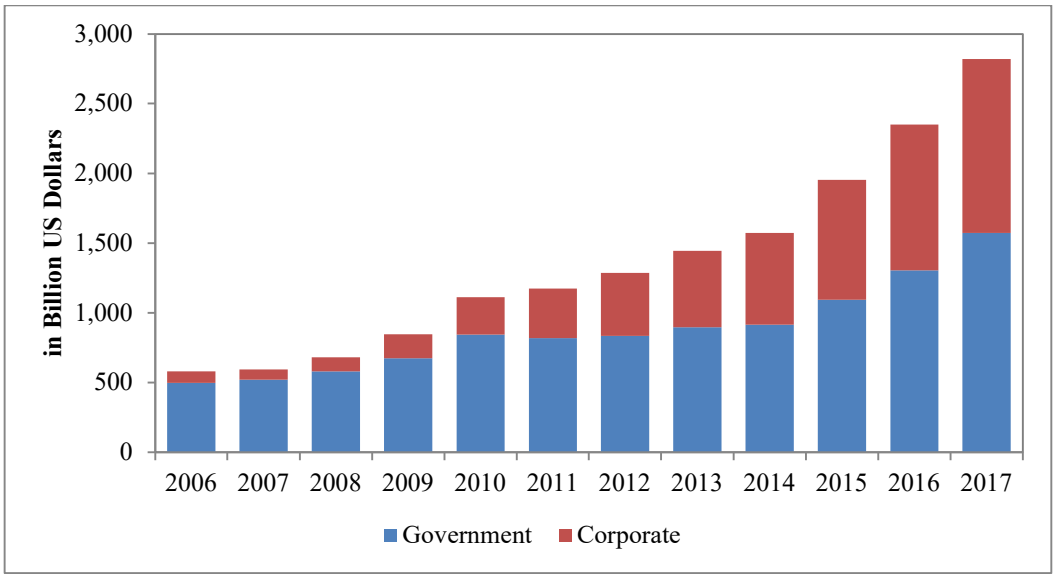


Table 1. Bank distribution across markets

This table lists the distribution of 447 commercial banks covered in the sample across 26 emerging markets worldwide.

Market	Number of Banks	Market	Number of Banks
Argentina	9	Pakistan	5
Bangladesh	5	Panama	6
Brazil	26	Peru	6
Bulgaria	6	Philippines	14
Chile	8	Poland	13
China	85	Romania	8
Colombia	19	Russia	27
Croatia	12	Serbia	3
Hungary	8	Sri Lanka	6
India	39	Thailand	17
Indonesia	31	Turkey	15
Malaysia	22	Ukraine	8
Mexico	46	Vietnam	3

TABLE 2. Bond Market Development in Emerging Markets, 2006-2017

This table presents 12-year average of government, corporate and aggregate bond market sizes of 26 emerging markets. Data is collected from Bloomberg LP data. Numbers are in billion US dollars.

Market	Government	Corporate	Total
Argentina	252.27	27.67	279.94
Bangladesh	17.22	0.30	17.51
Brazil	1,250.35	641.63	1,891.98
Bulgaria	11.46	1.70	13.16
Chile	34.29	72.55	106.83
China	3,363.64	2,508.93	5,872.57
Colombia	99.78	56.14	155.92
Croatia	26.89	3.86	30.75
Hungary	113.46	19.80	133.26
India	1,162.35	344.01	1,506.35
Indonesia	186.12	46.54	232.66
Malaysia	183.50	161.26	344.77
Mexico	523.70	278.82	802.51
Pakistan	63.23	2.46	65.70
Panama	18.69	16.61	35.30
Peru	38.16	33.49	71.65
Philippines	116.28	35.07	151.35
Poland	270.17	23.87	294.05
Romania	57.72	1.97	59.69
Russia	275.78	314.02	589.80
Serbia	15.53	0.38	15.91
Sri Lanka	38.38	3.48	41.86
Thailand	202.46	84.11	286.57
Turkey	295.30	33.50	328.81
Ukraine	45.28	11.06	56.34
Vietnam	46.68	3.29	49.98

Table 3. Descriptive Statistics of sample

This table lists summary statistics of the variables included in our models. The sample covers 447 banks for the period 2006-2017. Winsorization was done for the top 3% of RWA. Extreme values for all other variables were winsorized at 3 standard deviations around the mean.

