Bank Competition and Financial Stability: Liquidity Risk Perspective

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Abstract

We study whether competition affects banks' liquidity risk-taking, which was at the heart of the 2008 financial crisis. We find that banks with greater market power take more liquidity risk, implying that competition enhances financial stability. This result is robust even after controlling for endogeneity issues. During the crisis, however, the effects of market power on liquidity risk are different across bank size. Small banks with more market power reduce liquidity risk while large banks with higher market power still take greater liquidity risk, suggesting that higher charter values are crucial to small banks' stability during times of market stress.

JEL classification: G21, G28

Keywords: Bank Competition, Liquidity Risk, Financial Stability, Regulation

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1. Introduction

Although the effect of competition on financial stability has long been a subject of interest to both researchers and policy makers, the 2008 global financial crisis reminds us that more research is still needed on this issue. Extensive previous research has focused on the impact of competition on bank risk-taking in the form of credit or default risk. Not much attention has been paid to the role of competition in liquidity risk-taking[1], which played a central role in the development of the unprecedented crisis. A number of banks with higher liquidity risk, which were engaged excessive maturity mismatch while relying heavily on short-term market funding, were failed during the crisis (Acharya and Naqvi 2012; Brunnermeier and Oehmke 2013; Farhi and Tirole 2012; Shin 2009).

This paper attempts to fill this gap in the literature by exploring the following three questions. First, whether competition affects banks' liquidity risk-taking behavior? There are two conflicting hypotheses. On the one hand, competition contributes to lower liquidity risk because banks with greater market power take on more liquidity risk by granting more loans, by attracting more funding, and by reducing liquid reserves (Carletti and Leonello 2014; Petersen and Rajan 1995)[2]. On the other hand, competition leads to higher liquidity risk because competition destroys a bank's charter value and thus compels it to take excessive liquidity risk (e.g., Keeley 1990).

Our next question is that how competition affects bank liquidity risk during the crisis? An understanding of the effect of competition policy during the crisis is essential to both restore financial stability and prevent another crisis. Particularly, during times of market stress, stability issues and market power concerns are acutely conflicting. Basically, banks suffer from reduced charter values during crises. In this situation, more intense competition aggravates the problem, which may lead to higher liquidity risk attributable to banks' risk-shifting (Hakenes and Schnabel 2010; Jensen and Meckling 1976; Keeley 1990; Stiglitz and Weiss 1981). Implicit or explicit guarantees for economic stability enable banks to behave prudently by reducing the risk-shifting incentives[3]. However, those

[1] In this paper, we focus on funding liquidity risk, which is the risk where a bank has difficulty in funding at once in response to creditors' (or borrowers') demands (Allen and Gale 2004; Brunnermeier and Pedersen 2009; Bryant 1980; Diamond and Dybvig 1983; Diamond and Rajan 2001).

[2] Banks should raise funds in order to lend. During the decade prior to the recent crisis, banks rapidly increase short-term wholesale funding (rather than core deposits) to lend, which in turn results in the credit boom (Cornett, McNutt, Strahan, and Tehranian, 2011; Dagher and Kazimov 2015; Hahm, Shin, and Shin 2013; Ivashina and Scharfstein 2010).

[3] Numerous countries provided extensive bail-out programs during the crisis to stabilize the economy. Norther Rock was nationalized by the British government in 2008. UBS (Switzerland), Citibank (US), and Fortis (Belgium, Luxembourg, Netherlands) were also bailed out during the crisis.

public guarantees pose another problem. Bank rescue packages distort competition and disturb level playing field in the banking system as guaranteed banks are able to have lower cost of funding (Akins, Li, Ng and Rusticus 2015; Beck, Coyle, Dewatripont, Freixas and Seabright 2010; Gropp, Hakenes and Schnabel 2010). Protected banks—often Too-big-to-fail (TBTF) banks—may attempt to increase lending by relying on their funding advantage. Therefore, protected banks are expected to take higher liquidity risk by expanding their balance sheets.

Our last question is that how the effect of competition on liquidity risk varies across bank size during the crisis. Large banks are more likely to be publicly guaranteed (O'hara and Shaw 1990; Boyd and Gertler 1994; Vives 2011). Therefore, during the crisis, greater market power for large and small banks may produce different results in their liquidity risk-taking behavior. While large banks with greater market power have an incentive to take more liquidity risk due to moral hazard, small banks with greater market power reduce liquidity risk exposure in order to protect their increased charter value. To put it differently, more intense competition may force small banks, which already suffer from reduced charter value due to the sluggish economy, to take more liquidity risk by encouraging risk-shifting incentives.

The recent crisis emphasized liquidity risks which stem from the drawdown of committed credit lines and from the withdrawal of short-term market funding. After the failure of Lehman Brothers in 2008, banks experienced runs by both short-term wholesale financiers and borrowers who drew down their existing lines of credit (Cornett, McNutt, Strahan and Tehranian 2011; Ivashina and Scharfstein 2010). Traditionally, bank liquidity risk considered to be come from a bank's role as a liquidity creator in relation to demand deposits (e.g., Diamond and Dybvig 1983). In recent years, however, liquidity risk from demand deposits is not severe because deposits, protected from deposit insurance in most countries, rather flow into banks to search for safe havens during crises (Acharya and Mora 2015; Gatev, Schuermann and Strahan 2009; Gatev and Strahan 2006). Therefore, we focus on liquidity risks in the form of undrawn credit lines, short-term wholesale funding, liquidity creation, and liquid asset holdings.

Constructing a panel dataset for 10,561 banks in 25 OECD countries from 2000 to 2010, we find that market power is positively associated with liquidity risk, suggesting that competition is beneficial to financial stability. Specifically, banks with more market power increase exposure to credit lines and to wholesale funding, reduce liquid reserves, and create more liquidity. These results are robust even after controlling for endogeneity concerns, across various definitions for liquidity risk, and across

different economic specifications such as Tobit analysis. During the crisis, however, the effects of bank market power on the liquidity risk-taking behavior are different for large and small banks; while the positive effects for large banks remain unchanged, those for small banks weaken during the crisis. In other words, competition leads to financial stability for large banks, but in contrast, leads to financial fragility for small banks during times of financial turbulence. These results imply that enhanced market power during the crisis encourages small banks to behave prudently in order to protect their charter values, whereas it helps large banks subject to moral hazard.

We address potential endogeneity problems because market power and liquidity risk may be jointly determined. For example, a bank taking higher liquidity risk—through granting more loans and credit lines and through attracting more short-term funding—can gain more market power. To address the endogeneity, we perform regressions using the one-year lagged variables of market power. We also perform instrumental variables (IV) regressions using a generalized method of moments (GMM) estimator. We employ entry barriers and control of corruption as instrumental variables of market power.

The remainder of the paper proceeds as follows. Section 2 reviews the literature and develops our hypotheses. Section 3 describes methods of constructing measures for liquidity risks and market power. Section 4 explains the data and empirical strategies. Section 5 presents the empirical results. Section 6 provides robustness checks. Section 7 concludes the paper.

2. Literature Review

What is liquidity risk in banking? Liquidity risk for a bank is the risk where a bank is unable to meet its obligations in a timely manner when depositors attempt to withdraw funds. This liquidity risk stems from the asset transformation function of banks (e.g., Diamond and Dybvig 1983). Banks provide liquidity to depositors by transforming illiquid bank assets into liquid demand deposits[4]. However, this fundamental role of banks makes them vulnerable to runs by depositors. Therefore, banks hold liquid assets in order to manage their liquidity risk. While earlier studies mainly focus on liquidity risk from demand deposits, later studies pay attention to liquidity risk from undrawn credit lines (Holmström and Tirole 1998; Kashyap, Rajan, and Stein 2002). A line of credit gives a borrower an option to draw down funds at any time during the period of the contract. That is, both demand

[4] Depositors do not have to hold illiquid assets directly because banks offer more liquid demand deposits and invest in illiquid bank assets (Diamond 2007).

deposits and credit lines make banks fragile because they require the banks to pay funds to depositors and borrowers on demand. However, recent studies show that demand deposits are no longer a source of liquidity risk due to government guarantees. Gatev and Strahan (2006) and Gatev, Schuermann, and Strahan (2009) provide evidence that deposits flow into banks during times of tight market liquidity, which helps banks hedge liquidity risk from the drawdown of credit lines. Instead, the recent financial crisis shed light on the importance of managing liquidity risk from credit-line drawdowns and short-term funding withdrawals. Ivashina and Scharfstein (2010) and Cornett, McNutt, Strahan and Tehranian (2011) report that, after the bankruptcy of Lehman Brothers, there were runs by both borrowers and short-term creditors while deposits flew into banks.

