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Deposit Competition, Interbank Market, and Bank Profit

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Abstract: In this paper, we study how the interbank market could impact deposit competition and bank profits. We first document two stylized facts: the net interbank funding ratio is negatively correlated with net interest margin (NIM), as well as with the cost-to-income ratio (CIR). To rationalize these two facts, we embed the interbank market into a BLP model framework. The model is calibrated using Chinese listed banks' data. A counterfactual experiment reveals that shutting down the interbank market will lead to a decline in NIM and bank profits. Our results indicate that the interbank market can facilitate specialization and reduce the intensity of deposit competition.

Keywords: deposit competition; interbank market; structural estimation; BLP; Bank Profitability

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1. Introduction

The collapse of the wholesale funding market is considered one of the main factors that amplified the Global Financial Crisis. In light of financial fragility in the wholesale funding market, the Basel III accord introduced several regulations targeting the wholesale funding market, the liquidity coverage ratio (LCR), and the net stable funding ratio (NSFR).

Despite this concern, the wholesale funding market may facilitate specialization and improve the efficiency of liability management in the financial sector. In this paper, we consider this positive aspect of the wholesale funding market. Specifically, we ask the following questions: (i) How does the wholesale funding market interact with an imperfectly competitive deposit market? (ii) Does a higher ratio of wholesale funding dependence jeopardize bank profits?

We use China's interbank market as an example to study these two questions. The reason we use China's interbank market stems from the fact that, unlike developed countries like the United States, the interbank rate is endogenously determined. This feature isolates an important factor, namely, central bank intervention which can act to distort interest rate signals.

To answer the first question, we embed an interbank market in the BLP framework and study the tradeoff between borrowing from the wholesale funding market and the retail market.[1] Calibrated with China's banking sector data, we conduct a counterfactual experiment by shutting down the interbank market to address the second question. We find that the wholesale funding market could impact how banks set deposit rates. Shutting down the interbank market will negatively affect bank profit.

We begin our analysis by documenting two stylized facts about China's interbank market and banking sector: (i) the net interbank funding ratio is negatively associated with the NIM; (ii) the CIR and net interbank funding ratio are also negatively correlated. These two stylized facts reveal a contradiction in the data. On the one hand, a higher net interbank funding ratio indicates lower profit. On the other hand, bank efficiency as measured by the CIR is higher for banks with larger net interbank funding ratios.

To reconcile this paradox, we embed the interbank market in a BLP model. In the model, depositors' demand for deposits is determined by the liquidity service they provide and by the interest rate that banks offer to them. A bank's funding needs can be met by either borrowing from the interbank market at market interest rate, attracting depositors by increasing the deposit rate, or by offering better liquidity services. We assume that the capacity of banks to improve their liquidity services is limited in the short run;[2] hence, the only margin a bank can adjust to compete with others in the deposit market is by changing its deposit rate. We also assume that banks have lower management costs for interbank liabilities than they do for deposits as there are fixed costs associated with the provision of liquidity services such as operating branches. This assumption implies that deposits and interbank borrowing are imperfectly substitutable products. The interbank market is perfectly competitive so that banks take the interbank rate as given. Banks trade-off the volume of deposits and interbank liabilities by setting the deposit rate and choosing the volume of interbank funding.

Next, we calibrate the model on a panel of Chinese listed bank data. The calibrated model successfully generates a negative correlation between the net interbank funding ratio and the NIM. Moreover, the model replicates the negative correlation between the net interbank funding ratio and the CIR. Equipped with the calibrated model, we conduct a counterfactual experiment by shutting down the interbank market. Our objective is to examine how bank profits and the NIM change in the absence of the interbank market.

We demonstrate that the NIM shrinks for all banks. Without interbank borrowing, banks elevate their deposit rate to compete with other banks, and as a result, their NIM drops. We also find that profit declines for all banks. To illustrate the mechanism by which this occurs, we decompose the profit change into three components. These are the change in interest income, the change in interest expenses, and the change in operating costs. Our result suggests that the fall in bank profit can be mainly attributed to the decline in interest income. Since banks cannot borrow from other banks to scale their size, interest income decreases. However, banks' interest expenses and operating costs decrease as well. Though the deposit rate is higher, a smaller bank portfolio actually reduces banks' interest expenses.

The rest of the paper is organized as follows. Section 2 reviews several strands of literature that are related to our work and specify our contribution to the literature. Section 3 presents three stylized facts. Section 4 describes the model. Section 5 calibrates the model. Section 6 conducts the counterfactual exercise and Section 7 concludes the paper.