						Percentile			
	N	**Mean**	**SD**	**Min**	**Max**	**5th**	**10th**	**50th**	**90th**	**95th**
Dependent Variables										
RWA	3,235	0.67	0.16	0.03	1.00	0.41	0.48	0.67	0.87	0.94
DEP	3,292	0.66	0.19	0.00	1.00	0.23	0.43	0.70	0.84	0.86
NSFR	3,293	0.76	0.63	0.00	10.14	0.17	0.26	0.63	1.33	1.57
LCR	3,295	0.15	0.18	-0.94	0.73	-0.19	-0.08	0.19	0.34	0.38
Key Independent Variables										
Bond	3,295	0.57	0.26	0.09	1.37	0.21	0.25	0.56	0.93	1.10
GovB	3,295	0.40	0.17	0.01	0.96	0.12	0.17	0.39	0.61	0.68
CorpB	3,295	0.17	0.14	0.00	0.67	0.01	0.03	0.14	0.37	0.46
Microeconomic Control Variables										
Size	3,295	16.39	1.62	9.28	21.39	13.27	14.31	16.38	18.25	19.09
CSR	3,295	0.13	0.06	-0.22	0.52	0.07	0.08	0.12	0.18	0.22
ROA	3,295	0.01	0.02	-0.74	0.09	-0.01	0.00	0.01	0.02	0.03
NIM	3,295	0.04	0.02	-0.06	0.16	0.01	0.02	0.03	0.06	0.08
Macroeconomic Control variables										
CR3	3,295	0.51	0.14	0.35	1.00	0.36	0.37	0.45	0.72	0.75
GDPG	3,295	0.05	0.03	-0.10	0.14	-0.02	0.01	0.05	0.09	0.10
ICRG	3,295	4.25	0.07	3.98	4.39	4.13	4.16	4.26	4.34	4.36
IR	3,295	0.06	0.06	0.00	1.06	0.01	0.02	0.04	0.10	0.12
FXV	3,295	0.02	0.01	0.00	0.14	0.01	0.01	0.01	0.03	0.04

TABLE 4. Pearson's Pairwise Correlation Coefficients

This table presents the Pearson's correlation coefficients for each pair of variables. A total of 2,518 observations from 350 banks covering the period 2005-2017 were used in the calculations.

Variables	RWA	DEP	NSFR	LCR	Bond	GovB	CorpB	Size	CSR	ROA	NIM	CR3	GDPG	ICRG	IR	FXV
RWA	1.000															
DEP	-0.087	1.000														
NSFR	-0.229	-0.276	1.000													
LCR	0.341	0.526	-0.398	1.000												
Bond	-0.186	-0.135	0.002	-0.172	1.000											
GovB	-0.210	-0.081	-0.045	-0.087	0.873	1.000										
CorpB	-0.090	-0.153	0.058	-0.215	0.802	0.409	1.000									
Size	-0.033	-0.042	0.188	0.029	0.222	0.142	0.243	1.000								
CSR	-0.086	-0.207	-0.041	-0.218	-0.077	-0.043	-0.092	-0.355	1.000							
ROA	0.084	-0.032	0.011	0.015	-0.055	-0.068	-0.020	0.105	0.210	1.000						
NIM	0.330	-0.059	-0.198	0.230	-0.196	-0.167	-0.162	-0.168	0.248	0.246	1.000					
CR3	0.141	-0.003	-0.035	0.181	-0.329	-0.226	-0.339	-0.261	0.048	-0.085	0.125	1.000				
GDPG	-0.153	0.278	0.111	0.007	-0.115	-0.108	-0.083	0.268	-0.198	0.078	-0.171	-0.420	1.000			
ICRG	-0.178	0.058	0.106	-0.145	0.284	0.147	0.352	0.251	-0.121	0.046	-0.229	-0.313	0.417	1.000		
IR	0.107	-0.096	-0.030	0.052	-0.055	0.030	-0.139	-0.129	0.052	-0.104	0.135	0.259	-0.359	-0.536	1.000	
FXV	0.135	-0.201	-0.041	-0.041	0.001	-0.013	0.017	-0.111	0.058	-0.081	0.168	0.153	-0.430	-0.375	0.664	1.000