Competition particularly matters in the banking sector because banks are inherently exposed to the risk of instability and systemic financial crises (Claessens and Laeven 2004; Vives 2011). Like other industries, competition enhances efficiency, innovation, and the quality of products. However, more importantly for the banking sector, the degree of competition is closely related to banks' risk-taking behavior, which affects stability of the economy. Because of the importance of competition policy, there has been rich research studying the relationship between competition and financial stability. But previous studies provide mixed findings about the relationship. Some studies argue that higher competition leads to financial fragility (e.g., Keeley 1990), while others show that enhanced competition contributes to stability (e.g., Boyd and Nicoló 2005).

The "competition-fragility" view is based on the idea that more intense competition erodes bank charter values, and thus decreases their incentives to behave prudently (Hellmann, Murdock and Stiglitz 2000; Keeley 1990; Marcus 1984; Matutes and Vives 1996). According to the charter value hypothesis, banks restrain their risk-taking to protect monopoly rents from bank charters. The decrease in charter value leads banks to take excessive risk, reducing penalty for bank failure. Keeley (1990) finds that increased competition attributable to deregulation in the 1980s reduce bank capital buffers and increase the probability of default. Repullo (2004) shows that greater market power reduces banks' gambling incentives and suggests that risk-based capital requirements are effective to control banks' risk-taking. Using data on 69 countries from 1980 to 1997, Beck, Demirgüç-Kunt, and Levine (2006) find that banking crises are less likely to occur in economies with more concentrated banking systems.

This "competition-stability" view, however, challenged the conventional view. Boyd and Nicoló (2005) show that more market power results in higher loan rates, which lead borrowers to choose more risky investments (Stiglitz and Weiss 1981). Consequently, this leads to higher risk of bank

failures. Boyd, Nicoló, and Jalal (2007) and Nicolò and Loukoianova (2007) provide empirical evidence that banks are more likely to take greater risk in less a competitive banking system. Carletti and Leonello (2014) argue that competition enhances stability in terms of bank liquidity risk. Greater market power increase opportunity costs of holding liquid assets because loans become more profitable, which lead banks to take more liquidity risk.

Recently, Martinez-Miera and Repullo (2010) show that there is a u-shaped relationship between competition and default risk. As competition increases, bank default risk firstly declines because lower interest rates encourage borrowers to behave prudently, but later it increases beyond a certain point because the lower interest rates erode bank margins from loans. Their findings are confirmed in empirical studies by Berger, Klapper, and Turk-Ariss (2009) using data for banks in 23 developed countries from 1999 to 2005 and Jiménez, Lopez, and Saurina (2013) using Spanish bank data over the period 1988-2003.

Whether is competition desirable or detrimental to stability during crises? In times of financial turmoil, the trade-off between market power concerns and stability considerations become particularly acute. Some argue that competition policy should not be suppressed because a crisis has a positive impact on the economy through its disciplinary role, while others argue that protecting the system by avoiding contagion of financial distress dominates competition concerns (Carletti 2008; Vives 2011). During a crisis, competition itself could be burdensome for banks, which are already in a tough condition, because competition destroys monopoly rents. Governments provide various guarantee programs in order to prevent negative economy-wide externalities and to stabilize the economy.

However, stability through government guarantees comes at a cost. Those programs impede fair competition and disturb level playing field in the banking system as publicly guaranteed banks are able to have lower cost of capital (Akins, Li, Ng and Rusticus 2015; Beck, Coyle, Dewatripont, Freixas and Seabright 2010). In this situation, large banks are more likely to be protected because they are more systemically important than small banks (Boyd and Gertler 1994; O'hara and Shaw 1990). Using a panel dataset for US commercial banks from 2006 to 2012, Kim and Joh (2015) find that most of failed banks are small banks while none of TBTF banks failed during the recent financial crisis. Therefore, the effect of competition on financial stability may vary across bank size. Protected banks attempt to take advantage of their monopoly rents from government guarantees (Gropp, Hakenes, and Schnabel 2010). In the presence of this kind of moral hazard, competition is expected to be beneficial to stability of large banks by mitigating the moral hazard problem. In contrast, small

banks, which are less likely to be publicly guaranteed, are subject to the risk-shifting problem due to lower charter values during times of turbulence. In this situation, more competitive pressure deteriorates small banks' charter values more significantly. Therefore, competition is expected to be harmful for stability of small banks during crises.

3. Measurements of Liquidity Risks and Market Power

3.1 Liquidity Risk Measures

As mentioned above, we employ four liquidity risk measures: exposure to committed credit lines, wholesale funding, liquidity creation, and the amount of liquid asset holdings. First, liquidity risk from undrawn credit lines is calculated as undrawn credit lines as a fraction of total assets plus committed credit lines, following Cornett, McNutt, Strahan and Tehranian (2011). Second, liquidity risk from the exposure to wholesale funding is defined as the ratio of wholesale funds to total assets. Third, liquidity risk from liquidity creation is calculated as the Berger and Bouwman (2009)'s liquidity creation measure divided by total assets. Berger and Bouwman (2009) suggest that both on- and off-balance sheet activities should be considered to precisely measure the degree of liquidity creation. We construct their preferred "cat fat" liquidity creation measure by classifying all balance sheet activities as illiquid, semi-liquid, and liquid, and then by assigning weights to each activity in the category. Finally, liquidity risk from the magnitude of liquid reserves is calculated as the ratio of liquid asset holdings to total assets. The estimated coefficients of liquid asset holdings are expected to have opposite signs of other liquidity risk measures because the more liquid assets a bank holds, the lower liquidity risk the bank has.

3.2 Market Power Measure: Lerner Index

The Lerner index, which is a measure of market power, captures a bank's pricing power of charging price above its marginal cost. It has the following advantages as a proxy of market power. First, the Lerner index is a more direct proxy to measure bank market power compared to concentration measures. Claessens and Laeven (2004) and Beck, Demirgüç-Kunt and Levine (2006) find no evidence that competition is negatively associated with concentration in the banking system. Second, the Lerner index allows us to calculate the degree of market power for each bank-year observation although concentration measures, such as the Herfindahl-Hirschman index (HHI) and the three-firm concentration ratio (CR3), are calculated just as in the country-year level. Finally, the Lerner index is more likely to conform the notion of the charter value hypothesis and to consider the fact that banks often compete across national borders.

Following Berger, Klapper, and Turk-Ariss (2009), we construct the Lerner index as follows:

$$Lerner_{it} = \frac{p_{it} - MC_{it}}{p_{it}} \quad (1)$$

Where $Lerner_{it}$ denotes the Lerner index for bank *i* in year *t*. p_{it} indicates the output price, which is calculated as total revenues divided by total assets. Total revenues include both interest income and non-interest income in that a bank's revenues come from both activities. MC_{it} is the marginal cost at the current output level, derived from the following translog cost function.

$$ln\,TOC_{it} = \alpha_0 + \gamma_1 lnTA_{it} + \frac{\gamma_2}{2} lnTA_{it}^2 + \sum_{k=1}^{3} \delta_k ln\omega_{kit} + \sum_{k=1}^{3} \beta_k lnTA_{it} ln\omega_{kit} + \sum_{k=1}^{3}\sum_{j=1}^{3} \varphi_{jk} ln\omega_{kit} ln\omega_{jit} + \varepsilon_{it} \quad (2)$$

The marginal cost is defined as:

$$MC_{it} = \frac{\partial TOC_{it}}{\partial TA_{it}} = \frac{TOC_{it}}{TA_{it}} \left[\hat{\gamma}_1 + \hat{\gamma}_2 lnTA_{it} + \sum_{k=1}^{3} \hat{\beta}_k ln\omega_{kit}\right] \quad (3)$$

Where TOC_{it} indicates total operating costs, TA_{it} total assets, which is a proxy for a bank's output, ω_{kit} input factors, which includes labor, borrowed funds, and fixed capital. Time dummies are included to control for changes in technological and macroeconomic environments. All standard errors are robust to heteroskedasticity and clustered by country to account for serial correlation.