2. Literature Review

This paper is related to several strands of literature. First, we contribute to a burgeoning literature that adopts the framework proposed in Berry et al. (1995) to study bank competition and monetary policy. Martín-Oliver (2018) use BLP to model the demand side of bank's loan and deposit markets and Spanish banks' competition as they offer close substitutes. Montes (2014) study the effect of banking sector consolidation on mortgage risk after the financial crisis based on the mixed-logit model in line with BLP. Xiao (2020) constructs a BLP type model to study monetary policy transmission through shadow banking in the US. Wang et al. (2020) use this model to examine the pass-through of the Fed Funds rate to the deposit rate in the banking sector in the US. Egan et al. (2017) adopt the BLP framework to investigate the cross section of bank value. They find that deposit productivity mainly contributes to the banks' market value in the cross-section in the US.[3] Whited et al. (2021) also use the BLP framework to study how a low interest rate environment impacts banks' risk-taking in the US. Jiang (2019) apply the BLP framework to study how upstream market power in the banking sector impact the downstream shadow banks. Buchak et al. (2018) employ the BLP framework to quantify the role of regulation on the growth of shadow banking in the US. We extend the BLP model to study the interbank market. So, the interconnection of the banking sector is taken into account in the modeling process. We embed the interbank market into this modeling environment, which allows us to study banks' endogenously determined liability structure as well as to investigate how the interbank market affects deposit competition.

This paper is also related to a strand of the literature that focuses on banks' market power in the deposit market. Drechsler et al. (2017) find that the deposit spread, defined as the difference between the Fed Funds rate and the retail deposit rate, is critical for the bank lending channel in the US. Di Tella and Kurlat (2021) introduce the deposit spread in a general equilibrium model in order to explain maturity mismatch in the banking sector. Drechsler et al. (2021) use the deposit spread as a proxy for bank's market power and study how monetary policy shaped the housing boom in the US. Brunnermeier and Koby (2018) find that the reversal interest rate phenomenon is related to the degree of the pass through to the deposit rate. Drechsler et al. (2020) relate the origin of 1970s inflation in the United States to the suppressed deposit spread in the banking industry. These papers point out the critical role of the deposit spread in determining monetary policy transmission. We show that the deposit spread proposed by Drechsler et al. (2017) not only reflects the market power of a bank in the local market but also reflects a bank's endogenous decision on taking wholesale funding. However, the definition of the deposit spread is built from experience in the United States, where the short-term interest rate is set by the central bank. In other countries such as China, the interbank rate is endogenously determined. It might be misleading to use the deposit spread as a measure of a bank's market power in the deposit market. This paper takes this endogenously determined interbank rate into account and introduces the interbank market to study banks' optimal liability structures.

Finally, we contribute to a strand of literature related to the wholesale funding market. Cornett et al. (2011), Dagher and Kazimov (2015), and Irani and Meisenzahl (2017) focus on the risk of reliance on wholesale funding during financial crisis and find negative relationship between reliance on wholesale funding and the supply of credit. Hahm et al. (2013) investigate the relationship between wholesale funding reliance and the financial vulnerability. Huang and Ratnovski (2011) illustrate the role of wholesale funding in facilitating bank runs. Choi and Choi (2021) find that banks increasingly turn to wholesale funding as monetary policy tightens in the US. King (2013) show the banks' NIM fell in response to the implementation of Basel III net stable funding ratio. Gu and Yun (2019) find that the loan to deposit ratio contributes to the issuance of negotiable CDs. Banks with a higher ratio of negotiable CDs on their liabilities is associated with lower ROE and NIM. We find a similar result. Unlike Gu and Yun (2019), this paper incorporates deposit competition in the analysis. In the counterfactual experiment, we find that shutting down of the interbank market actually reduces banks' profit. This result reveals that the negative correlation between the net interbank funding ratio and bank profits could be misleading if we do not consider banks' optimal liability structure decisions.

3. Some Stylized Facts

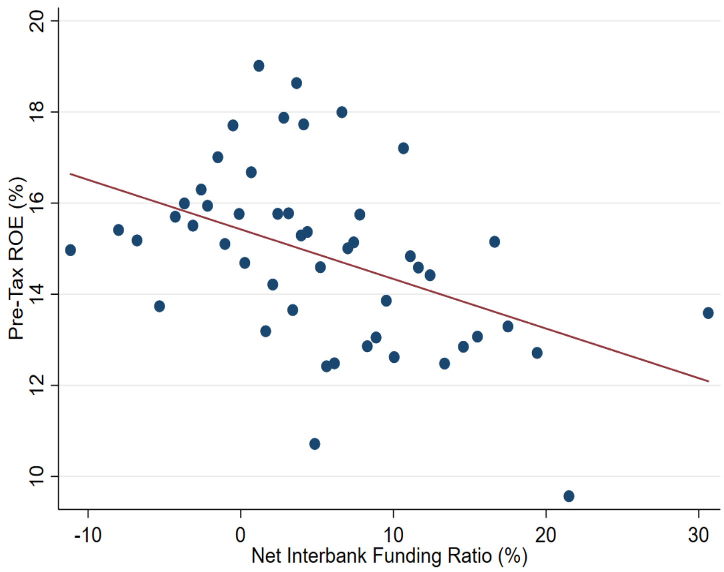
We define interbank funding as the sum of interbank borrowing. That is, we do not constrain the analysis to overnight and unsecured debt. Interbank borrowing here consists of overnight borrowing, placements with banks and other financial institutions (PBOFI), and financial assets sold for repurchase (FA Repo).[4] Interbank borrowing constitutes of only a small portion of total interbank funding. PBOFI is the deposits from other financial institutions for payment clearing and portfolio management.[5] FA Repo is a form of borrowing for financial institutions using financial assets as collateral. Unlike a typical Repo in the US, the underlying collateral for an FA Repo is much broader including loans, bank acceptance notes, and other financial assets. The maturity of the FA Repo could be much longer than a typical Repo in the US.