TABLE 5: Fixed Effects Regression: Aggregate Bond Market Impact on Bank Risk

This table reports parameter estimates of the fixed effects regressions of the baseline model in panel B and the alternative model for robustness check in panel A. ***, **, * 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.

	Panel A				Panel B			
VARIABLES	(1) RWA	(2) DEP	(3) NSFR	(4) LCR	(5) RWA	(6) DEP	(7) NSFR	(8) LCR
Bond					-0.0758**	-0.0636**	0.806***	-0.0596*
					(-2.45)	(-2.51)	(5.01)	(-1.94)
Size	0.0497***	-0.0825***	0.0851**	-0.0459***	0.0498***	-0.0822***	0.0825**	-0.0457***
	(3.79)	(-6.37)	(2.19)	(-3.33)	(3.84)	(-6.37)	(2.21)	(-3.35)
CSR	-0.442***	-0.155	0.877	-0.481***	-0.432***	-0.147	0.775	-0.473***
	(-3.94)	(-1.40)	(1.54)	(-5.01)	(-3.94)	(-1.33)	(1.39)	(-5.00)
ROA	0.313***	0.147	-0.933***	0.237**	0.295***	0.133	-0.753***	0.224**
	(3.28)	(1.19)	(-4.11)	(2.37)	(3.13)	(1.06)	(-3.66)	(2.22)
NIM	1.240***	-0.0198	-2.844***	1.395***	1.217***	-0.0405	-2.582***	1.376***
	(4.16)	(-0.06)	(-2.89)	(4.12)	(4.15)	(-0.12)	(-2.80)	(4.10)
CR3	-0.214***	-0.0314	-0.136	-0.132**	-0.216***	-0.0334	-0.111	-0.134**
	(-2.62)	(-0.55)	(-0.71)	(-2.07)	(-2.69)	(-0.59)	(-0.60)	(-2.14)
GDPG	0.0981	0.342***	-1.093***	0.345***	0.0697	0.319***	-0.802**	0.323***
	(0.81)	(3.08)	(-3.08)	(3.19)	(0.59)	(2.93)	(-2.45)	(3.09)
ICRG	-0.275***	0.223***	0.180	0.297***	-0.331***	0.175**	0.786*	0.252**
	(-3.08)	(3.11)	(0.41)	(3.07)	(-3.52)	(2.36)	(1.84)	(2.49)
IR	0.0664	0.185***	-0.0298	0.155**	0.0698	0.188***	-0.0684	0.158**
	(1.49)	(3.01)	(-0.29)	(2.44)	(1.57)	(3.07)	(-0.67)	(2.49)
FXV	-0.829***	0.00493	0.901	-0.280	-0.734***	0.0832	-0.0962	-0.206
	(-2.96)	(0.02)	(0.91)	(-0.90)	(-2.67)	(0.41)	(-0.10)	(-0.68)
Constant	1.192***	1.013***	-1.108	-0.378	1.470***	1.247***	-4.069*	-0.159
	(2.67)	(2.79)	(-0.53)	(-0.77)	(3.13)	(3.26)	(-1.92)	(-0.31)
Observations	3,235	3,292	3,293	3,295	3,235	3,292	3,293	3,295
Number of banks	447	447	447	447	447	447	447	447
Adjusted R-squared	0.139	0.200	0.017	0.094	0.143	0.204	0.037	0.096
Time fixed effect	YES	YES	YES	YES	YES	YES	YES	YES

Table 6: Impacts of Government and Corporate Bond Markets on Bank Risks

This table reports parameter estimates of the fixed effects regressions of the baseline model including the individual effects of government and corporate bond markets. ***, **, * 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.