4. Data and Methodology

4.1 Data

We construct a panel dataset for commercial banks in OECD countries from 2000 to 2010. The bank-level financial information is obtained from the Bankscope database. The information on merger and acquisition activities is collected from Thomson's SDC platinum database. The data on GDP per capita, GDP growth rates, and real interest rates are from the World Development Indicators (WDI). M2 is retrieved from the International Monetary Fund's International Financial Statistics (IMF IFS). For our instrumental variables, information on entry barriers and control of corruption is collected from the databases provided by Barth, Caprio, and Levine (2001, Updated in 2003 and 2008), and the Worldwide Governance Indicators (WGI) developed by Kaufmann, Kraay, and Mastruzzi (2011), respectively.

We apply multiple selection criteria. First, banks with missing data on dependent, explanatory, and instrumental variables are deleted from the sample. Second, banks with zero total assets, loans, deposits, and equity are removed. Third, countries with fewer than five banks are excluded from the sample[5]. Finally, the bank-level financial statement variables are winsorized at the 1st and 99th percentiles to control for the impact of outliers. The final sample consists of 89,417 bank-year observations for 10,561 banks from 25 OECD countries, spanning between 2000 and 2010.

4.2 Empirical Methodology

In this paper, we employ three econometric methodologies: the fixed effects model as our main empirical strategy[6], the IV analysis in order to mitigate the endogeneity concerns, and the panel Tobit regressions to control for left censored observations of some dependent variables.

Our main empirical methodology is the following fixed effects model:

$$Liquidity\ Risk_{ijt} = \beta_0 + \beta_1 Market\ Power_{ijt-1} + \beta_2 Bank_{ijt-1} + \beta_3 Country_{jt-1} + \theta_i + \tau_t + \varepsilon_{ijt} \quad (4)$$

Where $Liquidity\ Risk_{ijt}$ denotes liquidity risk for bank i from country j in year t, $Market\ Power_{ijt-1}$ the degree of market power, $Bank_{ijt-1}$ bank-specific characteristics, $Country_{jt-1}$ country-specific characteristics, and ε_{ijt} the error-term. All explanatory variables are one year lagged values to mitigate the impact of the potential endogeneity between dependent variables and control variables. All regressions include bank fixed effects (θ_i) to capture time-independent differences across banks as well as time fixed effects (τ_t) to control for changes in the macroeconomic and business environment common to all banks in our sample. Standard errors are robust and clustered at the country level.

Specifically, $Liquidity\ Risk_{ijt}$ includes liquidity risks from credit lines (*Credit Lines*), short-term wholesale funds (*Short-term Wholesale Funds*), liquid asset holdings (*Liquid Assets*), and liquidity creation (*Liquidity Creation*). The Lerner index is employed as a proxy of market power

[5] Eight countries—Austria, Chile, Estonia, Finland, Greece, Iceland, Ireland, and New Zealand— are removed from the initial sample.

[6] We employ the fixed effects model instead of the random effects model because the Hausman test for endogeneity rejects the null hypothesis that unobserved individual effects are uncorrelated with other regressors in the model.

($Market\ Power_{ijt-1}$).

The bank-specific factors include bank size (*Assets*), bank credit risk (*Nonperforming Loans Ratios*), equity ratio (*Equity Ratios*), and mergers and acquisitions history (*M&A Activity*). Bank size, which is calculated as the natural logarithm of total assets, is included to capture differences in risk management capabilities (Demsetz and Strahan 1997; Elsas, Hackethal, and Holzhäuser 2010) and the possibility of public bailouts (i.e., too-big-to-fail policy) between large and small banks. The squared bank size term ($Assets^2$) is also included to capture nonlinearity in the effect of banks size on liquidity risk-taking. Bank credit risk is measured by non-performing loans as a fraction of total loans. Non-performing loans may be negatively associated with liquidity risk because a bank with a high non-performing loans ratio is subject to suffering from the lack of lending capacity or holding more liquid assets to improve its risk management. The equity ratio is defined as the ratio of total equity to total assets. The relationship between bank equity capital and liquidity risk is ambiguous. On the one hand, more capital leads to higher liquidity risk because it improves a bank's risk-bearing capacity (Bhattacharya and Thakor 1993). On the other hand, more bank capital results in lower liquidity risk because the less fragile capital structure discourages the bank to create more liquidity by encouraging the bank to expropriate rents from its customers (Diamond and Rajan 2001). M&A activity is a dummy variable which equals one if a bank engages in one or more M&A activities during the previous three years. It is added to account for the impact of M&A events on corporate strategies for liquidity management (Carletti, Hartmann, and Spagnolo 2007).

The country-specific factors include the GDP per capita (*GDP per Capita*), the GDP growth rate (*GDP Growth Rates*), the money supply (*M2 to GDP*), and real interest rates (*Real Interest Rates*). The GDP per capita and the GDP growth rate are introduced to control for the impact of economic development and of the business cycle, respectively. The money supply is included to capture the impact of the degree of aggregate liquidity in a country. The real interest rate, which is the lending interest rate adjusted for inflation, is included because it affects banks' lending decisions (Ongena and Peydró 2011).

To address the endogeneity problem, we perform GMM estimations because GMM is more efficient than two-stage least squares (2SLS) if there is heterogeneity of unknown form. For the IV approach using a GMM estimator, we employ entry restrictions (*Entry Barriers*) and the control of corruption index (*Control of Corruption*) as instrumental variables. The restriction on entry into banking is a composite index that takes values between 1 and 8, with higher values indicating greater entry

restrictions arising from legal requirements for obtaining a banking license. The control of corruption index captures the perceived levels of corruption in a country, which has values from -2.5 (weak) to 2.5 (strong). Higher values indicate less corruption. In order to include bank fixed effects in the GMM regression, we choose instruments which have sufficient variations.

In addition, we conduct the Tobit estimations for *Credit Lines*, *Short-term Wholesale Funds*, and *Liquid Assets* because those three dependent variables are left censored at zero. We run panel Tobit regressions with random effects and report the estimated marginal effects. For dummy variables, the marginal effects are calculated as the discrete change in the expected value of the dependent variable as the dummy variable changes from 0 to 1. The ρ-statistic evaluates whether the panel Tobit estimation is required. When ρ is close to zero, the panel Tobit analysis is not significantly different from the standard Tobit analysis.

Table 1 shows definitions and data sources of dependent, explanatory, and instrumental variables.

[Insert Table 1 around here]

Table 2 shows summary statistics for main variables we use in the empirical analyses. Among our four dependent variables, some of observations on liquidity risks from undrawn credit lines and short-term wholesale funds have zero values. *Credit Lines* has 5,443 zero-value observations. *Short-term Wholesale Funds* has 31,148 zero-value observations. Large or sound banks are more likely to attract wholesale funds in the capital market (Park and Pennacchi 2009). Therefore, there exist a number of banks without short-term market funding. In Table 8, we attempt to mitigate estimation problems arising from these zero-value observations as follows. First, we re-estimate regressions after dropping zero observations of *Credit Lines* and *Short-term Wholesale Funds*. Second, in the case of short-term wholesale funds, we re-estimate regressions using deposits instead of wholesale funds because there is a substitute relationship between wholesale funds and deposits (Craig and Dinger 2013; Huang and Ratnovski 2011). Deposits have no zero-value observations. We dropped those banks in our sample because they do not seem to operate in reality. In addition, three dependent variables except for *Liquidity Creation* are left censored at zero. Therefore, we conduct Tobit regressions for *Credit Lines*, *Short-term Wholesale Funds*, and *Liquid Assets*. According to Berger and Bouwman (2009), banks with negative liquidity creation may exist to perform banks' other crucial roles such as risk transformation.