Stylized Fact 1: The NIM is negatively associated with the net interbank funding ratio.

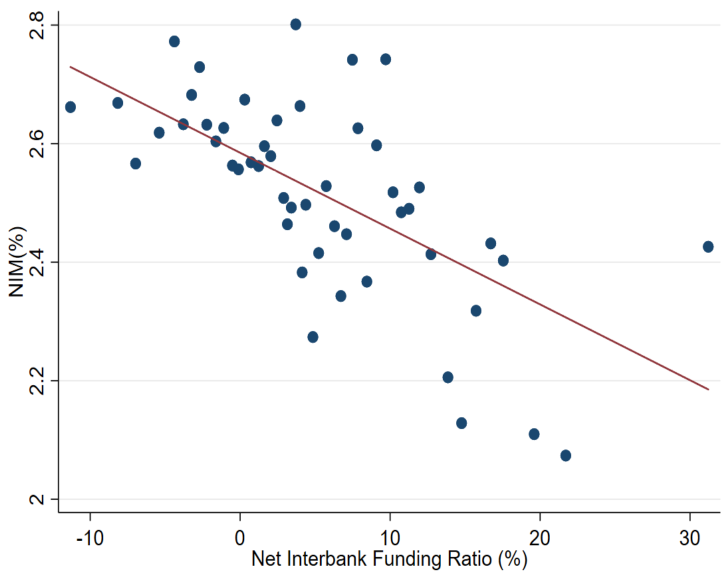
Figure 1 reveals a negative correlation between the net interbank funding ratio and bank profits as proxied by pre-tax ROE and NIM. Gu and Yun (2019) find a similar negative correlation in the negotiated CD market, which is a part of the interbank market.

Stylized Fact 2: The CIR of the banks is negatively correlated with net interbank funding ratio.

Figure 2 exhibits the relationship between the CIR and the net interbank funding ratio. CIR declines when net the interbank funding ratio is high.



(**A**)



(**B**)

Figure 1. Bank Profit and Net Interbank funding Ratio. Notes: Subfigure (**A**) plots the relationship between pre-tax ROE and net interbank funding ratio. Subfigure (**B**) depicts the relationship between NIM, and net interbank funding ratio. The net interbank funding ratio is defined as the net interbank funding divided by the total liability. The interbank net interbank funding is calcuated as the interbank liabilities minus interbank assets. The interbank liability consists of overnight borrowing, PBOFI, and FA Repo. We deduct the interbank assets from the total liability to address the double counting issue. The sample includes 16 public listed banks. Data source: Wind.

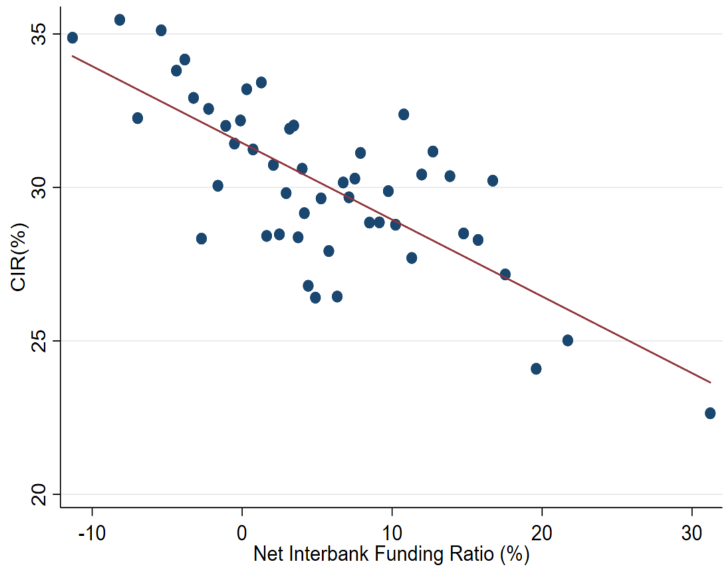


Figure 2. CIR and Net interbank funding Ratio. Notes: This figure depicts the relationship between CIR and net interbank funding ratio. The net interbank funding ratio is defined as the net interbank funding divided by the total liability. The interbank net interbank funding is calcuated as the interbank liabilities minus interbank assets. The interbank liability consists of overnight borrowing, PBOFI, and FA Repo. We deduct the interbank assets from the total liability to address the double counting issue. The sample includes 16 public listed banks. Data source: Wind.

The two stylized facts are at odds with each other. Stylized fact 1 points out a profit decline if a bank increases its borrowing from the interbank market. On the other hand, stylized fact 2 demonstrates that as banks become more dependent on interbank funding, efficiency improves. To address this puzzle, we extend the BLP framework by incorporating the interbank market and study its role together with deposit competition in determining bank profits and efficiency.