VARIABLES	(1) RWA	(2) DEP	(3) NSFR	(4) LCR
GovB	-0.178***	0.0486	0.693***	0.0534
	(-4.48)	(1.37)	(4.47)	(1.33)
CorpB	0.0911*	-0.246***	0.991***	-0.244***
	(1.80)	(-5.75)	(4.20)	(-5.04)
Size	0.0346**	-0.0662***	0.0663*	-0.0295**
	(2.45)	(-4.62)	(1.75)	(-2.14)
CSR	-0.421***	-0.154	0.782	-0.480***
	(-3.93)	(-1.45)	(1.40)	(-5.02)
ROA	0.299***	0.122	-0.742***	0.213**
	(3.32)	(1.09)	(-3.57)	(2.17)
NIM	1.216***	-0.0415	-2.581***	1.375***
	(4.03)	(-0.12)	(-2.80)	(4.18)
CR3	-0.148**	-0.110*	-0.0339	-0.211***
	(-2.00)	(-1.78)	(-0.18)	(-3.08)
GDPG	0.103	0.280***	-0.762**	0.283***
	(0.89)	(2.62)	(-2.27)	(2.67)
ICRG	-0.219**	0.0529	0.910**	0.129
	(-2.25)	(0.67)	(2.12)	(1.28)
IR	0.118**	0.134**	-0.0135	0.103
	(2.51)	(2.29)	(-0.13)	(1.63)
FXV	-0.774***	0.129	-0.142	-0.161
	(-2.84)	(0.64)	(-0.15)	(-0.54)
Constant	1.188***	1.567***	-4.392**	0.163
	(2.59)	(4.26)	(-2.07)	(0.32)
Observations	3,235	3,292	3,293	3,295
Number of banks	447	447	447	447
Adjusted R-squared	0.156	0.227	0.038	0.111
Time fixed effect	YES	YES	YES	YES

Table 7: Bond Market Impact on Bank Risk across different sizes

This table reports parameter estimates of the fixed effects regressions of models including the interaction of bank size with total bond market in Panel A, and government and corporate bond markets in Panel B. BIG represents a dummy variable denoting the top 25% of banks based on size of total assets, and replacing the continuous variable SIZE, which we include in all our other models. The interaction terms represent effect of bond market on risk taking among big banks. ***, **, * 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.

