How do banks price liquidity? The role of market power.

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Abstract

We empirically examine the effects of different measures of liquidity on interest margins of a sample of U.S. commercial banks from 2001 to 2018. Overall, the results reveal that liquidity ratios exert a positive influence on bank margins. Furthermore, the study investigates the role of market power in the relationship between liquidity and interest margins. It is documented that dominant banks incorporate the costs associated with investing in liquidity into the bank margins to a lesser extent than banks with less market power, suggesting that the cost of complying with regulatory liquidity standards is reduced when the competition in the banking sector is less intense. The study highlights that market competition might be important in the design and implementation of liquidity regulations.

JEL Classification: G21; G28.

Keywords: Market power; Lerner index; Liquidity; Net interest margin; NSFR.

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1 Introduction

The important role that banks play in financing economic activities has been long recognised and emphasised in the literature. By accepting deposits from savers on the one hand and extending credits or lines of credits to borrowers on the other, banks channel funds from depositors to investors and manage to fulfil multiple and seemingly opposing liquidity needs (Kashyap et al. 2002). This has been considered as the primary financial intermediation function of banks.

From the social welfare perspective, it is crucial that this financial intermediation function of banks is undertaken at a low cost. The efficiency of the intermediation process performed by the banking system is often measured by bank spread which is the difference between loan and deposit rates. That is, as a performance benchmark, bank spread or interest margin represents the cost of financial intermediation or the economic cost of the banking sector's output. Large margins usually suggest that the banking sector is inefficient in carrying out its intermediation function of channelling resources (Demirguc-Kunt et al. 2004) which has several economic implications. On the one hand, large bank margins represent high funding costs to businesses and may adversely affect investment; on the other hand, low returns on deposits also discourage savings. This may distort the financial intermediation function of banks as well as increase financing costs of the real sectors which subsequently undermine economic activities.

For this reason, the banking literature has placed considerable emphasis on examining bank interest margin and its determinants (e.g. Ho & Saunders 1981, McShane & Sharpe 1985, Angbazo 1997). For instance, while lack of competitive pressure in the banking market could result in large interest margin, relatively small margins could be indicative of intense competition in the banking business (Saunders & Schumacher 2000).

Economic theories attribute investments in liquidity to precautionary, transactional and speculative motives, given unexpected exogenous shocks and market constraints (Keynes 1936). The transaction motive suggests that banks' liquidity needs arise from the transactions that are performed as part of their business

activities. Banks also invest in asset liquidity as a buffer against negative shocks to their cash flow for precautionary purposes. By holding more liquidity for speculative purposes, banks may be able to reap the potential profit from investment opportunities that may arise in the future. Later studies such as Bhattacharya & Thakor (1993) show that the presence of explicit/implicit deposit guarantees and 'lender of last resort' gives rise to the underinvestment in liquidity.

Due to the nature of their business, however, it is important that banks hold a sufficient amount of liquidity to withstand liquidity shocks emanating from adverse economic conditions. For example, banks may face the risk that depositors suddenly withdraw their deposits. In fact, liquidity shocks are often deemed to be primarily responsible for the 2008 Global Financial Crisis which revealed the weaknesses in bank risk management. Together with credit risk, liquidity risk has been identified as a major cause of commercial bank failures during the crisis (Imbierowicz & Rauch 2014). Against this backdrop, the Basel III, which is a new set of regulatory standards, was introduced by the Basel Committee on Banking Supervision (BCBS) to address both short-run and long-run liquidity risks, highlighting the importance of liquidity regulation in the banking system.

Despite the fact that there is no general consensus regarding the accurate measurement of liquidity that is able to capture all dimensions of liquidity risk, the objective of liquidity standards is to minimise the likelihood and intensity of banks' liquidity dry-ups, to enhance the resilience of banks during downturn periods (e.g., Hong et al. 2014, Dietrich et al. 2014, Vazquez & Federico 2015, Du 2017, Chiaramonte & Casu 2017). Nevertheless, Acharya & Viswanathan (2011) highlight that in competitive banking markets, the higher opportunity costs associated with holding low-yielding liquid assets adversely affect bank wealth creation. This suggests that although investment in liquidity assets reduces the likelihood of bank failure due to sudden liquidity shortage, it comes with a cost that should be incorporated into bank interest margins.

This chapter studies the effect of measures of liquidity on bank interest margins for a sample of U.S. banks from 2001 to 2018. We construct the conventional liquid

assets ratio, the Basel III Net Stable Funding Ratio (NSFR) and the Liquidity Coverage Ratio (LCR) and find these liquidity ratios exert a positive impact on bank interest margins, indicating that there is a cost associated with complying with liquidity rules. Furthermore, this study examines how market power affects banks' valuation of liquidity. In particular, it seeks to understand how banks with varying market power take liquidity into account when determining their interest margins.

Our results indicate that banks with greater market power as measured by the Lerner index incorporate the costs of liquidity into the interest margins to a lesser extent relative to those banks with less market power. The findings suggest that the cost of investing in liquidity becomes less expensive as banks achieve more market power. Further investigation reveals that the role of market power in affecting banks' valuation of liquidity appears to be more important for small banks than for large banks. We perform a number of robustness checks including using an alternative measure of interest margins, employing the funding-adjusted Lerner index as a proxy of market power and the System Generalized Methods of Moments (SGMM) to tackle the possible endogeneity problem that might arise in our estimations. Our findings remain robust to all these tests.

This study contributes to the existing literature in several ways. First, prior studies have identified various bank-specific characteristics that play important roles in determining bank interest margins. In particular, most studies seek to understand the impacts of market power and liquidity on bank interest margins (e.g., Amidu & Wolfe 2013, Entrop et al. 2015, Birchwood et al. 2017, Cruz-García & de Guevara 2020). To the best of our knowledge, no attention has been paid to their interaction effect on interest margins. This study, therefore, adds to the literature on the determinants of bank interest margins by being the first to examine how banks' valuation of liquidity changes with their market power.

Second, this study enhances the literature on the impact of competition on banks' behaviours, financial intermediation and financial stability (e.g., Beck et al. 2004, Calderon & Schaeck 2016). Prior studies focus on the effect of market power

on net interest margins (e.g., Corvoisier & Gropp 2002), financial stability (e.g., Berger et al. 2009, Beck et al. 2013), bank risk-taking (e.g., Agoraki et al. 2011), bank efficiency (e.g., Maudos & de Guevara 2007, Turk-Ariss 2010). This study highlights the importance of market power in reducing the costs associated with liquidity requirements.

Third, we employ several measures of bank liquidity including the Net Stable Funding Ratio (NSFR), the Liquidity Coverage Ratio (LCR) proposed by the Basel Committee on Banking Supervision (BCBS) in the Basel III accord so as to have a more comprehensive view on the interaction effect of market power and bank liquidity on interest margins. In this regard, this study contributes to the growing literature on the new liquidity standards and their possible effects on the resilience and efficiency of the banking system once these new liquidity requirements are implemented (e.g., Hong et al. 2014, Dietrich et al. 2014, Vazquez & Federico 2015, Du 2017, Chiaramonte & Casu 2017, Sclip et al. 2019).

In terms of policy implications, regulators should consider the resilience-efficiency trade-off in the banking system when designing liquidity standards such as the NSFR and LCR. Furthermore, as the cost of liquidity that is taken into account in interest margins can be reduced when the competition in the banking sector is less intense, this study highlights that market competition might be important in the design of bank liquidity management frameworks, and regulators might not take the 'one size fits all' approach to the implementation of bank liquidity requirements.

The remainder of this chapter is organised as follows. Section 2 provides a literature review and hypothesis development. Section 3 introduces the data, the variables of interest and methodology. Section 4 presents the empirical results and discussions. Section 5 presents the study summary and conclusion.

2 Literature review and hypothesis development

2.1 Determinants of bank interest margins

The literature on bank interest margin and its determinants follows the seminal work by Ho & Saunders (1981) that draws on the inventory model that is well-known in the literature of market microstructure and attempts to understand how banks determine their interest margin. In their paper, a bank can be viewed as a financial intermediary between depositors and borrowers and plays the role of a risk-averse dealer in the lending and depositing market. Banks, therefore, carry inventory risk that emanates from the mismatch between their assets and liabilities due to the asymmetric timing of funding supply and credit demand. Banks will require compensation for carrying this risk and determine the interest margin, which is the difference between the deposit and lending rates to maximize their profits. That is, similar to the margin of the dealers in the financial markets, economic costs incurred by banking firms when performing their role of financial intermediation should be reflected in the interest margins. Bank spread or interest margin is also known as the price of intermediation, and its optimal size is a function of banks' risk aversion, market structure or degree of competition in the banking sector, the volatility of interest rates and the size of bank transactions.

In their study, Ho & Saunders (1981) employ the two-stage approach decomposes bank spread into a pure spread and a premium which accounts for various risks that banks face. Accordingly, in the first stage regression, the theoretical pure spread is estimated by taking into account the additional factors that influence the bank's actual margin. The authors regress the actual bank margin against the controlling bank-specific variables, including bank default probability, opportunity costs of reserves and implicit interest payments. The constant of this regression represents the estimated pure spread which subsequently enters into the second stage regression. The theoretical determinants including interest rate volatility and market structure appear as the explanatory variables of the pure spread in the second stage regression.

Later studies attempt to extend the 'dealership model' of Ho & Saunders (1981) by including other factors that may have some bearing on bank interest margins. For example, McShane & Sharpe (1985) consider the effects of interest rate risk arising from the uncertainty of the money markets instead of interest rates of deposits and loans. Allen (1988) demonstrates the impact of cross-elasticities of demand between bank products (i.e. different types of loans) in reducing the pure spread while Angbazo (1997) focuses on the importance of loan default risk in addition to interest rate risk. Maudos & de Guevara (2004) explicitly incorporate administrative and operating costs in the theoretical model. Valverde & Fernández (2007) demonstrate that bank margins are significantly related to their non-traditional activities. Entrop et al. (2015) extend the seminal model by considering the interest rate risk of bank assets and liabilities with varying maturities.

Empirical studies that employ the two-stage methodology as in Ho & Saunders (1981) include Brock & Suarez (2000) that investigate the determinants of bank spreads in seven Latin American countries and Saunders & Schumacher (2000) who look into the bank margins of selected OECD countries. While Brock & Suarez (2000) report that besides bank-specific factors such as capital and liquidity risk, macro-level factors such as inflation, interest rate volatility, GDP growth and reserve requirements also affect bank spreads Saunders & Schumacher (2000) decompose interest margins into risk premium component, market structure component as well as regulatory component.