4. Model

A representative household has M units of endowment (or money) which deposits in $J+1$ risk neutral banks.[6] Each bank supplies a deposit product that has two features: a transaction service and a deposit rate. Besides deposits, banks have access to the interbank market and can get financing from other banks.[7] They will invest their deposits and interbank funding in a risky project that yields a stochastic interest rate R_j drawn from a normal distribution $R_j \sim N(\mu_j, \sigma_j)$.

4.1. Household Deposit Allocation

It is assumed that the household has linear stochastic preferences over all $J+1$ deposit choices. For each unit of endowment deposited in any bank j, it extracts utility from the retail deposit rate r_j offered , a vector of liquidity services $\boldsymbol{X}_j \in \mathbb{R}^m$,[8] as well as bank-specific service δ_j.[9] Payoffs are characterized by the following expression:

$$u_j = \beta r_j + \gamma \sum_{q=1}^{m} X_{qj} + \delta_j + \varepsilon_j \; \forall j \in \{1, 2, \ldots J+1\} \tag{1}$$

where the random variables ϵ_j are iid and follow a Gambel extreme value distribution with a cumulative distribution function $F(\varepsilon) = exp\{-exp(-\varepsilon)\}$. Parameter β represents the semi-elasticity of the deposit share in response to deposit rate changes. It will be a critical parameter for us, as it will allow for the computation of commercial bank markups. Finally, γ is the household's sensitivity to bank j's liquidity services.

The object that is of interest is the household's choice for the share of deposits s_j it allocates to bank j. The household will choose to deposit its endowment in bank j if and only if it extracts more utility by doing so than depositing in any other bank. Since the variables ϵ_j are stochastic, the probability that this event occurs is given by:

$$s_j = Pr(u_j > u_1, u_j > u_2, \ldots, u_j > u_k, \ldots, u_j > u_{J+1}) = \Pi_{k \neq j} Pr(u_j > u_k)$$

where the second equality follows from the iid assumption. This probability may in turn be interpreted as the share of deposits that the household will allocate to bank j. Simple calculations yield:

$$s_j(r_j, \boldsymbol{r}_{-j}) = \frac{exp(\beta_i r_j + \gamma \sum_{q=1}^{m} X_{qj} + \delta_j)}{\sum_{k=1}^{J} exp(\beta_i r_k + \gamma \sum_{q=1}^{m} X_{qk} + \delta_k) + out} \tag{2}$$

where $\boldsymbol{r}_{-j}$ is a vector of deposit rates of all other banks and where "*out*" refers to depositors outside option. While the outside option is not observable, we will discuss its treatment when estimating the demand function in Section 5. We note that the household's demand function for the deposit share in bank j is the same as Egan et al. (2017).

4.2. Bank Portfolio Decision

A bank will trade-off its liabilities from the household and interbank funding in order to lend to a risky project R_j, incurring a quadratic operating cost.[10] The bank's portfolio problem is given by (3).

$$\max_{r_j, k_j} E\{(R_j - r_j) \cdot Ms_j + (R_j - i_k)k_j - \frac{(Ms_j + \alpha k_j)^2}{2\varphi_j}\} \tag{3}$$

where i_k is the interbank interest rate, and where k_j, φ_j are respectively interbank funding and an operating cost parameter of bank j. So the first and second terms in (3) are the profits by lending money to project R_j borrowed from the depositors and the interbank market respectively, the last term indicates the operating cost. Notice that a higher φ_j means a lower operating cost per unit of liabilities.[11] The cost parameter α drives all the results of this model and can be interpreted in several ways. One is that α determines the level of imperfect substitution between the interbank funding and retail deposits. If α is equal to 1, the interbank funding and retail deposits are perfectly substitute products, in which case the model yields a corner solution where no interbank funding or lending will occur. A more interesting case is that of $\alpha < 1$ where the two are imperfectly substitute products. Banks will choose to lend to each other due to the varying levels of comparative advantage in liability management and asset quality governed by the magnitude of α.

Another interpretation is that α can be understood as an operating cost parameter of interbank funding where $\alpha < 1$ implies that this cost is less than that of retail deposits. Several pieces of evidence could back such an interpretation. First, a bank must set up physical branches, ATMs, and hire marketing employees to attract retail deposits. In addition, the regulatory cost for retail deposits and interbank funding differs. For example, a bank's loan to deposit ratio can not exceed the 75% cap as the deposits here are defined as retail deposits. Finally, in most cases, a bank must pay deposit insurance fees for insured retail deposits as opposed to uninsured interbank funding. In this simple model, α captures the difference in operating costs and regulatory costs between interbank funding and retail deposits.