[Insert Table 2 around here]

5. Empirical Results

5.1 The effect of Market Power on Liquidity Risk

Table 3 reports the results of the fixed effects regressions on the relationship between market power and liquidity risk (equation (4)). Dependent variables are liquidity risks stem from committed credit lines, short-term wholesale funding, liquid reserves, and liquidity creation. The second models of each dependent variable (Models (2), (4), (6), (8)) incorporate *Real Interest Rates* into baseline models (Models (1), (3), (5), (7)).

[Insert Table 3 around here]

In Model (1), we find that market power (*Lerner*) is positively associated with liquidity risk from credit lines (*Credit Lines*). This result suggests that enhanced competition helps a bank reduce the exposure to liquidity risk, consistent with Boyd and Nicoló (2005) and Carletti and Leonello (2014). The coefficient of *Nonperforming Loans Ratios* is negative (-0.3103) and statistically significant at the 1% level, implying that banks with high credit risks take less liquidity risk. *Equity Ratios* and *M&A Activity* are positively related to *Credit Lines*. All of these relations still hold in Model (2). Furthermore, the statistical significance becomes more stronger for some variables of Model (2). *Real Interest Rates* is negatively and significantly related to *Credit Lines*.

The remaining models confirm the results of Models (1) and (2) using other liquidity risk measures (*Short-term Wholesale Funds*, *Liquid Assets*, and *Liquidity Creation*) as dependent variables. The results show that our findings are pretty robust across various liquidity risk measures. In Models (3) and (4) for *Short-term Wholesale Funds*, the coefficients of *Lerner* are 0.0050 and 0.0055, respectively. These coefficients are all statistically significant at the 1% levels. These results imply that banks with greater market power take more liquidity risk in the form of relying more on short-term wholesale funding. Models (5) and (6) employ liquid asset holdings as a dependent variable. The estimated coefficients of *Liquid Assets* are expected to have opposite signs of other liquidity risk measures because more liquid reserves mean lower liquidity risk. Our results still strongly hold to liquidity risk from the degree of liquid reserves. The coefficents of *Lerner* is negative (-0.0461 and -0.0516) and statistically significant at the 1% levels, suggesting that banks hold fewer liquid assets as they have greater market power. Models (7) and (8) for *Liquidity Creation* provide the same results

with previous tests. *Lerner* are positively and significantly associated with *Liquidity Creation*, implying that banks with higher market power create more liquidity, leaving them vulnerable to liquidity risk.

5. The Impact of the 2008 global Financial Crisis

In Table 4, we test whether the positive effect of market power on liquidity risk change during the financial crisis of 2008. To accomplish this, we add an interaction term (*Lerner*Crisis*) between *Lerner* and *Crisis*. *Crisis* is a dummy variable that equals one if the year is 2008 or 2009. *Lerner*Crisis* provides mixed findings. That is, the effect of market power on liquidity risk during the crisis is different depending on liquidity risk measures. Specifically, the positive relationship between market power and liquidity risk from committed credit lines is intensified during the crisis (Models (1) and (2)); the coefficients of *Lerner*Crisis* are positive (0.0128 and 0.0126) and statistically significant at the 1% levels. In contrast to Models (1) and (2), Models (5)-(8) for *Liquid Assets* and *Liquidity Creation* provide evidence that the positive relationship between market power and liquidity risk weakens during the crisis; *Lerner*Crisis* is positively (0.0097 and 0.0125) related to *Liquid Assets* and negatively (-0.0217 and -0.0247) associated with *Liquidity Creation*. These results suggest that banks with greater market power decrease liquidity risk-taking by holding more liquid assets and by reducing liquidity creation during the crisis. Models (3) and (4) show no significant relationship between *Lerner*Crisis* and *Short-term Wholesale Funds*, implying that there is no significant changes in liquidity risk-taking behavior in the form of short-term market funding during the crisis.

[Insert Table 4 around here]

What is the reason of these conflicting findings? How do we reconcile them? To address this issue, we focus on bank size. To be specific, we focus on the difference in the possibility of being publicly guaranteed depending on bank size. As is well-known, large banks are more likely to be bailed out. Therefore, they have a less incentive to behave prudently than small banks even during the severe financial crisis. Table 5 reports regression estimates of market power on liquidity risk dividing banks into tercile groups based on asset size: large, medium, and small banks. Panels A and B shows regression results for large and small banks, respectively. In Panel A, the coefficient of *Lerner*Crisis* in Models (1) is positive and statistically significant at the 1% level while those in Models (2)-(4) are insignificant. These results suggest that, for large banks, market power worsens banks' liquidity risk-taking behavior in the form of credit lines and does not affect other forms of liquidity risk during the crisis. This may be attributed to moral hazard of large banks, taking advantage of public guarantees.

On balance, large banks with greater market power take more liquidity risk regardless of macroeconomic conditions. In Panel B, however, small banks seem to pursue safer strategies to keep their charter values in case of their failures by holding more liquid reserves and by reducing the degree of liquidity creation during the crisis. Model (3) in Panel B, *Lerner*Crisis* is positively and significantly related to *Liquid Assets* while *Lerner* is negatively and significantly related to *Liquid Assets*. These results imply that, for small banks, the negative effect of market power of holding liquid assets weakens during the crisis. Consistent with the result of Model (3) in Panel B, Model (4) shows that the positive effect of market power on the degree of liquidity creation reduces during the crisis. The coefficient of *Liquidity Creation* is negative (-0.0231) and statistically significant at the 10% level.

[Insert Table 5 around here]

6. Robustness checks

6.1 IV Analysis: GMM estimations

We confirm our findings using IV regressions in Table 6. The second column shows the first-stage results for our GMM estimations. The dependent variable of the first-stage regressions is the Lerner index. The last four columns provide the second-stage regression results for our liquidity risk measures. We employ the level of entry restrictions and the control of corruption in a country as instrumental variables. To be valid, the instrumental variables should satisfy two conditions. First, they have to be exogenous to liquidity risk-taking during the sample period. Second, they have to be correlated with the level of market power. In order to bank fixed effect in the estimations, we choose instruments which have sufficient variation. We present specification tests regarding the relevance and the validity of the instrumental variables. The first-stage F-statistic and the Hansen's J-statistic test for whether given instruments are weak and valid, respectively. The F-statistic and J-statistic in Table 6 confirm that our instruments are appropriate.

[Insert Table 6 around here]

Our first instrumental variable is entry restrictions into the banking industry. Tighter entry restrictions help banks from exploiting market power (Cetorelli and Strahan 2006; Claessens and Laeven 2004). Consistent with the notion, *Entry Barriers* are positively and significantly related to *Lerner*, as shown in the second column of the first-stage results. Our second instrument is the control of corruption index, which measures the degree to which public power is exercised for private gain. Corruption

hinders transparency and effective competition. In fact, *Control of Corruption* is positively (0.0627) and significantly associated with *Lerner*.

The second-stage regressions confirm our prior findings on the positive impact of market power on bank liquidity risk. *Lerner* is positively and significantly related to *Credit Lines*, *Wholesale Funds*, and *Liquidity Creation*. In the case of *Liquid Assets*, there is no significant result on the relation between *Lerner* and *Liquid Assets*.

6.2 Zero-value Observations of Dependent Variables

Table 7 shows regression results for liquidity risk from credit lines (*Credit Lines*) and short-term wholesale funds (*Short-term Wholesale Funds*) considering the impact of zero-value observations. Panel A provides regression results for liquidity risk to the exposure from credit lines after dropping zero-value observations in the sample. Panel B reports results for liquidity risk form short-term market funding. Panel B1 shows regression results for liquidity risk from the reliance on short-term wholesale funds after removing zero-value observations in the sample. Panel B2 reports results for liquidity risk from deposits because there is a substitute relationship between wholesale funds and deposits (Craig and Dinger 2013; Huang and Ratnovski 2011). As described above, deposits are safe with deposit insurance in recent years. If a bank has more deposits, it experiences deposit inflows during times of financial turbulence. This means that more deposits indicate lower liquidity risk during the crisis. Therefore, the estimated coefficients for deposits are expected to have opposite signs of those for wholesale funding.