Alternatively, other studies employ a single-stage regression approach that accounts for both the variables in the theoretical model and other factors in the regression. Angbazo (1997) shows that the net interest margins of U.S. banks are positively associated with their loan default risk and interest rate risk exposure. The positive association between banks' net interest margins and their management quality as well as risk preferences is also reported. Studying bank interest margins in the Australian banking sector, Williams (2007) offers evidence in support of the role of market power and the importance of operating costs in determining banks'

interest margins, considering the differences between domestic and foreign banks. Using a sample of German banks, Entrop et al. (2015) demonstrate that interest rate risk and expected excess holding period returns are priced into the interest margins.

In their early cross-country study, Demirguc-Kunt & Huizinga (1999) provide a comprehensive analysis of a large set of determinants of bank interest margins in 80 countries from 1988–1995. Similarly, Maudos & de Guevara (2004) examine the interest margin determinants of countries in the European Union and reveal that several bank-specific characteristics such as loan default risk, operating costs, interest rate risk, quality of bank management and bank risk aversion explain the margins which is consistent with prior studies. Notably, they use the measure of market power instead of concentration ratios to control the competitive condition in the European banking sector and find a positive relationship between market power and bank interest margins. Similar findings are also provided by Claeys & Vennet (2008) who explore the factors that explain the relatively high interest margins of banks in Central and Eastern European (CEE) countries. These factors include imperfect competition in the markets, low capital, low operational efficiency, as well as a high proportion of state and foreign ownership. In an international study, Gelos (2009) provides evidence suggesting that the prevalent high spreads in 14 countries in Latin America can be explained by large reserve requirements, high interest rates and less efficient banking system relative to other economies. Studies such as Lepetit et al. (2008) and Nguyen (2012) emphasise the role of non-traditional fee-based activities on net interest margins. A study by Amidu & Wolfe (2013) sheds light on the implications of funding strategies on interest margins in both developed and emerging markets. Their findings indicate that the interest margins of banks with market power are more sensitive to funds that are generated internally than to wholesale and deposit funding. In another cross-country study, Demirguc-Kunt et al. (2004) find that tighter regulations bank activities and bank entry raise bank spreads. In addition, national indicators such as property rights protection and economic freedom also explain the cost of

intermediation. Similarly, in a study on the interest margins of Central American and Caribbean countries, Birchwood et al. (2017) find that significant reductions in bank margins are associated with a higher presence of foreign banks, reductions in entry requirements and increased transparency in the financial statement. In a recent study, Cruz-García & de Guevara (2020) find that deposit insurance and capital requirements are positively associated with bank net interest margins for a sample of banks from 31 OECD countries, implying that the costs of those stricter regulations are ultimately borne by banks' customers.

Overall, the literature on interest margins seeks to identify the factors that determine bank interest margins. These include the degree of market competition, the bank's risk aversion, bank capital and liquidity, operating capacity, administrative and other operating costs, interest rate and credit risk together with regulations and other macro-economic factors. These studies do not investigate how liquidity is priced into bank spread under imperfect competitive environments. For this reason, the present study seeks to fill the gap in the existing literature by examining how banks with varying degree of market power price liquidity into their interest margins.

2.2 Hypothesis development

Following the 2008 Global Financial Crisis, the role of liquidity in banks' risk management frameworks has received considerable attention. The literature (e.g., Ratnovski 2013) suggests that an investment in liquidity acts as a buffer against liquidity shocks and improves the resilience of the banking system under adverse economic conditions. Nevertheless, as liquid assets generally generate lower returns compared to illiquid assets, maintaining a higher level of liquidity tends to come with a cost that should be incorporated into bank margins. On the one hand, according to the 'structure - conduct - performance' view in the literature (e.g., Berger & Hannan 1989, Corvoisier & Gropp 2002) banks that acquired more market power may find themselves in a better position to determine their interest margins. In other words, banks exploit their increased market power to extract rents at the

expense of customers. Similarly, the 'pricing channel' view (e.g., Boot & Thakor 2000) suggests that banks adjust their pricing policies in response to heightened competition by increasing deposit rates and reducing loan rates, thereby shrinking interest margins. Therefore, it is expected that banks with greater market power take advantage of their pricing power and set a larger interest margin to compensate for the costs associated with investing in liquidity. Market power enhances the effect of liquidity on bank interest margins.

On the other hand, banks with greater market power might experience fewer frictions in assessing funding markets. The 'charter value' paradigm of Keeley (1990) suggests that dominant banks tend to be perceived as less risky. This implies that once banks establish their reputation in the lending and depositing markets and acquire sufficient market power, they may have better access to both wholesale and retail funding sources (Cocco et al. 2009). Those banks are able to obtain funding at relatively cheaper costs as the costs of wholesale funding tend to depend on bank risk (Dinger & von Hagen 2009). Moreover, with better access to funding liquidity, dominant banks might lessen their reliance on asset liquidity which is associated with adverse selection, moral hazard concerns and higher opportunity costs. This is in line with Paal et al. (2013) who document that banks with more market power tend to hold less liquid assets and earn greater profits from high-yield assets. For these reasons, investment in liquidity becomes relatively cheaper for banks with greater market power.

Furthermore, dominant banking firms in the depositing and lending markets may have a greater advantage in identifying business opportunities. Their bargaining power also allows them to obtain better terms in the contract creation. Dominant banks also realize economies of scale and efficiency gains might be passed onto customers via more beneficial interest rates (Craig & Dinger 2009). Therefore, dominant banks are able to generate more income that can compensate for the costs associated with liquidity investments, thereby reducing their interest margins. Market power moderates the effect of liquidity on bank interest margins.

Following these competing arguments, bank interest margins could have a

positive/negative relationship with the interaction between market power and liquidity. This leads to two alternative hypotheses to be tested in this chapter:

Hypothesis 1: Market power enhances the effect of liquidity on bank interest margins.

Hypothesis 2: Market power moderates the effect of liquidity on bank interest margins.

3 Data and Methodology

3.1 Data

The empirical analysis is carried out using quarterly bank-level financial statement and balance sheet data retrieved from the Call reports from the FFIEC (Federal Financial Institutions Examination Council) Central Data Repository's Public Data Distribution. The sample of our study consists of commercial banking institutions in the U.S. for the 2001–2018 period. We do not consider other types of banks to avoid possible bias that may emanate from the differences in terms of business nature and scope. Cooperative banks, investments banks and savings banks may have different business specifications and objectives. The sample period starts from 2001 because Call reports do not have information on bank risk-weighted assets in different categories to calculate the liquidity measures before 2001. A number of filtering rules are applied to arrive at the final sample. Specifically, bank-quarters with negative expenses, income, total loans reported are omitted. We also exclude from the sample bank-quarters that do not have deposits, loans or assets. In addition, banks that do not have complete information to construct the market power measures and liquidity are excluded. To account for the possible effects of mergers and acquisitions, we exclude observations with greater than 50% or less than –50% quarterly growth in assets. Bank-specific variables are winsorised at the top and bottom 1% of the distribution to prevent the impact of outliers following prior studies (e.g. Berger et al. 2009). After dropping errors

and inconsistencies, the final sample consists of 9882 banks and a total of 325073 bank-quarter observations. The macroeconomic variables such as real GDP growth rate, inflation rate and federal fund rate are obtained from Fed Bank of St. Louis. The dummy for the 2007 Financial Crisis is defined according to the definition of the National Bureau of Economic Research (NBER). The definition summary of the variables used in the study and data source are given in Table 1.

Table 1: Variable definitions

Variables	*Notation*	*Definitions*	*Data source*
Dependent variables			
Net interest margin	NIM_1	Interest income on loans to total loans minus interest expenses of deposits to total deposits	Call reports
	NIM_2	Net interest income to total assets	Call reports
Bank-specific variables			
Liquidity	*LIQUIDITY ASSETS*	Liquid assets to total assets	Call reports
	NSFR2010	The ratio of available stable funding to required stable funding as defined by Basel III 2010	Call reports
	NSFR2014	The ratio of available stable funding to required stable funding as defined by Basel III 2014	Call reports
	LCR	The ratio of stock of HQLA to net cash outflows over the 30-day stress period	Call reports
Market power	*LERNER*	The conventional Lerner index	Call reports
	ADJUSTED LERNER	The funding-adjusted Lerner index	Call reports
	HIGH LERNER	Dummy variable equal to 1 if a bank's *LERNER* is larger than the median value in a quarter and 0 otherwise	Call reports
Credit risk	*CREDIT RISK*	Non-performing loans to total loans	Call reports
Equity ratio	*CAPITALIZATION*	Equity to total assets	Call reports
Expenditure ratio	*EXPENDITURE*	Total non-interest expenses to operating income	Call reports
Income diversification	*DIVERSIFICATION*	Non-interest revenue to operating income	Call reports

Table 1 continued

Macroeconomic variables			
Fed fund rate	*FED RATE*	The federal fund rate	Fed Bank of St. Louis
GDP growth	*GDP GROWTH*	Real GDP growth rate	Fed Bank of St. Louis
Inflation	*INFLATION*	Inflation rate	Fed Bank of St. Louis
Crisis dummy	*CRISIS*	Dummy that is equal to 1 from 2007 Q4 to 2009 Q2 and 0 otherwise.	NBER

3.2 Methodology

Following the literature that considers the impact of different explanatory factors on bank interest margin, the interest margin of banks is estimated by the following model:

$$Y_{i,t} = \alpha + \beta_0 Market\ power_{i,t-1} + \beta_1 Liquidity_{i,t-1} + \beta_2 Market\ power \times Liquidity_{i,t-1} + \gamma Controls_{i,t-1} + \gamma_t + \varepsilon_{i,t} \quad (1)$$

where i denotes individual banks, t represents the time dimension and $\varepsilon_{i,t}$ represents robust standard errors.