	Panel A				Panel B			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	RWA	DEP	NSFR	LCR	RWA	DEP	NSFR	LCR
Bond	-0.0831**	-0.0363	0.877***	-0.0531				
	(-2.36)	(-1.13)	(4.40)	(-1.59)				
BIG*Bond	0.0206	-0.0770**	-0.174	-0.0198				
	(0.64)	(-2.38)	(-1.38)	(-0.66)				
GovB					-0.227***	0.111***	0.728***	0.0440
					(-5.14)	(2.93)	(4.34)	(1.08)
BIG*GovB					0.0497	0.00430	-0.322**	0.126***
					(0.93)	(0.10)	(-2.27)	(2.60)
CorpB					0.164***	-0.311***	1.168***	-0.253***
					(3.11)	(-6.93)	(3.58)	(-4.41)
BIG*CorpB					-0.0476	-0.100**	-0.0956	-0.112**
					(-0.96)	(-1.98)	(-0.39)	(-2.09)
BIG	-0.00791	0.0150	0.121	-0.0116	-0.0106	-0.0105	0.164**	-0.0517**
	(-0.34)	(0.67)	(1.52)	(-0.52)	(-0.43)	(-0.49)	(2.05)	(-2.15)
CSR	-0.495***	-0.0166	0.663	-0.405***	-0.450***	-0.0641	0.712	-0.437***
	(-4.80)	(-0.16)	(1.20)	(-4.07)	(-4.44)	(-0.63)	(1.29)	(-4.47)
ROA	0.417***	-0.0961	-0.498***	0.0955	0.371***	-0.0458	-0.552***	0.133
	(3.64)	(-0.68)	(-3.11)	(0.78)	(3.82)	(-0.38)	(-3.37)	(1.22)
NIM	1.084***	0.192	-2.785***	1.501***	1.138***	0.118	-2.701***	1.440***
	(3.35)	(0.49)	(-3.03)	(4.48)	(3.48)	(0.30)	(-2.94)	(4.38)
CR3	-0.281***	0.0444	-0.275	-0.0887	-0.162**	-0.0932	-0.128	-0.190***
	(-3.11)	(0.75)	(-1.28)	(-1.40)	(-2.12)	(-1.50)	(-0.67)	(-2.87)
GDPG	-0.0379	0.497***	-1.007***	0.425***	0.0468	0.380***	-0.872**	0.325***
	(-0.31)	(4.36)	(-2.94)	(3.84)	(0.40)	(3.52)	(-2.52)	(2.95)
ICRG	-0.357***	0.209**	0.739*	0.270***	-0.196**	0.00943	0.961**	0.109
	(-3.71)	(2.47)	(1.72)	(2.65)	(-1.99)	(0.11)	(2.20)	(1.07)
IR	0.0939**	0.151**	-0.0687	0.141**	0.154***	0.0869	-0.00475	0.0997
	(2.03)	(2.53)	(-0.66)	(2.21)	(3.21)	(1.54)	(-0.04)	(1.60)
FXV	-1.176***	0.811***	-0.841	0.193	-1.080***	0.625***	-0.599	-0.00480
	(-4.88)	(3.93)	(-0.86)	(0.72)	(-4.44)	(3.24)	(-0.60)	(-0.02)
Constant	2.413***	-0.266	-2.495	-0.990**	1.644***	0.687*	-3.555*	-0.224
	(5.61)	(-0.73)	(-1.32)	(-2.21)	(3.80)	(1.87)	(-1.84)	(-0.50)
Observations	3,235	3,292	3,293	3,295	3,235	3,292	3,293	3,295
Number of banks	447	447	447	447	447	447	447	447
Adjusted R-squared	0.117	0.113	0.035	0.077	0.146	0.178	0.037	0.109
Time fixed effect	YES	YES	YES	YES	YES	YES	YES	YES

Table 8: Bond Market Impact on Bank Risk across different Capital buffer levels

This table reports parameter estimates of the fixed effects regressions of models including the interaction of capital buffer with total bond market in Panel A, and government and corporate bond markets in Panel B. CAP represents a dummy variable denoting the top 25% of banks with high capital buffer based on the level of their capital sufficiency ratio, and replacing the continuous variable CSR, which we include in all our other models. The interaction terms represent effect of bond market on risk taking among capital-sufficient banks. ***, **, * 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.