[Insert Table 7 around here]

We again find the positive relationship between market power and liquidity risk-taking. In Panel A, the coefficients of *Lerner* are positive and statistically significant at the 1% levels. Likewise, *Lerner* is positively associated with *Short-term Wholesale Funds* in Panel B1 while *Lerner* is negatively associated with *Deposits* in Panel B2. Both results are statistically significant at the 10% and 1% levels, respectively.

6.3 Tobit Analysis

Table 8 reports the results of Tobit regressions of market power on liquidity risk from undrawn credit lines, short-term wholesale funds, and liquid reserves. The Tobit estimations also confirm the positive relationship between market power and liquidity risk. In Panel A for liquidity risk from committed credit lines, the coefficients of *Lerner* are positive and statistically significant at the 1% levels, which suggest that banks with greater market power take more liquidity risk by increasing committed credit lines. Panel B provides the results for short-term wholesale funds. As in Table 7, we use both short-term wholesale funds (Panel B1) and deposits (Panel B2) as sources of liquidity risks due to their substitute relationship. Market power is positively correlated with liquidity risk from short-term wholesale funds while it is negatively related to liquidity risk from deposits. Panel C also provides consistent results with our previous findings. The coefficients of *Lerner* are negative and statistically significant, implying that banks with greater market power take more liquidity risk by reducing liquid asset holdings.

[Insert Table 8 around here]

7. Conclusion

There is a rich body of research on the relationship between bank competition and stability from the perspective of credit risk. However, there are only few researches studying it from the perspective of liquidity risk. The recent liquidity crisis highlights the need of managing liquidity risk. Does competition policy affect banks' liquidity risk-taking behavior? Does the impact of competition on liquidity risk change during the crisis? Is there a difference between large and small banks in changing their incentives to taking liquidity risk depending on the degree of competition when the economy tightens? We seek to the answers about those three questions and contribute to the literature on competition, liquidity risk, and financial stability.

Using bank data from 25 OECD countries during the period 2000-2010, we find evidence that banks take on more liquidity risk as they achieve greater market power. This result implies that competition is beneficial to financial stability. The results are robust across different kinds of liquidity risks and the changes in determinants of the dependent variables. Furthermore, the results are robust even after controlling for both endogeneity concerns using GMM estimations and across different econometric

specifications such as Tobit analysis. During the crisis, however, the effects of bank market power on liquidity risk vary across bank size. When the economy tightens, large banks do not change their liquidity risk-taking behavior although they obtain market power. Large banks rather increase the exposure of committed credit lines as they have greater market power during the crisis. This may be attributed to moral hazard resulting from the higher possibility of government guarantees. In contrast, small banks with greater market power reduce liquidity risk-taking during the crisis by increasing liquid asset holdings and by decreasing liquidity creation. These results suggest that increased charter value from enhanced market power contributes to banks' financial stability during times of financial turbulence. To put it differently, if competition becomes more severe during times of market stress, small banks, which are more likely to fail, are subject to have risk-shifting incentives to survive.

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Table 1 Variable Definition and Data Sources

This table reports definitions and data sources for dependent, explanatory, and instrumental variables.

Variables	Definitions	Sources
Dependent variables		
Credit Lines	Liquidity risk from committed credit lines, calculated as the ratio of undrawn credit lines to total assets plus undrawn credit lines. Higher values indicate more liquidity risk.	Bankscope
Short-term Wholesale Funds	Liquidity risk from short-term wholesale funds, defined as the ratio of short-term wholesale funding to total assets. Higher values indicate more liquidity risk.	Bankscope
Liquidity Creation	Liquidity risk from liquidity production, measured as the ratio of Berger and Bouwman (2009)'s preferred liquidity creation measure, which is constructed by categorizing all on- and off-balance sheet activities and then by imposing weights on them, divided by total assets. Higher values indicate more liquidity risk.	Bankscope Authors' calculations
Liquid Assets	Liquidity risk from the extent to which a bank holds liquid assets, calculated as the ratio of liquid reserves to total assets. Higher values indicate less liquidity risk.	Bankscope
Explanatory variables		
Lerner	Lerner index, defined as the difference between price and marginal cost divided by price. Higher values indicate more market power.	Bankscope Authors' calculations
Assets	Natural logarithm of total assets	Bankscope
Nonperforming Loans Ratios	Non-performing loans as a fraction of total loans	Bankscope
Equity Ratios	Equity to total assets	Bankscope
M&A Activity	A dummy variable that takes a value of 1 if a bank was involved in one or more mergers and acquisitions over the past three years.	SDC Platinum

GDP per Capita	Natural logarithm of GDP per capita	WDI
GDP Growth Rates	Annual percentage growth rate of GDP	WDI
M2 to GDP	M2 divided by GDP. M2 consists of M1, savings deposits, money market deposit accounts, and time deposits.	IMF IFS
Real Interest Rates	Lending interest rate adjusted for inflation	WDI
Instrument variables		
Entry Barriers	An index that takes values between 1 and 8, with higher values indicating greater entry restrictions.	Barth, Caprio, and Levine (2001, updated in 2003 and 2008)
Control of Corruption	An annual index that represents the level of control of corruption, ranging from -2.5 (weak) to 2.5 (strong). Higher values indicate less corruption.	WGI

Table 2 Summary Statistics

This table shows summary statistics for dependent, control, and instrumental variables we use in the empirical analysis. The sample consists of 10,561 commercial banks from 25 OECD countries over the period 2000 through 2010. *Credit Lines* is calculated as undrawn credit lines divided by total assets plus undrawn credit lines. *Short-term Wholesale Funds* is the ratio of short-term wholesale funding to total assets. *Liquidity Creation* is the ratio of Berger and Bouwman (2009) liquidity creation measure to total assets. *Liquid Assets* is the ratio of liquid asset holdings to total assets. *Lerner* is defined as the difference between price and marginal cost divided by price. *Assets* is the natural logarithm of total assets. *Nonperforming Loans Ratios* is non-performing loans as a fraction of total loans. *Equity Ratios* is the ratio of total equity to total assets. *M&A Activity* is a dummy variable that takes a value of 1 if a bank was involved in one or more mergers and acquisitions over the past three years. *GDP per Capita* is the natural logarithm of GDP per capita. *GDP Growth Rates* is the annual percentage growth rate of GDP. *M2 to GDP* is the ratio of M2 to GDP. *Real Interest Rates* is the lending interest rate adjusted for inflation. *Control of Corruption* is an annual index that represents the level of control of corruption. *Entry Barriers* is an index that takes values between 1 and 8. Table 1 provides more detailed definitions of all variables.