For the purpose of the analysis, Y denotes the interest margin. In this study, the main measure of interest margins (NIM_1) is the difference between the lending rate and the deposit rate. While the former is calculated as the ratio of interest income on loans to total loans, the later is obtained by dividing the bank's interest expenses of deposits by total deposits following Birchwood et al. (2017). In the robustness checks, we use an alternative measure of interest margins (NIM_2) which is defined as the net interest income (interest income minus interest expenses) divided by total assets (e.g. Lin et al. 2012, Nguyen 2012). *Market power* represents the measures of bank market power and *Liquidity* denotes the measures of liquidity. The main interest of this study is to understand how banks determine their interest margins with respect to liquidity as their market power changes. Therefore, the measure of liquidity is multiplied by the bank's market power (*Market power* $\times$ *Liquidity*). This interaction term is incorporated into the model specification to capture the heterogeneous effects of liquidity on bank margin for banks with varying pricing power. The positive estimated coefficient of this interaction term suggests that banks will charge larger interest margins for liquidity by leveraging their market power. By contrast, if the estimated coefficient is negative, banks with larger market power will charge less for their liquidity. *Controls* is the vector of bank-specific characteristics. In the subsequent part of the analysis, we replace time fixed effects (γ) with macro-economic variables (*Macros*).

Equation (1) is estimated by using the panel fixed-effects technique. The estimation with the fixed effect takes into consideration the heterogeneity of individual banks as it allows unobserved bank-specific characteristics to arbitrarily correlate with the observed independent variables (Baltagi 2008). The effect of bank time-invariant characteristics is removed and the underlying relationship between bank interest margins and other variables specified in the regression model can be examined. In all estimations, one-quarter lag of each of bank-specific and macro-economic variables is used as in Chen et al. (2017), Birchwood et al. (2017), Khan et al. (2017), Kim & Sohn (2017) to mitigate any possible endogeneity bias. Furthermore, this study assumes that banks take into account their current specific characteristics and macroeconomic conditions when determining the interest margins in the next period. In our regression estimations, robust standard errors are clustered at the bank level.

3.2.1 Construction of liquidity measures

Following the literature, four measures of *Liquidity* are employed in this study. *LIQUID ASSETS* is the ratio of liquid assets to total assets. Banks invest in liquidity as it helps insulate their loans from the effects of monetary shocks (Cornett et al. 2011). Liquidity is expected to have a positive effect on bank interest margin as banks are more likely to adjust their lending rates upwards to reflect the costs associated with investing in liquidity.

Alternatively, the study uses the Net Stable Funding Ratio (*NSFR*) proposed by the Basel Committee on Banking Supervision (BCBS) in the Basel III accord as a measure of liquidity. The aim of NSFR is to promote longer term funding of banking institutions' assets as well as other activities. In other words, NSFR is designed to ensure that a bank relies on more stable and long term sources of funding to finance their liquid assets, which reduces the risk associated with maturity transformation Chiaramonte & Casu (2017). For a certain amount of liquidity of the bank's assets, a minimum acceptable amount of stable funding is required meaning that the required ratio is more than 100 per cent. The NSFR is

the ratio between available stable funding (ASF) and the required stable funding (RSF). ASF is the weighted sum of funding sources including capital and other liabilities over a one-year horizon and reflects the contractual maturity of those liabilities. RSF is the weighted sum of the various assets as well as off-balance sheets (OBS) exposures of the bank. The RSF calculation requires specific RSF factor that indicates the proportion of the exposure that should be backed by stable sources of funding. The weights associated with the ASF and RSR factors are defined in the 2010 version of the Basel III accord (Basel Committee on Banking Supervision 2010) and subsequently revised in 2014 (Basel Committee on Banking Supervision 2014). This study, therefore, follows the literature (e.g. DeYoung & Jang 2016, Hong et al. 2014) to construct two NSFR measures: *NSFR2010* and *NSFR2014*. The ASF and RSR factors are given in Table B1 in the Appendix.

$$NSFR = \frac{ASF}{RSF} \tag{2}$$

Finally, the study employs the Liquidity Coverage Ratio (LCR) as a proxy for liquidity (Basel Committee on Banking Supervision 2013). Liquidity Coverage Ratio is designed to ensure that banks maintain an adequate amount of unencumbered high-quality assets (HQLA) to meet their liquidity needs for a 30-calendar-day liquidity stress scenario. The LCR is defined as the ratio of HQLA to total net cash outflows over the 30-day stress period:

$$LCR = \frac{Stock\ of\ HQLA}{Net\ cash\ outflows\ over\ 30\ calendar\ days} \tag{3}$$

where HQLA consists of cash or other assets with the potential to be unencumbered over the next 30-day stress scenario and can be immediately converted into cash at little or no loss of value. Net cash outflows is the difference between total expected cash outflows and total expected cash inflows over the 30-day stress period. The LCR, therefore, assesses banks' survivability under extreme liquidity conditions (Du 2017). We follow Hong et al. (2014) to calculate LCR and Table B2 in the Appendix provides the comprehensive construction of LCR.

It should be noted that the banking literature also uses the concept of liquidity

creation as a proxy of liquidity risk. However, unlike our three measures of liquidity, liquidity creation of a bank refers to its provision of finance to the real sector. The three liquidity measures employed in this study, on the other hand, refer to either the ability of banks to turn their assets into cash quickly with little impact on their value (Brunnermeier 2009) or the ability to raise funds to meet financial obligations in a timely fashion. Therefore, liquidity creation measure does not offer insight on how banks with varying market power price the cost of liquidity into their margins. For this reason, this study does not use liquidity creation as a proxy of liquidity.

3.2.2 Construction of market power measures

In this study, two measures of *Market power* (the conventional and the funding-adjusted Lerner index) which are used extensively in the literature are employed. The first measure of bank market power (*LERNER*) is measured by the traditional Lerner index (Lerner 1934) that uses the information on bank assets and funding and captures the pricing power of the banks (Beck et al. 2013). Compared with other measures of competition (e.g. the Panzar and Rosse H-statistic) the Lerner index, which measures the disparity between price and marginal cost expressed as a percentage of price, does not require the market to be in the long-run equilibrium (Beck et al. 2013). The index is also a better measure of bank-specific market power than measures of market concentration or market share (such as the Herfindahl-Hirschman index) as these measures only reflect the level of concentration in a geographically defined market rather than the pricing power of individual banks. This is because the Lerner index focuses on the banks' conduct by incorporating information on the profit and costs from the operations of the banks. Therefore, it reflects better the pricing power on both the asset and funding sides of the banks. Unlike concentration measures, Lerner index does not require information on the geographic product markets. Such information is difficult to obtain as banks often operate in more than one country (Beck et al. 2013). While the banking literature has reached the conclusion that the link between concentration and competition in banking is very weak (Schaeck & Cihak 2013) and, to the best of the author's

knowledge, concentration measures are not used as proxies of bank market power, Lerner index is used to capture market power in this study.

The conventional Lerner index is expressed as follows:

$$LERNER_{it} = \frac{P_{it} - MC_{it}}{P_{it}} \tag{4}$$

where P_{it} and MC_{it} are the price of a bank's outputs and its marginal cost, respectively. The price of the bank's outputs is the quotient between total bank revenues (interest and non-interest income) and total assets. Marginal costs can be obtained after estimating the following trans-log total cost function as in Berger et al. (2009), Beck et al. (2013):

$$\begin{aligned} \ln(TC_{it}) = \alpha_0 + \alpha_1 \ln(Q_{it}) + \frac{1}{2}\alpha_2(\ln(Q_{it}))^2 + \sum_{n=1}^{3} \beta_n \ln(W_{n,it}) \\ + \frac{1}{2}\sum_{m=1}^{3}\sum_{n=1}^{3} \gamma_{mn} \ln(W_{m,it}) \ln(W_{n,it}) + \sum_{n=1}^{3} \mu_n \ln(Q_{it}) \ln(W_{n,it}) \\ + \delta_1 T + \delta_2 \frac{1}{2}(T)^2 + \delta_3 T \ln(Q_{it}) + \sum_{n=1}^{3} \rho_n T \ln(W_{n,it}) + \varepsilon_{it} \end{aligned} \tag{5}$$

where TC_{it} represents total costs which are the sum of interest expenses, personnel expenses and other operating and administrative expenses. Bank output Q_{it} is total assets and W_{it} denotes the price of three inputs: capital (W_1), labour (W_2) and borrowed funds (W_3). The price of funds is the ratio of interest expenses to total funds (the sum of short-term funding and total deposits), physical capital price is computed as total administrative and operating expenses to total assets, the price of labour is measured as personnel expenses divided by total assets. Changes in the business cycle and technological development are accounted for by a trend (T) and ε_{it} is an error term. Following Beck et al. (2013), a number of restrictions are imposed to achieve the homogeneity of degree one in input prices: $\sum_{n=1}^{3} \beta_n = 1$, $\sum_{n=1}^{3} \mu_n = 0$, $\forall m \in \{1, 2, 3\} : \sum_{n=1}^{3} \gamma_{mn} = 0$. The translog function is estimated using panel fixed-effects technique to capture the specificities of each firm. Marginal costs are calculated as follows:

$$MC_{it} = \frac{\partial TC_{it}}{\partial Q_{it}} = \frac{TC_{it}}{Q_{it}} \left(\hat{\alpha_1} + \hat{\alpha_2} \ln(Q_{it}) + \sum_{n=1}^{3} \hat{\mu_n} \ln W_{n,it} + \hat{\delta_3} T \right) \tag{6}$$

The conventional Lerner index (*LERNER*) is often criticized for the fact that it is likely to reflect the monopoly power emanating from deposit markets which is the ability of banks to raise funds at a relatively less expensive cost (e.g. Maudos & de Guevara 2007, Turk-Ariss 2010). Turk-Ariss (2010) points out that when determining the price of loans, funding costs, a risk premium and another premium to reflect the market power of the bank are taken into consideration. That is, the bank's market power in the deposit market is already taken into account in the price of the loans. Therefore, including financing costs in the cost function when computing market power may lead to bias in the results. The funding-adjusted Lerner (*ADJUSTED LERNER*) which excludes the funding cost in the computation is used as an alternative measure of market power. That is, in the trans-log cost function (Equation (5)) and the marginal cost function (Equation (6)), the price of borrowed funds (W_3) is not included. By doing this, the pure pricing power that does not reflect the market power in the deposit market when raising funds can be obtained (Maudos & de Guevara 2007). Numerous studies show that banks operating in markets with less intensive competition charge higher interest margins than those operating in markets with more dispersed market power (McShane & Sharpe 1985, Demirguc-Kunt et al. 2004, Peria & Mody 2004). It is therefore expected that the more market power a bank has (higher Lerner index) the higher its margin will be, pointing to the positive association between market power and interest margin. As a robustness check, we also define *HIGH LERNER* as a dummy variable which equals 1 if a bank's *LERNER* is larger than the median value in a particular quarter and 0 otherwise.