Due to the risk-neutral assumption, banks' portfolio problem is essentially deterministic. Since μ_j is the expected returns to project R_j, the solution to the bank's optimization problem reads:

$$\mu_j - r_j - \frac{Ms_j + \alpha k_j}{\varphi_j} = \frac{1}{(1 - s_j)\beta} \tag{4}$$

$$k_j = \frac{\varphi_j(\mu_j - i_k)}{\alpha^2} - \frac{Ms_j}{\alpha} \tag{5}$$

Plugging (5) into Equation (4) yields:

$$\mu_j - r_j - \frac{1}{\alpha}(\mu_j - i_k) = \frac{1}{(1 - s_j)\beta} \tag{6}$$

4.3. Equilibrium

The equilibrium is characterized by a set of deposit rates$\{r_1, r_2 \ldots, r_{J+1}\}$, interbank market net exposures $\{k_1, k_2, \ldots k_{J+1}\}$ and an interbank interest rate i_k such that:

1. Consumers' demand for bank j's deposit share satisfies Equation (2);
2. Given the interbank interest rate i_k, bank j solves the portfolio problem by making a decision about its deposit rate r_j and interbank funding(or lending) k_j which satisfy Equations (4) and (5);
3. The interbank funding market clears:

$$\sum_J k_j = 0 \tag{7}$$

Plugging (5) into Equation (7) yields the following expression which determines the interbank rate i_k.

$$\frac{\sum_J \varphi_j \mu_j - \alpha \sum_J Ms_j}{\sum_J \varphi_j} = i_k \tag{8}$$

Notice that there is a one-to-one relationship between the parameter α and the interbank interest rate i_k. This allows us to infer information pertaining to α from the interbank interest rate. Equation (8) explores a cross-sectional relationship across banks as we have taken M, the aggregate retail deposits, to be exogeneous. In reality, M is largely driven by monetary policy.

5. Calibration

We estimate the model using Chinese bank-level data. Due to the simplicity of the model as well as data limitations that fail to illustrate the true nature of the interbank market, the estimated parameters are not too precise. Though the estimation is problematic, it successfully replicates the two stylized facts.

5.1. Data

We use data from 16 publicly listed commercial banks to estimate the model. The publicly listed banks provide the necessary information that enable us to break down deposit expenses and interbank funding expenses, which is key to the estimation process. Moreover, deposits of these 16 listed banks account for over 80 percent of total deposits in China. Therefore, the sample is representative of the Chinese banking sector.

Financial data of the banks in our sample come from the Wind Terminal. This includes overnight borrowing, PBOFI, and FA Repo. We collect the four types of banks' deposit average interest expense, personal time deposits, corporate demand deposits, and corporate time deposits, from their annual report. We also extract the banks' operating information like employee and management fees from Wind.

We extract banks' branch information from a website operated by the China Bank Regulatory Commission which documents registration licences and operating data for every branch in China. We use the weighted 7-day Repo rate (R007) as the interbank interest rate where depository institutions use high quality bonds as collateral. Given a large volume of transactions, the 7-day Repo rate contains important information about banks' funding costs. We retrieve the total deposit in the banking sector from CEIC.

The summary statistics from Table 1 shows that NonState Banks have a mean interbank funding ratio of 20.9% as opposed to 10.1% in the State Banks. The difference is significant as well.

Table 1. Summary Statistics.

	NonState Bank		State Bank		Difference
	Mean	**SD**	**Mean**	**SD**	**b**
Wholesale Funding Ratio	0.209	0.069	0.101	0.027	0.108 ***
Pre-Tax ROE	0.300	0.151	0.279	0.141	0.021
Net Interest Margin	2.525	0.424	2.492	0.348	0.033
(N)	529		158		687

*** denotes that p-value is smaller than 0.01. Notes: This table reports the summary statistics for State Banks and NonState Banks from 2007 and 2017.

5.2. Demand Estimation

Demand estimation is biased due to the deposit cap imposed in the banking sector before 2015. A majority of banks during the sample periods set the deposit rate at the ceiling level resulting in a biased estimator. Egan et al. (2017) use the average deposit rate, defined as the ratio of interest expense to total deposit, to estimate the demand side. Though the cross-bank variation in the average deposit rate is maintained due to the heterogeneity in the clientele and maturity structure, unlike Egan et al. (2017), our estimator captures a different interpretation. Nonetheless, the average deposit rate is still an important reference rate for banks to determine interbank funding. The biased demand side estimation should not affect our supply side calibration to the extent that the semi-elasticity of the deposit rate is not deviating from the true value too much.

The regression specification implied by Equation (2) is:

$$lns_{i,t} - lns_{o,t} = \beta(r_{i,t} - r_{o,t}) + \gamma(X'_i - X'_o) + \delta_i + \epsilon_{i,t}$$

where $s_{o,t}$ and $r_{o,t}$ is the deposit share and retail deposit rate of the outside option. To calculate the deposit rate r_t, we first calculate the deposit rate for each type of deposits, personal demand deposits, personal time deposits, corporate demand deposits, and corporate time deposits. Then, the deposit rate is measured as the weighted average of the deposit rate of these four types of deposits for each bank, weighted by the average deposit outstanding. Since we do not observe the outside option, we estimate a model following Egan et al. (2017) that incorporates a time fixed effects absorbing common shocks to every bank in each quarter.

$$lns_{i,t} = \beta r_{i,t} + X'_i + \delta_i + \delta_t + \epsilon_{i,t}$$

Table 2 reports the demand estimation result.[12] The IV estimation adopts the standard instruments in BLP demand estimation such as the number of all competitor bank branches and all log-transformed competitor salaries. The standard deviation is clustered in the bank and quarter level.

Table 2. Demand Estimation.