Variables	Obs.	Mean	Std. Dev.	Min	Max
Dependent variables					
Credit Lines	89,417	0.0846	0.0639	0	0.3276
Short-term Wholesale Funds	89,417	0.0492	0.1045	0	0.6876
Liquid Assets	89,417	0.1115	0.1225	0.0051	0.8202
Liquidity Creation	89,417	0.3052	0.2397	-0.3874	1.2879
Explanatory variables					
Lerner	89,417	0.2118	0.1407	-0.3942	0.5191
Assets	89,417	12.046	1.530136	9.10217	17.999
Nonperforming Loans Ratios	89,417	0.0093	0.0169	0.0001	0.1310
Equity Ratios	89,417	0.1119	0.0670	0.0294	0.7839
M&A Activity	89,417	0.0153	0.1227	0	1
GDP per Capita	89,417	10.611	0.2030	8.4016	11.686
GDP Growth Rates	89,417	0.0194	0.0187	-0.0780	0.1058
M2 to GDP	89,417	0.8375	0.4676	0.2625	6.3651
Real Interest Rates	86,609	0.0376	0.0189	-0.0581	0.1438
Instrumental variables					
Entry Barriers	89,417	7.7588	0.5489	3	8
Control of Corruption	89,417	1.5795	0.3522	-0.2734	2.5506

Table 3 The Effect of Market Power on Bank Liquidity Risk

This table shows fixed effects regression estimates of market power on liquidity risk for 10,561 banks from 25 OECD countries between 2000 and 2010. The dependent variables are liquidity risk from committed credit lines (*Credit Lines*), wholesale funding (*Short-term Wholesale Funds*), liquid asset holdings (*Liquid Assets*), and liquidity creation (*Liquidity Creation*). To mitigate the impact of endogeneity, we use one year lagged values of the independent variables. $Assets^2$ is the squared bank size term. Detailed variable definitions are provided in Table 1. The standard errors are robust and clustered by country. *t*-statistics are in parentheses. ∗∗∗, ∗∗, and ∗ denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	Credit Lines		*Short-term Wholesale Funds*		*Liquid Assets*		*Liquidity Creation*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Lerner	0.0305***	0.0312***	0.0050**	0.0055***	-0.0461***	-0.0516***	0.0523***	0.0488***
	(15.99)	(22.51)	(2.11)	(2.91)	(-7.24)	(-22.72)	(10.46)	(14.69)
Assets	-0.0090	-0.0021	-0.0188	-0.0051	-0.0776***	-0.0683***	0.0222	0.0382**
	(-0.91)	(-0.33)	(-1.00)	(-0.48)	(-5.01)	(-3.18)	(1.10)	(2.36)
$Assets^2$	0.0001	-0.0002	0.0011	0.0005	0.0023***	0.0019**	-0.0011	-0.0018**
	(0.18)	(-0.74)	(1.24)	(0.95)	(3.91)	(2.15)	(-1.28)	(-2.68)
Nonperforming Loans Ratios	-0.3103***	-0.3156***	-0.0975***	-0.0877***	0.1012***	0.0929***	-0.3674***	-0.3897***
	(-8.25)	(-9.79)	(-7.29)	(-10.41)	(2.82)	(2.82)	(-3.98)	(-5.31)
Equity Ratios	0.0424***	0.0486***	-0.0215*	-0.0161*	0.0035	0.0016	-0.1339***	-0.1129***
	(4.54)	(9.55)	(-1.74)	(-1.74)	(0.33)	(0.18)	(-3.85)	(-6.51)
M&A Activity	0.0029**	0.0036***	-0.0062	-0.0034	-0.0081	-0.0063	-0.0053	-0.0031
	(2.43)	(2.93)	(-1.34)	(-1.33)	(-1.32)	(-1.21)	(-0.77)	(-0.55)
GDP per Capita	0.0081	0.0092	-0.0844***	-0.0681**	-0.0543	-0.0977	-0.1056**	-0.1128
	(0.71)	(0.61)	(-3.65)	(-2.28)	(-1.23)	(-1.61)	(-2.11)	(-1.65)
GDP Growth Rates	0.0224	0.1109	0.0360	-0.0626	0.4337**	0.2260	-0.8814***	-0.8515**
	(0.29)	(0.98)	(0.28)	(-0.33)	(2.58)	(0.80)	(-3.73)	(-2.14)
M2 to GDP	0.0017	0.0044	0.0044	0.0037	-0.0181	-0.0283	-0.0225	-0.0090
	(0.27)	(0.42)	(0.36)	(0.15)	(-1.03)	(-0.86)	(-0.61)	(-0.13)
Real Interest Rates		-0.0995*		-0.1955		-0.0226		-0.0855
		(-1.98)		(-1.47)		(-0.13)		(-0.36)
Constant	0.0758	0.0256	0.9925***	0.7634**	1.2630**	1.6794**	1.3005**	1.2581
	(0.51)	(0.15)	(3.23)	(2.54)	(2.70)	(2.50)	(2.44)	(1.68)
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.1271	0.1386	0.0179	0.0162	0.0517	0.0647	0.1209	0.1293
Observations	89,417	86,609	89,417	86,609	89,417	86,609	89,417	86,609

Table 4 The Effect of Market Power on Bank Liquidity Risk considering the Impact of the 2008 Financial Crisis

This table reports fixed effects regression estimates of market power on liquidity risk considering the impact of the 2008 global financial crisis. The dependent variables are liquidity risks from committed credit lines (*Credit Lines*), wholesale funding (*Short-term Wholesale Funds*), liquid asset holdings (*Liquid Assets*), and liquidity creation (*Liquidity Creation*). *Crisis* is a dummy variable that equals one if the year is 2008 or 2009. *Lerner*Crisis* is an interaction term between *Lerner* and *Crisis*. To mitigate the impact of endogeneity, we use one year lagged values of the independent variables. $Assets^2$ is the squared bank size term. Detailed variable definitions are provided in Table 1. The standard errors are robust and clustered by country. *t*-statistics are in parentheses. ∗∗∗, ∗∗, and ∗ denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	Credit Lines		*Short-term Wholesale Funds*		*Liquid Assets*		*Liquidity Creation*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Lerner	0.0266***	0.0274***	0.0043	0.0048**	-0.0490***	-0.0554***	0.0589***	0.0562***
	(15.99)	(21.96)	(1.65)	(2.50)	(-6.93)	(-22.59)	(11.04)	(13.92)
Crisis	0.0081*	0.0098	0.0261***	0.0151	0.0389***	0.0438**	0.1057***	0.1067***
	(1.80)	(1.57)	(3.02)	(0.87)	(2.88)	(2.36)	(6.45)	(5.75)
*Lerner*Crisis*	0.0128***	0.0126***	0.0025	0.0021	0.0097***	0.0125***	-0.0217***	-0.0247***
	(11.43)	(10.93)	(0.84)	(0.89)	(2.81)	(5.16)	(-4.19)	(-3.97)
Assets	-0.0073	-0.0004	-0.0184	-0.0048	-0.0763***	-0.0666***	0.0193	0.0348**
	(-0.72)	(-0.06)	(-0.98)	(-0.45)	(-4.95)	(-3.06)	(0.95)	(2.16)
$Assets^2$	0.0000	-0.0003	0.0011	0.0005	0.0023***	0.0018*	-0.0010	-0.0016**
	(0.04)	(-0.94)	(1.23)	(0.92)	(3.84)	(2.06)	(-1.16)	(-2.50)
Nonperforming Loans Ratios	-0.3086***	-0.3140***	-0.0972***	-0.0874***	0.1024***	0.0945***	-0.3702***	-0.3929***
	(-8.21)	(-9.76)	(-7.27)	(-10.59)	(2.87)	(2.84)	(-4.02)	(-5.40)
Equity Ratios	0.0418***	0.0480***	-0.0216*	-0.0162*	0.0030	0.0010	-0.1330***	-0.1117***
	(4.55)	(9.65)	(-1.75)	(-1.75)	(0.29)	(0.12)	(-3.81)	(-6.43)
M&A Activity	0.0029**	0.0036***	-0.0062	-0.0033	-0.0081	-0.0063	-0.0053	-0.0033
	(2.45)	(2.97)	(-1.34)	(-1.33)	(-1.31)	(-1.21)	(-0.79)	(-0.57)
GDP per Capita	0.0080	0.0090	-0.0844***	-0.0681**	-0.0544	-0.0980	-0.1054**	-0.1123
	(0.71)	(0.60)	(-3.65)	(-2.28)	(-1.23)	(-1.62)	(-2.11)	(-1.64)
GDP Growth Rates	0.0265	0.1162	0.0368	-0.0617	0.4368**	0.2312	-0.8883***	-0.8619**
	(0.34)	(1.03)	(0.29)	(-0.32)	(2.60)	(0.83)	(-3.74)	(-2.15)
M2 to GDP	0.0015	0.0043	0.0044	0.0037	-0.0182	-0.0283	-0.0221	-0.0089
	(0.24)	(0.42)	(0.36)	(0.15)	(-1.03)	(-0.86)	(-0.61)	(-0.13)
Real Interest Rates		-0.0967*		-0.1950		-0.0199		-0.0909
		(-1.94)		(-1.46)		(-0.11)		(-0.38)
Constant	0.0656	0.0169	0.9905***	0.7619**	1.2553**	1.6707**	1.3177**	1.2753
	(0.44)	(0.10)	(3.23)	(2.53)	(2.69)	(2.49)	(2.47)	(1.69)
Bank fixed effects	Yes		Yes		Yes		Yes	
Time fixed effects	Yes		Yes		Yes		Yes	
R^2	0.1278	0.1392	0.0179	0.0162	0.0518	0.0649	0.1210	0.1295
Observations	89,417	86,609	89,417	86,609	89,417	86,609	89,417	86,609