3.2.3 Bank-specific characteristics

The model also includes other bank-specific factors that are considered to be important determinants of bank spreads following the empirical literature. Credit risk (*CREDIT RISK*) is defined as the ratio of non-performing loans to total loans.

Credit risk, which reflects the expected loss from loan default, is an important risk factor and is expected to be positively related to bank interest margins. To compensate for the expected losses arising from loan default, banks with a high ratio of non-performing loans to total loans are likely to increase their interest margins by raising loan rates relative to deposit rates more than those with lower credit risk (Peria & Mody 2004).

Bank capitalization (*CAPITALIZATION*) is measured by the ratio of equity to total assets and is expected to have a positive association with bank spreads. Capital enhances the loss-absorbing capacity of banks and those that have sufficient capital have a lower probability of default, especially in times of crisis. Highly capitalised banks are less risky and are able to attract deposits at lower rates. This is consistent with the empirical evidence of Gambacorta & Shin (2018) who find that higher capital ratios are associated with lower funding costs. Furthermore, as capital is costly and if this cost is priced into the spreads, one should expect that capital increases bank margins. Therefore, banks with more capital may have larger bank spreads.

Bank expenditure (*EXPENDITURE*) is proxied by total non-interest expenses divided by total operating income. It is expected that banks that operate with higher administrative expenditures are less efficient and are likely to incorporate these costs into their spreads. For this reason, bank interest margins may increase with bank expenditure (Peria & Mody 2004, Maudos & de Guevara 2004).

The effect of income diversification (*DIVERSIFICATION*), which is the ratio of bank non-interest revenue to total operating income, on bank spreads is ambiguous. Revenue diversification might be negatively related to bank interest margins. Lepetit et al. (2008) document that the larger income share from commissions and fees is associated with lower interest margins and loan spreads. The authors argue that banks may reduce their spreads to attract customers for their non-traditional business. However, Nguyen (2012) shows that the interest margin is not always inversely related to income from non-traditional activities.

3.2.4 Macroeconomic variables

Macroeconomic variables are included in the model to control for the effects of these factors on interest margins. The growth rate of real GDP (*GDP GROWTH*) captures the effect of the business cycle. According to Peria & Mody (2004), inflation (*INFLATION*) exerts an asymmetric influence on deposit and lending rates, implying that inflation might affect bank interest margins. The federal fund rate (*FED RATE*) is included to capture the effects of interest rate policy which is related to bank risk-taking (e.g., Ioannidou et al. 2014), and in turn net interest margins. *CRISIS* is a dummy variable that equals to 1 for the period of the Global Financial Crisis, 2007 Q4 to 2009 Q2.

4 Empirical results and Discussions

4.1 Summary descriptive statistics

The descriptive statistics for all the variables used in the regression are shown in Table 2. Averaging across all observations, the mean values of NIM_1 and NIM_2 are 3.02% and 2.26%, respectively. The interest margins (NIM_1 and NIM_2) of the banks in the sample are relatively small, with 7.18%, 5.11% being the highest and 0.72% and 0.57% being the lowest.

Within the sample period, the mean of market power, which is proxied by the Lerner index (*LERNER*), is around 0.41 suggesting that banks on average priced their product at around 41% above marginal cost. The alternative measure of market power, which is the funding-adjusted Lerner index (*ADJUSTED LERNER*) also averages at 0.38, indicating a 38% mark-up. However, there is a great disparity in the degree of market power when the bank with the largest *LERNER* can charge 68% above its marginal cost while the one with the least market power can only charge an addition of 13%. The figures for the *ADJUSTED LERNER* are 62% and 10%, respectively. Overall, the *ADJUSTED LERNER* is smaller than the conventional *LERNER*, which indicates that the latter overestimates the degree of market power. This suggests that the use of an alternative measure of market

power in this study is necessary.

As for the measures of liquidity, while the 2010 Net Stable Funding Ratio (*NSFR2010*) averages at 1.54 and ranges from 0.76 to 5.02 in the sample, the mean of *NSFR2014* is 1.43 with the highest and lowest being 4.70 and 0.71, respectively. The figures demonstrate that banks in the U.S. appear to have more available stable funding than the amount that is required. Similarly, the mean of the Liquidity Coverage Ratio (LCR) across the sample is 1.39, with the highest and the lowest investment in high quality liquid assets in proportion to net cash outflows being 3.09 and 0.16, respectively. *LIQUIDITY ASSETS* which is the ratio of liquidity assets over total assets averages at 27.76%, with the highest and the lowest being 71.59% and 2.86%, respectively.

Table 2: Summary statistics for the regression variables

Variable	*Mean*	*S.D.*	*Min*	*Max*	*Obs.*
$NIM_{1,t}$	2.9833	1.5240	0.7235	7.1893	325073
$NIM_{2,t}$	2.2368	1.1115	0.5799	5.1112	325073
$LERNER_{t-1}$	0.4109	0.1027	0.1336	0.6841	310033
$ADJUSTED\ LERNER_{t-1}$	0.3802	0.1000	0.1080	0.6288	310033
$HIGH\ LERNER_{t-1}$	0.5000	0.5000	0.0000	1.0000	310033
$NSFR2010_{t-1}$	1.5482	0.6704	0.7627	5.0246	310033
$NSFR2014_{t-1}$	1.4387	0.6274	0.7156	4.7047	310033
LCR_{t-1}	1.3910	0.4513	0.1613	3.0982	310033
$LIQUIDITY\ ASSETS_{t-1}$	27.7628	14.8760	2.8616	71.5972	310033
$CAPITALIZATION_{t-1}$	10.7055	3.4844	5.7177	25.4941	310033
$EXPENDITURE_{t-1}$	47.6791	13.9406	19.6217	94.2795	310033
$DIVERSIFICATION_{t-1}$	11.5957	8.3190	0.8000	53.5450	310033
$CREDIT\ RISK_{t-1}$	1.4324	1.9408	0.0006	11.0698	310033
$FED\ RATE_{t-1}$	2.2074	1.8305	0.0700	5.5900	310033
$GDP\ GROWTH_{t-1}$	0.4370	0.6679	-2.1638	1.6982	310033
$INFLATION_{t-1}$	2.4731	1.0849	-0.3555	3.8391	310033
CRISIS	0.1523	0.3593	0.0000	1.0000	310033

This table reports the descriptive statistics for key variables in the regressions from 2001 to 2018. NIM_1 is defined as interest income on loans to total loans minus interest expenses of deposits to total deposits. NIM_2 is net interest income to total assets. *LIQUIDITY ASSETS* is liquid assets to total assets. *NSFR2010* is the ratio of available stable funding to required stable funding as defined by Basel III 2010. *NSFR2014* is the ratio of available stable funding to required stable funding as defined by Basel III 2014. *LCR* is the ratio of stock of HQLA to net cash outflows over the 30-day stress period. *LERNER* represents the conventional Lerner index and *ADJUSTED LERNER* denotes the funding-adjusted Lerner index. *HIGH LERNER* is a dummy variable equal to 1 if a bank's *LERNER* is larger than the median value in a quarter and 0 otherwise. *CREDIT RISK* is the ratio of non-performing loans to total loans. *CAPITALIZATION* is defined as equity to total assets. *EXPENDITURE* is the ratio of total non-interest expenses to operating income. *DIVERSIFICATION* is non-interest revenue divided by operating income. *FED RATE* is the federal fund rate. *GDP GROWTH* represents real GDP growth rate and *INFLATION* denotes inflation rate. *CRISIS* is a dummy variable that equals to 1 for the period of the Global Financial Crisis, 2007 Q4 to 2009 Q2. Bank-specific variables are winsorised at the top and bottom 1% of the distribution

Regarding credit risk, which is proxied by the ratio of non-performing loan over total loans, the mean of *CREDIT RISK* is 1.43% which is relatively low. The highest percentage of credit risk is 11.06, while the lowest is 0.06. As can be seen from the table, the degree of capitalization (*CAPITALIZATION*) of the banks in the sample, on average, is 10.70% while the figure for the highest capitalised bank is 25.49% and the lowest capitalised one is 5.71%. Within the sample period, those banks appear to be relatively efficient with the ratio of non-interest expenses to operating income (*EXPENDITURE*) averages at 47.67% with the highest and the lowest figure being 94.27% and 19.62%, respectively. On average, only 11.59% of the income of U.S. banks is generated from non-interest charging activities while the highest and lowest ratios of *DIVERSIFICATION*) are 53.54% and 0.80%, respectively.

The correlation matrix of the regression variables is given in Table B3 in the Appendix. Overall, the pair-wise correlation coefficients among the explanatory variables in each regression specification are less than 0.7, indicating that those explanatory variables are not highly correlated and multicollinearity is not a major problem in our empirical set-up.

4.2 Main estimation results

4.2.1 The interaction of bank market power and liquidity measures on net interest margins

In this section, we conduct a multivariate regression analysis of bank net interest margins from 2001 to 2018 to understand how banks with varying degree of market power price their liquidity. Net interest margin (NIM_1) is the ratio of interest income on loans to total loans minus interest expenses of deposits to deposits. Bank liquidity is measured by *LIQUID ASSETS*, *NSFR2010*, *NSFR2014* and *LCR* which are the ratio of liquid assets to total assets, the 2010 Net Stable Funding Ratio, the 2014 Net Stable Funding Ratio and the Liquidity Coverage Ratio, respectively. Bank market power is proxied by the conventional Lerner index (*LERNER*). We also include a number of bank-specific variables including credit

risk (*CREDIT RISK*), bank capitalization (*CAPITALIZATION*), expenditure ratio (*EXPENDITURE*) and income diversification (*DIVERSIFICATION*) to evaluate how much of the variation in bank net interest margins are explained by firm-specific characteristics. All variables are winsorised at the 1st and 99th percentiles. Bank and time fixed effects are included in all regressions and robust standard errors are clustered at the bank level.