	Panel A				Panel B			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	RWA	DEP	NSFR	LCR	RWA	DEP	NSFR	LCR
Bond	-0.0837***	-0.0735***	0.830***	-0.0670**				
	(-2.61)	(-2.81)	(4.81)	(-2.03)				
CAP*Bond	0.0110	0.0258	-0.0216	0.00244				
	(0.54)	(1.51)	(-0.36)	(0.11)				
GovB					-0.196***	0.0218	0.691***	0.0675
					(-4.66)	(0.63)	(4.26)	(1.53)
CAP*GovB					0.0375	0.0631**	0.0634	-0.0514
					(0.85)	(2.12)	(0.64)	(-1.22)
CorpB					0.0927*	-0.237***	1.031***	-0.269***
					(1.78)	(-4.87)	(3.99)	(-5.39)
CAP*CorpB					-0.0186	-0.0360	-0.134	0.0700
					(-0.34)	(-0.83)	(-0.69)	(1.28)
CAP	-0.0253**	-0.00731	0.00956	-0.0213	-0.0295**	-0.0150	-0.00513	-0.0124
	(-2.00)	(-0.70)	(0.28)	(-1.65)	(-2.07)	(-1.45)	(-0.16)	(-0.86)
Size	0.0539***	-0.0771***	0.0647*	-0.0388***	0.0382***	-0.0627***	0.0477	-0.0216
	(4.14)	(-5.13)	(1.66)	(-2.84)	(2.67)	(-3.78)	(1.18)	(-1.59)
ROA	0.128*	0.0673	-0.442**	0.0531	0.135**	0.0567	-0.430**	0.0406
	(1.70)	(0.74)	(-2.17)	(0.61)	(2.23)	(0.69)	(-2.00)	(0.44)
NIM	1.181***	-0.0655	-2.449***	1.321***	1.184***	-0.0616	-2.440***	1.315***
	(4.00)	(-0.19)	(-2.84)	(4.00)	(3.91)	(-0.17)	(-2.84)	(4.05)
CR3	-0.211***	-0.0322	-0.124	-0.125**	-0.142*	-0.106*	-0.0495	-0.204***
	(-2.59)	(-0.57)	(-0.68)	(-1.97)	(-1.90)	(-1.74)	(-0.27)	(-2.89)
GDPG	0.101	0.349***	-0.928**	0.368***	0.141	0.316***	-0.872**	0.315***
	(0.84)	(3.10)	(-2.47)	(3.48)	(1.19)	(2.92)	(-2.32)	(2.92)
ICRG	-0.383***	0.142*	0.935*	0.191*	-0.270**	0.0220	1.048**	0.0688
	(-3.70)	(1.81)	(1.91)	(1.78)	(-2.58)	(0.26)	(2.15)	(0.65)
IR	0.0521	0.177***	-0.0320	0.142**	0.101**	0.124**	0.0179	0.0883
	(1.26)	(3.10)	(-0.33)	(2.49)	(2.29)	(2.30)	(0.17)	(1.52)
FXV	-0.700**	0.137	-0.252	-0.160	-0.734***	0.183	-0.279	-0.127
	(-2.51)	(0.65)	(-0.27)	(-0.53)	(-2.67)	(0.89)	(-0.30)	(-0.43)
Constant	1.587***	1.298***	-4.350*	-0.0496	1.313***	1.633***	-4.608**	0.247
	(3.11)	(3.42)	(-1.96)	(-0.09)	(2.67)	(4.42)	(-2.11)	(0.46)
Observations	3,235	3,292	3,293	3,295	3,235	3,292	3,293	3,295
Number of banks	447	447	447	447	447	447	447	447
Adjusted R-squared	0.123	0.201	0.033	0.071	0.137	0.225	0.034	0.088
Time fixed effect	YES	YES	YES	YES	YES	YES	YES	YES

Appendix 1. Variable Names, Description and Data Sources

Variable	Definition	Data Source
RWA	Ratio of Risk-weighted Assets to Total Assets	SPGMI database
DEP	Ratio of Deposits to Total Assets	SPGMI database
NSFR	Net Stable Funding Ratio	SPGMI database
LCR	Ratio of Liquidity Creation to Total Assets	SPGMI database
Bond	Total Bonds Outstanding as a ratio of GDP	Bloomberg and WDI Online
GovB	Government Bonds as a ratio of GDP	Bloomberg and WDI Online
CorpB	Corporate Bonds Outstanding as a ratio of GDP	Bloomberg and WDI Online
Size	Natural logarithm of Total Assets	SPGMI database
NIM	Net Interest Margin	SPGMI database
ROA	Return on Assets	SPGMI database
CSR	Tier 1 regulatory capital/ RWA	SPGMI database
CR3	Total loans of the 3 largest banks within a market/ total loans of the banking system of a market	SPGMI database
GDPG	Growth rate of Real GDP	WDI Online
ICRG	Natural logarithm of ICRG Composite Market Risk Rating (0 – 100)	PRS Group ICRG
IR	One-year government bond yields	Bloomberg LP
FXV	Standard deviation of monthly real effective exchange rate changes	Bruegel

Notes: SPGMI – S&P Global Market Intelligence; WDI – World Development Indicators; ICRG – International Country Risk Guide

Appendix 2. Stylized bank sheet and weights to calculate the NSFR

This table summarizes the calculation of the NSFR following Vasquez and Federico (2015) where NSFR is defined as the ratio of the weighted sum of various types of liabilities (available stable funding) to the weighted sum of various types of assets (required stable funding). For each item in column 1, corresponding SPGMI item and weight are provided in columns 2 and 3, respectively. Weights reflect the relative stability of balance sheet items. Larger weights are assigned to assets which are less liquid and liabilities that are more stable sources of funding.