	(1) Lndep	(2) Lndep
DepRate	28.31 *	123.2 **
	(0.050)	(0.030)
Control	Yes	Yes
Firm FE	Yes	Yes
Time FE	Yes	Yes
(N)	149	149
(R^2)	0.993	−0.189

p-values in parentheses. * ($p < 0.10$), ** ($p < 0.05$), *** ($p < 0.01$). Notes: This table reports the demand estimation results. The sample includes 15 listed public banks. The sample period is from 2007 to 2017. The deposit rate is defined as the weighted average of personal demand deposits, personal time deposits, corporate demand deposits, and corporate time deposits. We drop the Bank of Hangzhou from our demand side estimation since there is only one observation in our sample. The dependent variable is a log of bank deposits. The control variables include salary payable of employees and number of bank branches.

5.3. Supply Side Calibration

On the supply side, we first assume α is considered as a given parameter. Since deposit rate r_j, the interbank funding k_j and interbank interest rate i_k variables are observable, we will be able to back out the unknown parameters $\{\varphi_j\}_{j=1}^J$ and $\{\mu_j\}_{j=1}^J$ from our system equations characterized by (5) and (6). Then, we calibrate the parameter α to target the banks' profit. In order to do that, we find a set of parameters that satisfy the system equations defined by (5) and (6) and minimize the sum of the squared errors between the model implied profits and real profits.

$$e_j = (\mu_j - r_j) \cdot Ms_j + (\mu_j - i_k)k_j - \frac{(Ms_j + \alpha k_j)^2}{2\varphi_j} - \pi_j$$

where π_j is the bank j's profit observed in the data; thus, e_j is the error term between model implied profit and real profit.

$$\min_{\{\alpha,\{\mu_j,\varphi_j\}_{j=1}^J\}} \sum_J \{(\mu_j - r_j) \cdot Ms_j + (\mu_j - i_k)k_j - \frac{(Ms_j + \alpha k_j)^2}{2\varphi_j} - \pi_j\}^2 \quad (9)$$
$$s.t. \;\; 0 < \alpha < 1, \;\; \mu_j > 0, \varphi_j > 0, \forall j = 1, 2, \ldots, J$$

We could implement a one-step nonlinear least square to estimate parameter α. We substitute μ_j from Equation (6) and φ_j from Equation (4) into Equation (9), in other words, we basically write μ_j, φ_j as functions of α and transfer (9) into a minimization problem with respect to α. Then, we utilize sequential quadratic programming to solve for α in (9), a constrained nonlinear optimization problem. We calibrate the model using data of 15 listed banks in 2014.[13] We use the information in 2014 to avoid possible conflating factors due to the new commercial banking law passed in China in 2015. Thus in our estimation, the parameter M is the total deposits in the banking sector in 2014, π_j is the bank j 's net profit in 2014.

We report the mean return μ, operating cost parameter φ and α in Table 3. We compute the model implied profit and show the comparison of the actual profits and model implied profit in Figure 3. We further calculate the NIM as the ratio of net interest income and interest-bearing assets:

$$\frac{(R_j - r_j) \cdot Ms_j + (R_j - i_k)k_j}{Ms_j + k_j}$$

The CIR ratio is computed as

$$\frac{(Ms_j + \alpha k_j)^2}{2\varphi_j})/(R_j \cdot Ms_j + R \cdot k_j)$$

The correlation matrix in Table 4 shows that the model successfully replicates the two stylized facts. The correlation coefficient between the net interbank funding ratio and net interest margin from our model is −0.587 as opposed to −0.738 in the data. The correlation coefficient between the CIR ratio and net interbank funding ratio in the model is −0.198 which is not far off from the correlation coefficient of −0.493 observed in the data.

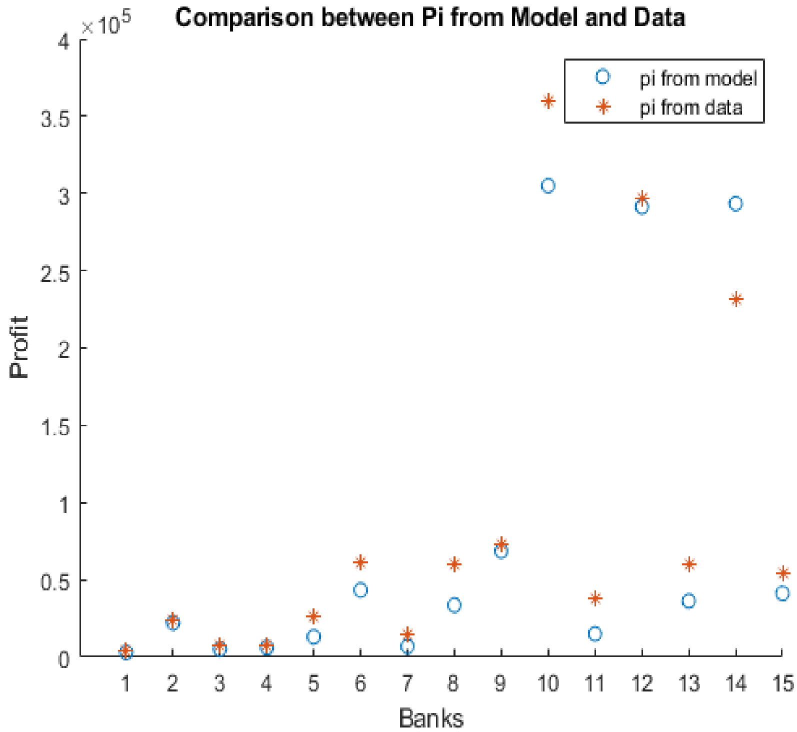


Figure 3. Model Fit: Profit. Notes: This figure depicts the profit in the data and calibrated profit in the model in 2014.