Table 3 presents the empirical results of the panel estimation of Equation (1) with eight specifications. Columns (1), (3), (5), (7) present the baseline regression results while columns (2), (4), (6), (8) include the interaction between measures of liquidity and bank market power. Across all model specifications, market power (*LERNER*) has a significant and positive influence on bank margins which is consistent with the expectation that banking firms in less competitive markets tend to have larger margins. The positive association between market power and interest margin is consistent with the argument that banking firms take advantage of their pricing power at the expense of their depositors and borrowers. The positive coefficients of *LIQUID ASSETS* and *LCR* (significant at 1% level) across the model specifications indicate that bank margins and their investments in liquid assets are positively associated. It should be noted that as banks hold more liquid assets, their liquidity risk is reduced, which points to the negative association between liquidity risk of banks and their interest margins. This relationship can be explained by the fact that holding liquid assets represents opportunity costs to banks as they have to forego interest earnings from lending, and these costs are priced into interest margins. Similarly, *NSFR2010* and *NSFR2014* also exert a positive influence on bank margins as evidenced by their significant coefficients at 1% significance level. Net Stable Funding Ratio represents the assets and off-balance sheet activities of the banks that should be backed by stable funding sources. As stable funding sources such as equity and other long-term liabilities are more expensive relative to other short-term funding sources, the banks' interest margins should reflect those costs. The finding is interesting as it has implications for the regulatory authority. That is, although from a banking regulation perspective banks benefit

from holding liquid assets as the likelihood of liquidity crisis is reduced, increased costs associated with strict liquidity requirement are likely to be passed on to banks' customers in the form of higher interest margins.

Table 3: The impact of liquidity measures on bank net interest margins

NIM_1	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$LERNER_{t-1}$	2.3316***	2.7675***	2.3241***	2.7988***	2.3250***	2.7900***	2.3129***	2.3643***
	(0.0344)	(0.0632)	(0.0340)	(0.0789)	(0.0340)	(0.0786)	(0.0336)	(0.0364)
$LIQUID\ ASSETS_{t-1}$	0.0030***	0.0038***						
	(0.0007)	(0.0011)						
$LERNER\ X\ LIQUID\ ASSETS_{t-1}$		-0.0160***						
		(0.0020)						
$NSFR2010_{t-1}$			0.0541***	0.0855***				
			(0.0118)	(0.0244)				
$LERNER\ X\ NSFR2010_{t-1}$				-0.3086***				
				(0.0484)				
$NSFR2014_{t-1}$					0.0595***	0.0878***		
					(0.0126)	(0.0263)		
$LERNER\ X\ NSFR2014_{t-1}$						-0.3251***		
						(0.0519)		
LCR_{t-1}							0.2422***	0.5390***
							(0.0282)	(0.0983)
$LERNER\ X\ LCR_{t-1}$								-0.6920***
								(0.2592)
$CAPITALIZATION_{t-1}$	0.0011	0.0009	0.0004	0.0006	0.0004	0.0006	0.0005	0.0005
	(0.0013)	(0.0014)	(0.0014)	(0.0014)	(0.0014)	(0.0014)	(0.0013)	(0.0013)
$EXPENDITURE_{t-1}$	0.0025***	0.0023***	0.0024***	0.0024***	0.0024***	0.0024***	0.0023***	0.0023***
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
$DIVERSIFICATION_{t-1}$	-0.0122***	-0.0124***	-0.0121***	-0.0122***	-0.0121***	-0.0122***	-0.0121***	-0.0121***

	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)
CREDIT RISK$_{t-1}$	-0.0011	-0.0011	-0.0017	-0.0014	-0.0017	-0.0014	-0.0015	-0.0015
	(0.0014)	(0.0014)	(0.0014)	(0.0014)	(0.0014)	(0.0014)	(0.0014)	(0.0014)
Constant	1.3381***	1.1440***	1.2868***	1.0538***	1.2895***	1.0616***	1.0405***	1.0170***
	(0.0714)	(0.0738)	(0.0509)	(0.0628)	(0.0504)	(0.0625)	(0.0315)	(0.0333)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	310,033	310,033	310,033	310,033	310,033	310,033	310,033	310,033
R-squared	0.8875	0.8876	0.8875	0.8876	0.8875	0.8876	0.8876	0.8876

The table reports the fixed effects panel regressions of the impacts of different measures of liquidity on bank net interest margins with varying degree of market power from 2001 to 2018. NIM_1 is defined as interest income on loans to total loans minus interest expenses of deposits to total deposits. *NSFR2010* is the ratio of available stable funding to required stable funding as defined by Basel III 2010. *NSFR2014* is the ratio of available stable funding to required stable funding as defined by Basel III 2014. *LCR* is the ratio of stock of HQLA to net cash outflows over the 30-day stress period. *LERNER* represents the conventional Lerner index. *CREDIT RISK* is the ratio of non-performing loans to total loans. *CAPITALIZATION* is defined as equity to total assets. *EXPENDITURE* is the ratio of total non-interest expenses to operating income. *DIVERSIFICATION* is non-interest revenue divided by operating income. Bank and time fixed effects are included in all regressions. Robust standard errors are clustered at the bank level and are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

The main interest of the chapter is the interaction terms of *LERNER* and asset liquidity measures, and it is found that the interaction terms (*LERNER X LIQUID ASSETS* and *LERNER X LCR*) have a negative effect on bank margins in columns (2) and (8) of Table 3. Specifically, the estimation results suggest that although banks price the cost of holding liquid assets into the margins, market power reduces this effect. For example, a standard deviation increase in *LERNER* reduces the effects of a 1-percentage-point increase in *LIQUID ASSETS* on NIM_1 by approximately 0.16 ($= 0.0160 \times 0.1027$) percentage points in a quarter. This finding implies that as market power increases, holding more liquid assets appears to be less costly to banks. In other words, banks incorporate the cost associated with holding liquid assets into their margins to a lesser extent as they achieve more market power. This result may be due to the fact that with more market power, banks may find themselves in a better position to price their products and services, to obtain better terms in the contracts with customers, to exploit more business opportunities, thereby earning more income which can compensate for the costs of holding more liquid assets. These arguments are in line with prior studies. For example, according to Acharya & Viswanathan (2011), investing in low-yielding liquid assets imposes opportunity costs to banks and these costs tend to rise in competitive banking markets. A similar finding is also reported in columns (4) and (6), the multiplications of *LERNER* and *NSFR2010* or *NSFR2014* are statistically significant at 1% level and negatively affect bank interest margins. It should be noted that the Net Stable Funding Ratios proposed in the Basel III are different from *LIQUID ASSETS* and *LCR* in the sense that while the former take into account required funding liquidity from the liability side of the balance sheet, *LIQUID ASSETS* and *LCR* only account for asset liquidity of banks. The finding is consistent with prior literature. Dinger & von Hagen (2009) point out that as uninsured wholesale lenders can either charge higher interest rates to risky banks or ration their funds, the cost of wholesale funding depends upon the level of bank risk. Therefore, banks with greater market power are able to access to wholesale funding at a relatively lower cost as market power is often perceived as lower risk

according to the classic 'charter value' paradigm (Keeley 1990). In line with these arguments, Cocco et al. (2009) argue that as banks' bargaining power increases with their market power, dominant banks are likely to be charged lower interest rates on their borrowings, particularly in the interbank market. Investment in liquidity becomes less costly for banks with greater market power.

Some other findings are also worth noting. Bank expenditure (*EXPENDITURE*) that is measured by the ratio of non-interest expenses to operating income appears to be an important determinant of bank margins. The positive and statistically significant effect of bank expenditure on interest margins is found in all model specifications. This is because bank expenditure is considered to be the cost of financial intermediation and should be priced into the spreads (e.g. Maudos & de Guevara 2004). Additionally, the impact of revenue diversification (*DIVERSIFICATION*) of bank earnings on interests margins is negative and significant across the estimation models, which suggests that banks with a higher level of non-traditional income reduce their margins. Similar findings are found for European banks (see Lepetit et al. 2008). The authors argue that in order to increase their earnings from transaction-based fee business, banks may reduce their interest margins in the traditional banking business.

4.2.2 Does bank size matter?

The effect of the interaction between bank market power and liquidity on net interest margins might differ considerably among banks of different sizes as the literature has documented differences in bank behaviours by bank size (e.g. Cornett et al. 2011). Our sample comprises numerous small banks and a minority of large banks. We are concerned that the regression results for the full sample could be driven by the behaviours of small banks. In this sub-section, we split our sample into subsamples: large banks, medium banks and small banks and re-estimate the regression models for each subsample following the criteria used by Kashyap & Stein (2000). In the unreported results, we observe that the size of banks in the top 1% is dramatically larger than those of other groups. Therefore, large

banks are defined as those with total assets above the 99th percentile, medium banks are those with total assets ranging from the 95th to 99th percentiles, and small banks are those with total assets less than the 95th percentile in each quarter period. Table 4 summarises the regression results for three groups of banks, that are large, medium and small banks, respectively. In all regressions, bank-specific characteristics, bank and time fixed effects are included and robust standard errors are clustered at the bank level.

Columns (1)–(4) report the regression results using different measures of liquidity for large banks. While the coefficients of *LIQUID ASSETS* and *LCR* are not significant, the estimated coefficients of *NSFR2010* or *NSFR2014* are both positive and statistically significant at 10%. The multiplication variables of *NSFR2010* and *NSFR2014* with *LERNER*, however, appear to be negative and statistically significant determinants of bank margins at 1% level. Similar findings are documented in columns (5)–(8). As for medium banks, the estimated coefficients of the interaction terms of bank liquidity measures and market power are negative and statistically significant at conventional levels. Columns (9)–(12) report the regression results for small banks. Consistent with prior findings, the interaction terms of liquidity measures and bank market power are negatively associated with bank interest margins, and the effect is significant at 1% significant level across model specifications. The findings indicate that U.S. banks' pricing behaviour with respect to liquidity costs is sensitive to the degree of market power, and the effect appears to be more important for smaller banks. Our results highlight the differences in bank behaviours for different groups of bank size. Small banks might be more concerned with the competition in the market and reduce their interest margins when possible to attract more customers. This might lead to a relatively stronger effect of market power on their pricing behaviour with respect to liquidity costs than very large banks that already dominate the market.