Table 5 The Effect of Market Power on Bank Liquidity Risk based on Bank Size

This table reports fixed effects regression estimates of market power on liquidity risk dividing banks into tercile groups based on asset size: large, medium, and small banks. Panels A and B shows regression results for large and small banks, respectively. The dependent variables are liquidity risks from committed credit lines (*Credit Lines*), wholesale funding (*Short-term Wholesale Funds*), liquid asset holdings (*Liquid Assets*), and liquidity creation (*Liquidity Creation*). *Crisis* is a dummy variable that equals one if the year is 2008 or 2009. *Lerner*Crisis* is an interaction term between *Lerner* and *Crisis*. $Assets^2$ is the squared bank size term. Detailed variable definitions are provided in Table 1. The standard errors are robust and clustered by country. *t*-statistics are in parentheses. ∗∗∗, ∗∗, and ∗ denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	Panel A: Large banks				Panel B: Small banks			
	Credit Lines	*Wholesale Funds*	*Liquid Assets*	*Liquidity Creation*	*Credit Lines*	*Wholesale Funds*	*Liquid Assets*	*Liquidity Creation*
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Lerner	0.0113***	0.0164*	-0.0491***	0.0525***	0.0466***	-0.0003	-0.0436***	0.0615***
	(3.84)	(1.84)	(-9.19)	(5.97)	(17.30)	(-0.04)	(-3.36)	(7.61)
Crisis	0.0101**	0.0149	0.0634***	0.0350	0.0184	0.0176	0.0546**	0.0662***
	(2.08)	(0.80)	(2.84)	(1.30)	(1.51)	(1.44)	(2.54)	(2.89)
*Lerner*Crisis*	0.0139***	-0.0095	0.0005	-0.0115	0.0019	-0.0017	0.0221***	-0.0231*
	(11.94)	(-1.40)	(0.16)	(-0.71)	(0.77)	(-0.29)	(3.09)	(-1.88)
Assets	0.0138	0.0534**	-0.1302***	-0.0052	-0.0530***	0.0126	-0.0539	0.0348
	(0.67)	(2.37)	(-5.32)	(-0.13)	(-4.51)	(0.36)	(-1.65)	(0.72)
$Assets^2$	-0.0005	-0.0016*	0.0044***	-0.0001	0.0015***	-0.0002	0.0011	-0.0008
	(-0.54)	(-1.82)	(5.01)	(-0.06)	(3.44)	(-0.12)	(0.73)	(-0.32)
Nonperforming Loans Ratios	-0.1703***	-0.0860**	0.1431**	-0.4039***	-0.3783***	-0.0276	0.1761***	-0.1605*
	(-7.24)	(-2.26)	(2.55)	(-3.80)	(-9.47)	(-0.95)	(5.08)	(-1.98)
Equity Ratios	0.0550***	-0.1530***	-0.0431*	-0.0713	-0.0241	-0.0017	0.0271	-0.1052***
	(6.41)	(-8.96)	(-1.73)	(-1.04)	(-1.54)	(-0.21)	(1.29)	(-3.66)
M&A Activity	0.0074	-0.0051	-0.0060	-0.0013	0.0041**	-0.0199	-0.0423	-0.0348
	(1.67)	(-1.57)	(-1.15)	(-0.17)	(2.27)	(-0.84)	(-1.40)	(-0.80)
GDP per Capita	-0.0052	-0.0523	-0.1190**	-0.2269***	-0.0165	-0.0671**	-0.0168	-0.0043
	(-0.42)	(-1.55)	(-2.15)	(-4.09)	(-0.84)	(-2.70)	(-0.26)	(-0.07)
GDP Growth Rates	0.0809	0.0753	0.2350	-0.9543***	0.0574	-0.0958	0.7344***	-1.1735***
	(0.98)	(0.44)	(1.20)	(-3.37)	(0.46)	(-0.53)	(2.94)	(-3.15)
M2 to GDP	0.0172**	0.0046	-0.0223	-0.0427	-0.0146	-0.0112	-0.0386*	-0.0321*
	(2.69)	(0.34)	(-0.76)	(-0.75)	(-0.97)	(-0.74)	(-1.81)	(-1.81)
Constant	0.0033	0.1928	2.2933***	2.7915***	0.7017**	0.6372*	0.7458	0.0596
	(0.02)	(0.45)	(4.43)	(4.41)	(2.79)	(1.92)	(1.17)	(0.08)
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.0637	0.0243	0.0500	0.1399	0.1892	0.0110	0.0550	0.1113
Observations	29,793	29,659	29,659	29,659	29,659	29,793	29,793	29,793

Table 6 Robustness Tests: Generalized Method of Moments (GMM) Estimation

This table reports the results of instrumental variables regressions on the relation between market power and liquidity risk. The second column shows the first-stage results for our instrumental variables estimations. The dependent variable of the first-stage regressions is the Lerner index. The last four columns provide the second-stage regression results for the liquidity risk measures. The dependent variables of the second-stage regressions are liquidity risks from committed credit lines (*Credit Lines*), wholesale funding (*Short-term Wholesale Funds*), liquid asset holdings (*Liquid Assets*), and liquidity creation (*Liquidity Creation*). $Assets^2$ is the squared bank size term. Detailed variable definitions are provided in Table 1. The first stage F-test and the Hansen's J test check for the relevance and the validity of the instruments, respectively. The standard errors are robust and clustered by country. *t*-statistics are in parentheses. ∗∗∗, ∗∗, and ∗ denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	First-stage	Second-stage			
	Lerner	*Credit Lines*	*Wholesale Funds*	*Liquid Assets*	*Liquidity Creation*
		(1)	(2)	(3)	(4)
Lerner		0.1068**	0.0772*	0.1810	0.6680***
		(2.24)	(1.71)	(1.54)	(2.80)
Assets	0.1870***	-0.0224*	-0.0266	-0.1177***	-0.0877*
	(20.03)	(-1.94)	(-1.29)	(-4.58)	(-1.82)
$Assets^2$	-0.0056***	0.0005	0.0012	0.0035***	0.0021
	(-14.42)	(1.05)	(1.51)	(4.19)	(1.35)
Equity Ratios	-0.2713***	0.0635***	0.0006	0.0651**	0.0411
	(-5.16)	(3.20)	(0.02)	(2.01)	(0.44)
Nonperforming Loans Ratios	-1.4181***	-0.2033***	0.0046	0.4203**	0.5100
	(-5.05)	(-2.95)	(0.04)	(2.43)	(1.44)
M&A Activity	0.0023	0.0027**	-0.0051	-0.0085	-0.0061
	(1.03)	(2.33)	(-1.27)	(-1.36)	(-0.86)
GDP per Capita	-0.0056	0.0055	-0.0823***	-0.0625	-0.1404***
	(-0.20)	(0.52)	(-4.60)	(-1.34)	(-2.61)
GDP Growth Rates	0.0692	-0.0078	0.0368	0.4097**	-1.0577***
	(0.35)	(-0.12)	(0.32)	(2.45)	(-3.85)
M2 to GDP	0.0055	0.0015	0.0045	-0.0209	-0.0265
	(0.18)	(0.29)	(0.37)	(-0.97)	(-0.89)
Instrumental Variables					
Entry Barriers	0.0130***				
	(2.95)				
Control of Corruption	0.0627***				
	(4.60)				
First stage F-test of instruments	17.99				
p-value	0.0000				
Hansen J-test of overidentifying restrictions		0.101	0.368	0.249	0.181
p-value		0.7510	0.5441	0.6175	0.6704
Bank fixed effects	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes
R^2	0.1993	0.0814	0.0040	0.0521	0.1005
Observations	89,417	89,417	89,417	89,417	89,417