Table 3. Calibration Result: μ and φ.

	μ	φ
Agricultural Bank of China	1.055767	4.51×10^8
Bank of Hangzhou	1.038712	7.23×10^7
Bank of Nanjing	1.04292	4.27×10^7
Bank of Ningbo	1.050615	1.73×10^7
Bank of Shanghai	1.037119	4.11×10^8
China CITIC Bank Corporation	1.043401	3.02×10^8
China Construction Bank	1.053691	5.41×10^8
China Everbright Bank	1.035749	1.04×10^{10}
China Merchants Bank	1.052267	1.57×10^8
China Minsheng Banking	1.044674	2.07×10^8
Hua Xia Bank	1.047451	8.67×10^7
Industrial Bank	1.04362	2.44×10^8
Industrial and Commercial Bank of China	1.048909	8.84×10^8
Ping An Bank	1.035982	3.25×10^9
Shanghai Pudong Development Bank	1.045303	2.33×10^8

Notes: This table reports the calibration results for μ and φ in the model. We calibrate the model with the data in 2014. The sample consists 15 listed banks.

Table 4. Correlation Matrix.

	Data		
	NIM	**CIR**	**Net Interbank Funding Ratio**
NIM	1		
CIR	0.433	1	
Net Interbank Funding Ratio	−0.738 **	−0.493	1
	Model		
	NIM	**CIR**	**Net Interbank Funding Ratio**
NIM	1		
CIR	0.853 ***	1	
Net InterBank Funding Ratio	−0.587 *	−0.198	1

* ($p < 0.05$), ** ($p < 0.01$), *** ($p < 0.001$). Notes: This table reports the correlation matrix between the NIM, CIR, and model implied NIM and CIR. We calibrate the model with the data in 2014. The sample consists 15 listed banks.

6. Policy Analysis: Shutting Down the Interbank Market

Equipped with the calibrated model, we conduct a counterfactual experiment by shutting down the interbank funding market and measure its impact on banks' profits and retail deposit rates.

By shutting down the interbank funding market, the bank's deposit rate decision would read:

$$\mu_j - r_j - \frac{Ms_j}{\varphi_j} = \frac{1}{(1-s_j)\beta} \tag{10}$$

$$s_j(r_j, \boldsymbol{r}_{-j}) = \frac{exp(\beta_i r_j + \gamma \sum_{q=1}^{m} X_{qj} + \delta_j)}{\sum_{k=1}^{J} exp(\beta_i r_k + \gamma \sum_{q=1}^{m} X_{qk} + \delta_k) + out} \tag{11}$$

We deduce the deposit rate based on the calibrated parameters μ_j , φ_j , β , and deposit share function s_j from Equation (2). We follow Egan et al. (2017) and fix the outside utility value when solving the system of equations. Table 5 reports the model and counterfactual deposit rate.[14] We find that all banks raise their deposit rate, a signal of elevated competition pressure. Furthermore, we see that there is a redistribution of deposit shares among the 15 listed banks. Specifically, the banks that are less aggressive in raising their deposit rate lose market share like Ping An Bank.

We further compute banks' NIM based on the counterfactual deposit rate and deposit share. In doing so, we assume that the expected return of the projects, μ, is unchanged. Thus, NIM is computed as the difference between the model and counterfactual deposit rate. Table 6 shows that the NIM shrinks as banks' deposit rate rises in the counterfactual.

$$\Delta\pi = \Delta IntInc - \Delta IncExp - \Delta OpeCost \tag{12}$$

Finally, we calculate counterfactual profits and decompose their changes into three parts—the change in interest income, the change in interest expense, and the change in operating cost shown in Equation (12) above. From the result reported in Table 7, profits drop for all banks. Interestingly, the decomposition shows that profit loss can be all attributed to the fall in banks' interest income. This suggests that banks will operate a smaller portfolio without interbank borrowing than they would in the presence of interbank borrowing. This result also explains the rapid expansion in China's banking industry, where regional banks constrained by regulation to local market activities saw portfolio expansion potential. Shutting down the interbank means a tightened geographical restriction for these regional banks, leading to a shrinkage in their portfolio. As a result, interest income falls.

Table 5. Counterfactual Result: Deposit Rate and Deposit Share.