Table 4: The impact of liquidity measures on bank net interest margins for small, medium and large banks

	Large banks (≥ 99%)				*Medium banks (95% ∼ 99%)*				*Small banks (≤ 95%)*			
NIM_1	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
$LERNER_{t-1}$	1.8075	2.8415***	2.8555***	2.1814***	2.7677***	3.1243***	3.1186***	2.1369***	2.7629***	2.7495***	2.7420***	2.3849***
	(1.1843)	(0.7102)	(0.7115)	(0.5327)	(0.3235)	(0.3626)	(0.3595)	(0.2047)	(0.0612)	(0.0792)	(0.0789)	(0.0362)
$LIQUID\ ASSETS_{t-1}$	0.0079				0.0050				0.0034***			
	(0.0114)				(0.0056)				(0.0011)			
$LERNER\ X\ LIQUID\ ASSETS_{t-1}$	-0.0013				-0.0205**				-0.0155***			
	(0.0269)				(0.0084)				(0.0020)			
$NSFR2010_{t-1}$		0.1891*				0.2055***				0.0730***		
		(0.1036)				(0.0740)				(0.0255)		
$LERNER\ X\ NSFR2010_{t-1}$		-0.6558***				-0.6529***				-0.2718***		
		(0.2021)				(0.1878)				(0.0486)		
$NSFR2014_{t-1}$			0.2138*				0.2215***				0.0742***	
			(0.1107)				(0.0789)				(0.0274)	
$LERNER\ X\ NSFR2014_{t-1}$			-0.7210***				-0.7031***				-0.2862***	
			(0.2202)				(0.2014)				(0.0521)	
LCR_{t-1}				1.7283				0.9200				0.5984***
				(1.0873)				(1.1144)				(0.0908)
$LERNER\ X\ LCR_{t-1}$				-2.6927*				-4.2963*				-0.8489***
				(1.5743)				(2.5167)				(0.2354)
Constant	1.1427*	1.5349***	1.5192***	1.4432***	1.3074***	1.0379***	1.0370***	1.1007***	1.1579***	1.0649***	1.0738***	1.0088***
	(0.6823)	(0.5199)	(0.5178)	(0.3912)	(0.3805)	(0.2235)	(0.2219)	(0.1371)	(0.0723)	(0.0657)	(0.0654)	(0.0337)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,891	2,891	2,891	2,891	11,927	11,927	11,927	11,927	294,567	294,567	294,567	294,567
R-squared	0.6881	0.6893	0.6893	0.6899	0.8615	0.8620	0.8620	0.8625	0.8921	0.8920	0.8920	0.8921

The table reports the fixed effects panel regressions of the impacts of different measures of liquidity on bank net interest margins with varying degree of market power from 2001 to 2018 for large, medium and small banks. Large banks are those with total assets above the 99th percentile, medium banks are those with total assets ranging from the 95th to 99th percentiles, and small banks are those with total assets less than the 95th percentile. NIM_1 is defined as interest income on loans to total loans minus interest expenses of deposits to total deposits. *NSFR2010* is the ratio of available stable funding to required stable funding as defined by Basel III 2010. *NSFR2014* is the ratio of available stable funding to required stable funding as defined by Basel III 2014. *LCR* is the ratio of stock of HQLA to net cash outflows over the 30-day stress period. *LERNER* represents the conventional Lerner index. Bank and time fixed effects are included in all regressions. Robust standard errors are clustered at the bank level and are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

4.2.3 Macroeconomic factors

In this section, we include macroeconomic variables into the regressions to investigate their potential influence on the findings. Following the literature, we consider federal fund rate (*FED RATE*), real GDP growth rate (*GDP GROWTH*), inflation rate (*INFLATION*) and crisis dummy (*CRISIS*) that may affect bank net interest margins. Our regressions also include other bank-specific characteristics and bank fixed effects. Robust standard errors are clustered at the bank level.

In general, Table 5 documents that all the variables that are considered in this study are shown to significantly influence bank margins. The results show that across the models, interest margins increase when banks have more market power. This is consistent with the well-known 'structure - conduct - performance' view in the literature which suggests that with increase market power, banks tend to charge higher interest rates at the expense of their customers in a monopolistic setting (e.g. Berger & Hannan 1989, Corvoisier & Gropp 2002). Similar to prior findings, *LIQUID ASSETS*, *NSFR2010*, *NSFR2014* and *LCR* exert a positive and significant influence on bank spreads, suggesting the opportunity costs of investing in liquidity that should be incorporated into the margins. The interaction terms between these liquidity measures and *LERNER* appear to negatively affect interest margins, implying that liquidity is less costly to dominant banks with more market power. Overall, the findings are largely consistent with prior analyses when macroeconomic variables are not considered.

Table 5: The impact of liquidity measures on bank net interest margins including macroeconomic factors

NIM_1	(1)	(2)	(3)	(4)
$LERNER_{t-1}$	2.6882***	3.1087***	3.0935***	3.1094***
	(0.0479)	(0.0916)	(0.0914)	(0.0572)
$LIQUID\ ASSETS_{t-1}$	0.0081***			
	(0.0008)			
$LERNER\ X\ LIQUID\ ASSETS_{t-1}$	-0.0027**			
	(0.0014)			
$NSFR2010_{t-1}$		0.1561***		
		(0.0315)		
$LERNER\ X\ NSFR2010_{t-1}$		-0.0998*		
		(0.0570)		
$NSFR2014_{t-1}$			0.1769***	
			(0.0341)	
$LERNER\ X\ NSFR2014_{t-1}$			-0.1199*	
			(0.0614)	
LCR_{t-1}				0.7416***
				(0.1328)
$LERNER\ X\ LCR_{t-1}$				-0.7960**
				(0.3203)
$CAPITALIZATION_{t-1}$	0.0374***	0.0296***	0.0297***	0.0297***
	(0.0012)	(0.0017)	(0.0017)	(0.0018)
$EXPENDITURE_{t-1}$	-0.0035***	-0.0031***	-0.0031***	-0.0032***
	(0.0002)	(0.0004)	(0.0004)	(0.0004)
$DIVERSIFICATION_{t-1}$	-0.0121***	-0.0130***	-0.0130***	-0.0124***

	(0.0005)	(0.0008)	(0.0008)	(0.0008)
CREDIT RISK$_{t-1}$	0.0133***	0.0380***	0.0379***	0.0360***
	(0.0011)	(0.0017)	(0.0017)	(0.0017)
CRISIS	-0.0947***	-0.2212***	-0.2210***	-0.2165***
	(0.0027)	(0.0044)	(0.0044)	(0.0045)
FED RATE$_{t-1}$	0.0471***	0.0208***	0.0209***	0.0268***
	(0.0010)	(0.0016)	(0.0016)	(0.0017)
GDP GROWTH$_{t-1}$	-0.0664***	-0.0990***	-0.0990***	-0.1114***
	(0.0013)	(0.0019)	(0.0019)	(0.0020)
INFLATION$_{t-1}$	0.0128***	0.0374***	0.0374***	0.0384***
	(0.0008)	(0.0012)	(0.0012)	(0.0013)
Constant	-0.5143***	2.1164***	2.1328***	2.1451***
	(0.0649)	(0.0807)	(0.0806)	(0.0476)
Firm FE	Yes	Yes	Yes	Yes
Observations	310,033	310,033	310,033	310,033
R-squared	0.4790	0.3566	0.3565	0.3664

The table reports the fixed effects panel regressions of the impacts of different measures of liquidity on bank net interest margins with varying degree of market power from 2001 to 2018, including macroeconomic factors. NIM_1 is defined as interest income on loans to total loans minus interest expenses of deposits to total deposits. *LIQUIDITY ASSETS* is liquid assets to total assets. *NSFR2010* is the ratio of available stable funding to required stable funding as defined by Basel III 2010. *NSFR2014* is the ratio of available stable funding to required stable funding as defined by Basel III 2014. *LCR* is the ratio of stock of HQLA to net cash outflows over the 30-day stress period. *LERNER* represents the conventional Lerner index and *ADJUSTED LERNER* denotes the funding-adjusted Lerner index. *CREDIT RISK* is the ratio of non-performing loans to total loans. *CAPITALIZATION* is defined as equity to total assets. *EXPENDITURE* is the ratio of total non-interest expenses to operating income. *DIVERSIFICATION* is non-interest revenue divided by operating income. *FED RATE* is the federal fund rate. *GDP GROWTH* represents real GDP growth rate and *INFLATION* denotes inflation rate. *CRISIS* is a dummy variable that equals to 1 for the period of the Global Financial Crisis, 2007 Q4 to 2009 Q2. Bank fixed effects are included in all regressions. Robust standard errors are clustered at the bank level and are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

The impacts of macroeconomic factors on bank margins are consistent with the prior literature. As expected, the impact of the 2007 Global Financial Crisis (*CRISIS*) on interest margins is negative and significant at 1% level. It is documented that real GDP growth (*GDP GROWTH*) has a negative relationship with bank margins that points to the countercyclicality of bank margins. Similar findings are reported in Mamatzakis & Bermpei (2016). Higher bank margins when the economy experiences a contraction limit the credit opportunities, which will in turn deepen the economic downturn. This effect is known as the financial accelerator and has important macroeconomic implications (see Bernanke et al. 1996). Another possible explanation may be that during economic upswings, greater competition on the credit markets tends to drive down the credit standards (Entrop et al. 2015). Inflation (*INFLATION*), on the other hand, exerts a positive influence on interest margins in all model specifications as in Entrop et al. (2015). Last but not least, the results document the positive influence of federal fund rate (*FED FUND*) on bank margins which is consistent with the results of prior studies (e.g., Mamatzakis & Bermpei 2016).

As for bank-specific characteristics, the impact of capitalization (*CAPITALIZATION*) on bank margins is positive and significant as capital is costly, and this cost may be reflected in higher interest margins. Moreover, capital represents the amount of available fund to support the bank's business and a safety net in adverse business conditions. As banks acquire a sufficient amount of capital and become less risky, depositors are more willing to provide funds at a lower deposit rate, which subsequently allows banks to raise their margins. The results are consistent with the depositor discipline literature (e.g. Disli et al. 2013). Bank revenue diversification (*DIVERSIFICATION*) has a negative and significant sign which suggests that interest income from traditional business and non-interest income are substitutes. Furthermore, the results show that *CREDIT RISK* has a positive impact on bank interest margins, implying that a larger amount of non-performing loans is associated with larger margins. As credit risk increases, banks tend to increase their margins to compensate for the higher expected losses in the portfolios

which is in line with the results of other studies (e.g. Peria & Mody 2004, Amidu & Wolfe 2013). In other words, the positive and significant sign of credit risk indicates that a risk premium is applied by banks to the interest rates that they charge for their operations (Amidu & Wolfe 2013). Finally, the regression results document the negative significant association between bank expenditure (*EXPENDITURE*) and interest margins which suggests that management inefficiency also affects bank profitability.

4.3 Robustness checks

4.3.1 Alternative measure of net interest margins

For robustness checks, we use an alternative measure of net interest margin (NIM_2), which is the ratio of net interest income to total assets. Table 6 summarises the regression results examining the impact of the interaction between market power and bank liquidity on net interest margins. In all regressions, we include bank-specific variables, time and bank fixed effects. Robust standard errors are clustered at the firm level. The results are largely consistent with the main empirical findings.