Assets (Required stable funding)	**SPGMI Item**	**WI (%)**
1 Total Earnings Assets		
1.A Loans	Total Gross Loans	100
1.A.1 Total Customer Loans	Mortgages, Other Mortgages Loans	
	Other Consumer/Retail Loans	
	Corporate & Commercial Loans, Other loans	
1.A.2 Reserves for Impaired Loans/NPLs		
1.B Other Earning Assets		35
1.B.1 Loans and Advances to Banks	Gross Bank Loans	
1.B.2 Derivatives	Derivative Financial Instruments	
1.B.3 Other Securities	Trading securities, Investment securities, Other Investments	
1.B.4 Remaining earning assets		
2 Fixed Assets	Fixed Assets	100
3 Non-earning Assets		
3.A Cash and due from banks	Cash and Cash Equivalents	0
3.B Goodwill	Goodwill	100
3.C Other Intangibles	Intangible Assets Other than Goodwill	100
3.D Other Assets	Total Other Assets	100
Liabilities (Available stable funding)	**SPGMI Item**	**WI (%)**
1 Deposits & Short-term funding		
1.A Customer Deposits		
1.A.1 Customer Deposits-Current	Transaction Accounts	85
1.A.2 Customer Deposits-Savings	Savings and MMDA	70
1.A.3 Customer Deposits-Term	[Retail Personal + Corporate] Time Deposits	70
1.B Deposits from Banks	Total Deposits from Banks	0
1.C Other Deposits and Short-term Borrowings	Other Deposits	0
2 Other interest-bearing liabilities		
2.A Derivatives	Derivative Liabilities	0
2.B Trading Liabilities	Trading Liabilities	0
2.C Long term funding		100
2.C.1 Total Long-term Funding	Senior Debt, Subordinated Debt, Other Funding	100
2.C.2 Pref. Shares and Hybrid Capital	Hybrid Securities	100
3 Other (Non-Interest bearing)	Other Liabilities	100
4 Loan Loss Reserves	Loan Loss Reserve	100
5 Other Reserves	Other Reserves and Provisions	100
6 Equity	Total Equity	100

Appendix 3. Balance Sheet Items for LC Calculation

This table presents a summary of the balance sheet items and their classification as liquid or illiquid for the calculation of the LC following Berger and Bouwman (2009). Items in column 2 are the corresponding SPGMI items for each item in column 1.

Bank Balance Sheet Items	SPGMI Item
Illiquid assets	
Commercial real estate loans (CRE)	Total Gross Loans
Loans to finance agricultural production	
Commercial and industrial loans (C&I)	
Other loans and lease financing receivables	
Other real estate owned (OREO)	Real Estate Owned and Repossessed Assets
Investment in unconsolidated subsidiaries	Other Investments; Investment in Partnerships
Intangible assets	Goodwill; Intangible Assets other than Goodwill
Premises	Fixed assets
Other assets	Total Other Assets
Liquid assets	
Cash and due from other institutions	Cash and Cash Equivalents
All securities (regardless of maturity)	Total Securities
Trading assets	Total Assets Held for Trading
Fed funds sold	Securities purchased to resell
Liquid liabilities	
Transactions deposits	Transaction Accounts
Savings deposits	Savings & MMDA
Overnight federal funds purchased	Repurchase agreements
Trading liabilities	Liabilities held for trading
Illiquid liabilities	
Subordinated debt	Total Subordinated Debt
Other liabilities	Other Liabilities
Equity	
Total equity	Total Equity