Table 7 Robustness Tests: Considering Zero-value Observations of Credit Lines and Short-term Wholesale Funds

This table shows fixed effects regressions of market power on liquidity risk from credit lines and short-term wholesale funds considering the impact of zero values because there are zero-value observations in those variables. Panels A and B show regression results for credit lines (*Credit Lines*) and short-term wholesale funds (*Short-term Wholesale Funds*) as dependent variables. Specifically, Panel A provides regression results for liquidity risk to the exposure from credit lines after dropping zero values in the sample. Panel B1 shows regression results for liquidity risk from the reliance on short-term wholesale funds after removing zero values in the sample. Panel B2 reports results for liquidity risk from deposits because all banks in the sample have positive deposit values. There is a substitute relationship between wholesale funds and deposits (Craig and Dinger 2013; Huang and Ratnovski 2011). $Assets^2$ is the squared bank size term. Detailed variable definitions are provided in Table 1. The standard errors are robust and clustered by country. *t*-statistics are in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	Panel A: Credit lines		Panel B: Short-term wholesale funds			
	Credit Lines without zero values		Panel B1: Short-term Wholesale Funds without zero values		Panel B2: Deposits instead of short-term wholesale funds	
	(1)	(2)	(3)	(4)	(5)	(6)
Lerner	0.0328***	0.0327***	0.0066*	0.0073*	-0.0177***	-0.0193***
	(34.31)	(45.02)	(1.81)	(1.97)	(-4.78)	(-8.87)
Assets	0.0012	0.0017	-0.0334*	-0.0187	-0.0233	-0.0399**
	(0.33)	(0.75)	(-1.84)	(-1.40)	(-0.88)	(-2.30)
$Assets^2$	-0.0004**	-0.0004***	0.0016*	0.0008	0.0001	0.0009
	(-2.41)	(-4.03)	(1.73)	(1.35)	(0.10)	(1.19)
Nonperforming Loans Ratios	-0.3181***	-0.3241***	-0.1146***	-0.1007***	0.1358***	0.1253***
	(-10.76)	(-13.33)	(-6.28)	(-6.65)	(10.54)	(8.06)
Equity Ratios	0.0547***	0.0553***	-0.0378	-0.0287	-0.3006***	-0.3047***
	(34.87)	(42.35)	(-1.59)	(-1.22)	(-27.69)	(-30.96)
M&A Activity	0.0036***	0.0039***	-0.0058	-0.0024	0.0059*	0.0038
	(3.60)	(3.67)	(-1.19)	(-0.98)	(1.82)	(1.54)
GDP per Capita	0.0002	-0.0013	-0.0833***	-0.0694**	0.1054***	0.0959*
	(0.02)	(-0.09)	(-3.59)	(-2.21)	(2.96)	(1.73)
GDP Growth Rates	0.0193	0.1149	0.0082	-0.0760	0.0834	0.2173
	(0.38)	(1.59)	(0.07)	(-0.42)	(0.66)	(0.95)
M2 to GDP	-0.0117	-0.0193	0.0068	0.0007	-0.0053	-0.0155
	(-1.09)	(-1.03)	(0.70)	(0.03)	(-0.43)	(-0.68)
Real Interest Rates		0.0168		-0.1836		0.3371*
		(0.37)		(-1.39)		(1.92)
Constant	0.1173	0.1294	1.1156***	0.9115***	-0.0014	0.1776
	(0.91)	(0.84)	(3.66)	(2.84)	(-0.00)	(0.30)
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.1530	0.1586	0.0174	0.0156	0.0837	0.0942
Observations	83,974	82,638	58,269	55,527	89,417	86,609

Table 8 Robustness Tests: Tobit Analysis

This table shows panel Tobit regressions of market power on liquidity risk from credit lines, short-term wholesale funds, and liquid reserves because those three dependent variables are left censored at zero. We run the random-effect Tobit estimation and report the estimated marginal effects. Panels A, B and C show regression results for credit lines, short-term wholesale funds, and liquid asset holdings as dependent variables. As in Table 8, we use both short-term wholesale funds (Panel B1) and deposits (Panel B2) as sources of liquidity risk due to their substitute relationship. *Assets*^{2} is the squared bank size term. Detailed variable definitions are provided in Table 1. For dummy variables, the marginal effects are calculated as the discrete change in the expected value of the dependent variables as the dummy variable changes from 0 to 1. The standard errors are robust and clustered by country. Absolute value of *z*-statistics is in parentheses. ∗∗∗, ∗∗, and ∗ denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	Panel A: Credit lines		Panel B: Short-term wholesale funds				Panel C: Liquid asset holdings	
	Credit Lines		Panel B1: *Short-term Wholesale Funds*		Panel B2: *Deposits*		*Liquid Assets*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Lerner	0.0245***	0.0247***	0.0030**	0.0025*	-0.0171***	-0.0179***	-0.0398***	-0.0439***
	(22.46)	(22.22)	(2.07)	(1.86)	(-8.53)	(-9.30)	(-20.07)	(-22.65)
Assets	-0.0008	-0.0021	0.0190***	0.0252***	-0.0012	-0.0218***	-0.0767***	-0.0718***
	(-0.40)	(-1.02)	(7.63)	(10.57)	(-0.31)	(-5.89)	(-22.97)	(-21.52)
Assets^2	0.0000	0.0001*	-0.0001	-0.0005***	-0.0011***	-0.0002	0.0027***	0.0025***
	(0.49)	(1.68)	(-1.34)	(-5.13)	(-7.73)	(-1.33)	(21.44)	(19.02)
Nonperforming Loans Ratios	-0.2889***	-0.3056***	-0.1153***	-0.1057***	0.1516***	0.1395***	0.0630***	0.0626***
	(-40.14)	(-41.58)	(-11.87)	(-11.71)	(11.48)	(11.09)	(4.77)	(4.88)
Equity Ratios	0.0556***	0.0620***	0.0035	0.0051	-0.3376***	-0.3395***	0.0368***	0.0326***
	(21.88)	(23.79)	(0.98)	(1.53)	(-71.19)	(-74.41)	(8.12)	(7.33)
M&A Activity	0.0024**	0.0031***	-0.0050***	-0.0035***	0.0068***	0.0052***	-0.0079***	-0.0066***
	(2.34)	(2.90)	(-4.19)	(-3.05)	(3.63)	(2.86)	(-4.36)	(-3.63)
GDP per Capita	0.0351***	0.0377***	-0.0834***	-0.0817***	0.1570***	0.1642***	-0.0915***	-0.1249***
	(17.74)	(16.79)	(-40.19)	(-37.80)	(45.57)	(43.20)	(-30.70)	(-38.86)
GDP Growth Rates	0.1037***	0.1595***	0.0245	0.0700**	0.0627	-0.0067	0.4121***	0.4344***
	(4.04)	(4.58)	(0.90)	(2.06)	(1.50)	(-0.12)	(9.93)	(7.96)
M2 to GDP	-0.0244***	-0.0474***	0.0404***	0.0791***	-0.0761***	-0.1650***	0.0866***	0.1471***
	(-22.61)	(-18.24)	(36.27)	(31.56)	(-36.07)	(-35.88)	(55.01)	(38.99)
Real Interest Rates		0.0124		-0.1647***		0.4870***		-0.2651***
		(0.48)		(-6.82)		(12.49)		(-6.88)
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Wald χ^2	11,496.62	12,274.65	7,295.55	6,770.15	13,068.29	13,905.31	7,833.00	8,068.77
p-value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ρ	0.8338	0.8261	0.8059	0.7993	0.8837	0.8750	0.7596	0.7489
Observations	89,417	86,609	89,417	86,609	89,417	86,609	89,417	86,609