Table 6: The impact of liquidity measures on bank net interest margins using an alternative measure of net interest margin

NIM_2	(1)	(2)	(3)	(4)
$LERNER_{t-1}$	3.3381***	3.4992***	3.5020***	2.9434***
	(0.0441)	(0.0505)	(0.0504)	(0.0304)
$LIQUID\ ASSETS_{t-1}$	0.0079***			
	(0.0006)			
$LERNER\ X\ LIQUID\ ASSETS_{t-1}$	-0.0167***			
	(0.0012)			
$NSFR2010_{t-1}$		0.1704***		
		(0.0133)		
$LERNER\ X\ NSFR2010_{t-1}$		-0.3948***		
		(0.0269)		
$NSFR2014_{t-1}$			0.1838***	
			(0.0143)	
$LERNER\ X\ NSFR2014_{t-1}$			-0.4263***	
			(0.0289)	
LCR_{t-1}				0.3369***
				(0.0614)
$LERNER\ X\ LCR_{t-1}$				-0.7340***
				(0.1585)
Constant	-1.0183***	-1.0111***	-1.0109***	-0.7732***
	(0.0490)	(0.0376)	(0.0374)	(0.0221)
Control variables	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Observations	310,033	310,033	310,033	310,033
R-squared	0.9191	0.9191	0.9191	0.9188

The table reports the fixed effects panel regressions of the impacts of different measures of liquidity on bank net interest margins with varying degree of market power from 2001 to 2018, using an alternative measure of net interest margins. NIM_2 is net interest income to total assets. *LIQUIDITY ASSETS* is liquid assets to total assets. *NSFR2010* is the ratio of available stable funding to required stable funding as defined by Basel III 2010. *NSFR2014* is the ratio of available stable funding to required stable funding as defined by Basel III 2014. *LCR* is the ratio of stock of HQLA to net cash outflows over the 30-day stress period. *LERNER* represents the conventional Lerner index. Bank and time fixed effects are included in all regressions. Robust standard errors are clustered at the bank level and are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 7: The impact of liquidity measures on bank net interest margins using an alternative measure of market power

NIM_1	(1)	(2)	(3)	(4)
$ADJUSTED\ LERNER_{t-1}$	2.9245***	2.9764***	2.9672***	2.5101***
	(0.0673)	(0.0836)	(0.0833)	(0.0384)
$LIQUID\ ASSETS_{t-1}$	0.0043***			
	(0.0011)			
$ADJUSTED\ LERNER\ X\ LIQUID\ ASSETS_{t-1}$	-0.0168***			
	(0.0022)			
$NSFR2010_{t-1}$		0.0983***		
		(0.0250)		
$ADJUSTED\ LERNER\ X\ NSFR2010_{t-1}$		-0.3352***		
		(0.0512)		
$NSFR2014_{t-1}$			0.1012***	
			(0.0269)	
$AJUSTED\ LERNER\ X\ NSFR2014_{t-1}$			-0.3533***	
			(0.0549)	
LCR_{t-1}				0.5735***
				(0.0999)
$ADJUSTED\ LERNER\ X\ LCR_{t-1}$				-0.7817***
				(0.2722)
Constant	1.0199***	0.9276***	0.9361***	0.9134***
	(0.0738)	(0.0631)	(0.0628)	(0.0337)
Control variables	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Observations	310,033	310,033	310,033	310,033
R-squared	0.8876	0.8876	0.8876	0.8876

The table reports the fixed effects panel regressions of the impacts of different measures of liquidity on bank net interest margins with varying degree of market power from 2001 to 2018, using an alternative measure of market power (*ADJUSTED LERNER*). For brevity, the definitions of the variables are given in Table 1. Bank and time fixed effects are included in all regressions. Robust standard errors are clustered at the bank level and are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

4.3.2 Alternative measure of bank market power

Next, we employ the funding-adjusted Lerner index (*ADJUSTED LERNER*) as an alternative measure for bank market power. It should be noted that the Lerner index employed in this study as a measure of market power may also reflect some form of pricing power emanating from deposit markets. Therefore it is possible that banks are able to raise interest margins due to their ability to acquire funding at a relatively low price. Berlin & Mester (1999) documents that penetration to a local deposit market enables banks that have more market power to have considerable access to relatively cheap deposit funding, thereby allowing them to maintain large interest margins. The *ADJUSTED LERNER* does not take into account the funding cost in its computation and does not reflect the market power in the deposit market, thereby reducing less bias in the regression results. Table 7 presents the estimation results employing the funding-adjusted Lerner index as a proxy for bank market power. The table provides consistent findings which suggest that banks leverage their market power to increase interest margins. The results also reveal that the pricing of the costs associated with liquidity into interest margins of banks differs with varying pricing power. Banks tend to incorporate the costs of liquidity into the interest margins to a lesser extent as their market power increases.

For ease of interpretation the results, we employ the dummy Lerner index (*HIGH LERNER*) as an alternative measure for bank market power. We define the variable as a dummy which equals to 1 if the *LERNER* value of a bank is larger than the median value in one particular quarter and 0 otherwise. Table 8 presents the estimation results and our conclusion holds across the estimation specifications.

Table 8: The impact of liquidity measures on bank net interest margins for banks with high and low market power

NIM_1	(1)	(2)	(3)	(4)
$HIGH\ LERNER_{t-1}$	0.3199***	0.3159***	0.3133***	0.2541***
	(0.0094)	(0.0121)	(0.0120)	(0.0049)
$LIQUID\ ASSETS_{t-1}$	0.0034***			
	(0.0007)			
$HIGH\ LERNER\ X\ LIQUID\ ASSETS_{t-1}$	-0.0029***			
	(0.0003)			
$NSFR2010_{t-1}$		0.0282**		
		(0.0115)		
$HIGH\ LERNER\ X\ NSFR2010_{t-1}$		-0.0490***		
		(0.0075)		
$NSFR2014_{t-1}$			0.0284**	
			(0.0122)	
$HIGH\ LERNER\ X\ NSFR2014_{t-1}$			-0.0510***	
			(0.0080)	
LCR_{t-1}				0.2956***
				(0.0269)
$HIGH\ LERNER\ X\ LCR_{t-1}$				-0.1637***
				(0.0313)
Constant	1.5159***	1.6741***	1.6790***	1.6623***
	(0.0720)	(0.0491)	(0.0487)	(0.0315)
Control variables	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Observations	310,033	310,033	310,033	310,033
R-squared	0.8808	0.8807	0.8807	0.8808

The table reports the fixed effects panel regressions of the impacts of different measures of liquidity on bank net interest margins with high and low degree of market power from 2001 to 2018, using an alternative measure of market power (*HIGH LERNER*). For brevity, the definitions of the variables are given in Table 1. Bank and time fixed effects are included in all regressions. Robust standard errors are clustered at the bank level and are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

4.3.3 System Generalized Methods of Moments

This study employs the two-step System Generalized Methods of Moments (SGMM) method (Arellano & Bover 1995, Blundell & Bond 1998) as an alternative approach to address the endogeneity concerns that might be present in our empirical set-up. The endogeneity problem may arise due to the reverse-causality issue. For example, the literature suggests that dominant banks are able to take advantage of their market power to earn higher interest margins. On the other hand, those banks that have high interest margins can use those earnings to increase their market, thereby gaining more market power. For this reason, the measure of market power is likely to be endogenous. In addition, according to Maudos & Solis (2009), banks may reduce their margins when offering traditional products to boost their income from non-traditional fee-generating businesses. Therefore, income diversification variable might also be endogenous.

We employ a dynamic model which includes the first lag of the dependent variable in the estimation. An advantage of this dynamic model is that it captures the effect of the previous values of interest margins on the current values. That is, the persistence in bank profits is accounted for by including the lagged dependent variable as one of the explanatory variables. Estimating a dynamic model using OLS would produce 'dynamic panel bias' due to the correlation of the lagged dependent variable and the error term. Therefore, we use the SGMM technique, which is efficient in dealing with endogeneity and provides consistent estimation for dynamic panel model in which lags of the dependent variable are included. Unlike the Difference GMM (DGMM) which is weak for unbalanced panels, SGMM allows for fixed effect in the panel (Roodman 2009*a*). Instead of transforming the regressors to eliminate the fixed effects as in DGMM, SGMM transforms the instruments to make them exogenous to the fixed effects (Roodman 2009*a*), thereby accounting for bank heterogeneity in the estimation. The SGMM estimator estimates simultaneously a set of equations in levels and differences. While the equation in levels is instrumented by the first-difference of the lagged values, the instruments in the equation in differences are the lagged level values (Roodman

2009*b*). All bank-specific characteristics are treated as endogenous variables, and used as instruments in the estimation. The optimal number of instruments employed in the estimation is based on the selection criteria following Arellano & Bond (1991), Roodman (2009*b*,*a*). In order to test for the validity of the models, several checks have been performed. The Arellano–Bond test ensures that there is no second-order serial correlation in the residuals (Arellano & Bond 1991). Hansen (1982) test of over-identification restrictions for which the null hypothesis is that instruments are exogenous is conducted.

Table 9: System General Method of Moment (SGMM) regressions for the impact of liquidity measures on bank net interest margins

NIM_1	(1)	(2)	(3)	(4)
NIM_{1t-1}	0.0187***	0.0183***	0.0182***	0.0234***
	(0.0006)	(0.0006)	(0.0006)	(0.0006)
$LERNER_{t-1}$	2.9240***	2.8661***	2.8125***	2.6880***
	(0.1105)	(0.1446)	(0.1442)	(0.0738)
$LIQUID\ ASSETS_{t-1}$	0.0144***			
	(0.0017)			
$LERNER\ X\ LIQUID\ ASSETS_{t-1}$	-0.0364***			
	(0.0034)			
$NSFR2010_{t-1}$		0.1124**		
		(0.0506)		
$LERNER\ X\ NSFR2010_{t-1}$		-0.5252***		
		(0.0910)		
$NSFR2014_{t-1}$			0.0981*	
			(0.0544)	
$LERNER\ X\ NSFR2014_{t-1}$			-0.5249***	
			(0.0975)	
LCR_{t-1}				0.8817***
				(0.1288)
$LERNER\ X\ LCR_{t-1}$				-1.4086***
				(0.3144)
Constant	1.0768***	1.7502***	1.8096***	0.5135***
	(0.0993)	(0.1297)	(0.1292)	(0.0784)
Control variables	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Observations	310,033	310,033	310,033	310,033
Banks	9703	9703	9703	9703
AR(1) p-value	0.004	0.002	0.001	0.003
AR(2) p-value	0.817	0.869	0.878	0.797
Hansen p-value	0.318	0.364	0.371	0.353

The table reports the System General Method of Moment (SGMM) regressions of the impacts of different measures of liquidity on bank net interest margins with varying degree of market power from 2001 to 2018, using an alternative measure of net interest margins. NIM_1 is defined as interest income on loans to total loans minus interest expenses of deposits to total deposits. *LIQUIDITY ASSETS* is liquid assets to total assets. *NSFR2010* is the ratio of available stable funding to required stable funding as defined by Basel III 2010. *NSFR2014* is the ratio of available stable funding to required stable funding as defined by Basel III 2014. *LCR* is the ratio of stock of HQLA to net cash outflows over the 30-day stress period. *LERNER* represents the conventional Lerner index. Time fixed effects are included in all regressions. Robust standard errors are clustered at the bank level and are reported in parentheses. The null hypothesis of the Hansen test is that the instruments are valid. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

The regression results from the SGMM estimation with the same variables considered in previous sections are shown in Table 9. Statistical diagnostics suggest that there is no second-order serial correlation. In addition, the Hansen (1982) J-statistics for over-identification restrictions are insignificant across the columns. The table documents the significant effect of the lag of interest margins (NIM_1). Bank margins are positively correlated over time, implying that banks tend to smooth their interest margins. This justifies the use of the dynamic model to capture the persistence effect of bank interest margins. Additionally, the positive and significant impacts of market power and liquidity measures are found across model specifications. Similar results in terms of sign and magnitude of the coefficients of the interaction variables are also obtained. Collectively, the findings are consistent with previous results from the main tables.

5 Concluding remarks

This chapter examines the impact of different measures of liquidity on bank interest margins and the role of market power as measured by the Lerner index in the relationship between liquidity and interest margins for a sample of U.S. banks from 2001 to 2018. Overall, the results reveal that liquidity ratio, the NSFR and LCR exert a positive influence on bank margins, stressing the costs associated with complying with regulatory liquidity standards.

Furthermore, the study is the first to investigate how banks with different level of market power price their liquidity into the interest margins. The findings highlight the importance of market power as it is documented that dominant banks with more pricing power incorporate the costs associated with investing in liquidity into the bank margins to a lesser extent relative to other banks with less market power. As a further step, we extend our analysis and find that the results are robust when considering the effects of a number of macroeconomic factors on bank margins. Our findings also show that the role of market power in affecting banks' valuation of liquidity appears to be more important for small banks than for large banks. We perform a number of robustness checks including employing

an alternative measure of interest margins, alternative measures of market power and SGMM method to address possible endogeneity concerns, and find that the main results hold.

The results of this study suggest important policy implications. While regulatory authorities require banks to invest in an adequate amount of liquidity to be able to withstand liquidity shocks, this comes with a cost that is incorporated into the banks' margins. In this regard, regulators should aim at the best possible trade-off between efficiency and resilience in the financial system when designing liquidity standards such as the NSFR and LCR. This study suggests that the cost of liquidity that is taken into account in interest margins can be reduced when the competition in the banking sector is less intense. It is, therefore, important for policy-makers and bank regulators to consider the role of market competition when implementing liquidity regulations that enhance the stability of the banking system and minimize the cost of financial intermediation.

Appendices

Table B1: Summary of Net Stable Funding Ratio calculation

	2010	*2014*
Available stable funding (ASF)		
Tier 1 capital	100%	100%
Tier 2 capital		
Time deposits with a remaining maturity of one year or more		
Other borrowed money with a remaining maturity of one year or more		
Stable retail transaction deposits	90%	95%
Small time deposits with a remaining maturity of less than one year		
Stable retail saving deposits		
Less stable retail transaction deposits	80%	90%
Less stable retail saving deposits		
Wholesale transaction deposits	50%	50%
Wholesale saving deposits		
Large time deposits with a remaining maturity of less than one year		
Foreign deposits		
Other borrowed money with a remaining maturity of less than one year		
Transaction deposits of U.S. government		
Transaction deposits of states and political subdivisions in the United States		
Transaction deposits of foreign governments and official institutions		
Required stable funding (RSF)		
Unused commitments	5%	5%
Letter of credit		
Securities in 0% risk weight category		
Securities in 20% risk weight category	20%	20%
Securities in 50% risk weight category	50%	50%
Loans in 0% risk weight category		
Trading securities in 0% risk weight category		
Other assets in 0% risk weight category		
Loans in 20% risk weight category	65%	65%
Trading securities in 20% risk weight category		
Other assets in 20% risk weight category		

Table B1 continued

Loans in 50% risk weight category	85%	85%
Trading securities in 50% risk weight category		
Other assets in 50% risk weight category		
Securities in 100% risk weight category and no risk weight	100%	100%
Loans in 100% risk weight category and no risk weight category		
Trading securities in 100% risk weight category and no risk weight category		
Other assets in 100% risk weight category and no risk weight category		

Source: Hong et al. (2014). In this study, the measures of *NSFR* are constructed following Basel Committee on Banking Supervision (2010), Basel Committee on Banking Supervision (2014), Hong et al. (2014), DeYoung & Jang (2016).

Table B2: Summary of Liquidity Coverage Ratio calculation

Panel 1: Stock of high-quality liquidity assets	100%
A. Level 1 assets	
Cash	
Securities in 0% risk weight category	
Reverse repos in 0% risk weight category	
B. Level 2 assets	85%
Securities in 20% risk weight category	
Reverse repos in 20% and 100% risk weight categories	
Panel 2: Cash outflows	
Stable retail transaction deposits	3%
Stable small time deposits with a remaining maturity of one month or less	3%
Stable saving deposits	3%
Stable foreign deposits with a remaining maturity of one month or less	5%
Less stable retail transaction deposits	10%
Less stable small time deposits with a remaining maturity of one month or less	10%
Less stable retail saving deposits	10%
Less stable foreign deposits with a remaining maturity of one month or less	25%
Stable wholesale transaction deposits	5%
Less stable wholesale transaction deposits	25%
Stable wholesale saving deposits	20%
Stable large time deposits with a remaining maturity of one month or less	20%
Less stable wholesale saving deposits	40%
Less stable large time deposits with a remaining maturity of one month or less	40%
Secured lending backed by level 2 assets	15%
All other secured funding transactions	100%
Other liabilities	100%
Negative fair value of derivatives	100%
Unused commitments of home equity line of credit	5%
Unused commitments of credit cards	5%
Unused commitments of commercial real estate	10%
Unused commitments for securities underwriting	100%
Other unused commitments	100%
Letters of credit	5%
Panel 3: Cash inflows	
50% of loans with a remaining maturity less than one month	100%
Positive fair value of derivatives	100%

Source: Hong et al. (2014). In this study, the measure of LCR is constructed following Basel Committee on Banking Supervision (2013), Hong et al. (2014).

Table B3: Correlations

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
(1)NIM_1	1.0000															
(2)NIM_2	0.9270	1.0000														
(3)*LERNER*	0.2090	0.2070	1.0000													
(4)*ADJUSTED LERNER*	0.1890	0.1960	0.8900	1.0000												
(5)*LIQUIDITY ASSETS*	0.1060	0.1050	0.0965	0.0676	1.0000											
(6)*NSFR2010*	0.1070	0.0882	0.1280	0.0900	0.8050	1.0000										
(7)*NSFR2014*	0.1090	0.0870	0.1290	0.0908	0.8030	0.9480	1.0000									
(8)*LCR*	0.0883	0.0110	0.0410	-0.0017	0.2800	0.3620	0.3630	1.0000								
(9)*CAPITALIZATION*	0.0310	0.0217	0.1200	0.0910	0.1650	0.2070	0.2160	0.2380	1.0000							
(10)*EXPENDITURE*	0.0971	0.0238	-0.1470	-0.2290	0.0423	0.0775	0.0803	0.0536	0.0539	1.0000						
(11)*DIVERSIFICATION*	0.0825	0.0346	0.3120	0.3130	0.0163	0.0319	0.0331	-0.0346	-0.0222	0.3040	1.0000					
(12)*CREDIT RISK*	0.0109	-0.0148	-0.0533	-0.0551	-0.0327	-0.0496	-0.0493	-0.0062	-0.0272	0.2180	0.0420	1.0000				
(13)*FED RATE*	-0.0812	-0.0279	-0.2880	-0.2460	-0.0926	-0.0546	-0.0543	0.0109	0.0197	-0.3300	-0.1080	-0.2510	1.0000			
(14)*GDP GROWTH*	0.1260	0.0953	0.1920	0.1700	0.0470	0.0416	0.0410	0.0308	-0.0103	0.0676	0.0634	-0.0804	0.0151	1.0000		
(15)*INFLATION*	0.0002	0.0205	-0.0570	-0.0471	-0.0250	-0.0110	-0.0106	0.0036	0.0175	-0.1160	-0.0312	-0.1620	0.4880	-0.0503	1.0000	
(16)*CRISIS*	-0.0913	-0.0561	-0.1760	-0.1550	-0.0764	-0.0488	-0.0477	-0.0417	0.0190	-0.0289	-0.0394	0.0770	-0.0912	-0.5840	0.0166	1.0000

This table reports the pairwise correlation matrix of variables used in our regression models. NIM_1 is defined as interest income on loans to total loans minus interest expenses of deposits to total deposits. NIM_2 is net interest income to total assets. *LIQUIDITY ASSETS* is liquid assets to total assets. *NSFR2010* is the ratio of available stable funding to required stable funding as defined by Basel III 2010. *NSFR2014* is the ratio of available stable funding to required stable funding as defined by Basel III 2014. *LCR* is the ratio of stock of HQLA to net cash outflows over the 30-day stress period. *LERNER* represents the conventional Lerner index and *ADJUSTED LERNER* denotes the funding-adjusted Lerner index. *CREDIT RISK* is the ratio of non-performing loans to total loans. *CAPITALIZATION* is defined as equity to total assets. *EXPENDITURE* is the ratio of total non-interest expenses to operating income. *DIVERSIFICATION* is non-interest revenue divided by operating income. *FED RATE* is the federal fund rate. *GDP GROWTH* represents real GDP growth rate and *INFLATION* denotes inflation rate. *CRISIS* is a dummy variable that equals to 1 for the period of the Global Financial Crisis, 2007 Q4 to 2009 Q2. Bank-specific variables are winsorised at the top and bottom 1% of the distribution

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