	Rate (Basis)			Share (Percent)		
Bank	**Model**	**CF**	**DIF**	**Model**	**CF**	**DIF**
Ping An Bank	272.49	272.82	0.33	2.35	2.25	−0.10
Bank of Ningbo	219.41	230.72	11.31	0.40	0.44	0.04
Shanghai Pudong Development Bank	236.27	244.71	8.44	3.58	3.79	0.21
Hua Xia Bank	271.92	272.53	0.61	2.02	1.94	−0.08
China Minsheng Banking	238.91	243.78	4.87	3.20	3.24	0.04
China Merchants Bank	209.96	217.35	7.39	4.35	4.54	0.19
Bank of Hangzhou	263.24	267.01	3.77	0.37	0.37	0.00
Bank of Nanjing	247.66	256.27	8.61	0.48	0.51	0.03
Industrial Bank	243.12	250.68	7.56	3.75	3.92	0.18
Bank of Shanghai	268.62	271.79	3.17	0.95	0.95	−0.01
Agricultural Bank of China	191.83	196.84	5.01	16.97	17.22	0.25
Industrial and Commercial Bank of China	205.13	209.57	4.44	20.47	20.62	0.15
China Everbright Bank	229.96	236.52	6.56	1.71	1.77	0.06
China Construction Bank	184.75	187.35	2.60	16.49	16.24	−0.25
China CITIC Bank Corporation	242.98	252.56	9.58	2.98	3.20	0.22

Notes: This table reports the model and counterfactual deposit rate and deposit share. The model deposit rate and deposit share is the same as in the data. We report the deposit rate in basis.

Table 6. Counterfactual Result: NIM and CIR.

	NIM (Basis)			CIR (Percent)		
Bank	**Model**	**CF**	**DIF**	**Model**	**CF**	**DIF**
Ping An Bank	85.00	84.67	−0.33	1.21	0.97	−0.24
Bank of Ningbo	286.74	275.43	−11.31	37.25	35.20	−2.05
Shanghai Pudong Development Bank	216.76	208.31	−8.44	32.03	29.75	−2.28
Hua Xia Bank	87.90	87.29	−0.61	3.10	2.59	−0.50
China Minsheng Banking	207.83	202.97	−4.87	30.46	29.34	−1.12
China Merchants Bank	312.71	305.32	−7.39	37.18	36.08	−1.10
Bank of Hangzhou	123.88	120.12	−3.77	18.17	16.09	−2.08
Bank of Nanjing	181.54	172.93	−8.61	29.36	26.41	−2.94
Industrial Bank	190.89	183.33	−7.56	29.39	26.96	−2.42
Bank of Shanghai	102.57	99.40	−3.17	11.39	8.79	−2.60
Agricultural Bank of China	345.08	340.07	−5.01	36.19	35.59	−0.61
Industrial and Commercial Bank of China	283.96	279.52	−4.44	32.41	31.71	−0.69
China Everbright Bank	244.55	237.99	−6.56	33.94	32.64	−1.30
China Construction Bank	372.92	370.32	−2.60	36.90	36.92	0.02
China CITIC Bank Corporation	193.22	183.64	−9.58	30.34	27.17	−3.16

Notes: This table reports the model and counterfactual NIM and CIR.

Table 7. Profit Decomposition.

Bank	**Δ Intinc**	**Δ Intexp**	**Δ OpeCost**	**Δ Profit**
Ping An Bank	−11,001.02	10,269.42	43.32	−688.28
Bank of Ningbo	−1909.81	1367.28	391.92	−150.61
Shanghai Pudong Development Bank	−15,065.42	11,311.62	2570.26	−1183.55
Hua Xia Bank	−7998.53	7321.81	85.81	−590.91
China Minsheng Banking	−6691.69	4496.23	1229.91	−965.54
China Merchants Bank	−11,286.23	7295.08	2647.53	−1343.63
Bank of Hangzhou	−1436.55	1213.74	110.27	−112.54
Bank of Nanjing	−2516.00	1992.77	352.68	−170.55
Industrial Bank	−15,920.95	12,316.06	2385.85	−1219.04
Bank of Shanghai	−6535.64	5989.87	248.22	−297.55
Agricultural Bank of China	−24,655.00	12,859.61	6987.31	−4808.08

Table 7. *Cont.*

Bank	Δ Intinc	Δ Intexp	Δ OpeCost	Δ Profit
Industrial and Commercial Bank of China	−29,382.31	16,163.88	7334.88	−5883.56
China Everbright Bank	−4482.38	3039.08	906.60	−536.70
China Construction Bank	−3954.31	−3953.09	2833.80	−5073.61
China CITIC Bank Corporation	−16,879.09	13,327.28	2492.92	−1058.88

Notes: This table reports the profit decomposition results. Column 2 is the change of interest income, defined as the difference between counterfactual interest income and model interest income. Column 3 is change of the interest expense, computed as the difference between model interest expense and counterfactual interest expense. Column 4 is the change of operating cost, calculated as the difference between model operating cost and counterfactual operating cost. Column 5 is the sum of column 2 to column 4.

7. Conclusions

We observe a negative correlation between the net interbank funding ratio and net interest rate margin, which gives people an impression that the interbank market can act to weaken banks' profitability. We investigate this by putting the interbank market in a general equilibrium setting where banks compete for deposits, and find that the interbank market is beneficial to banks. Through the use of the calibrated model, the experiment conducted shows that the interbank market could suppress the intensity of the deposit competition and promote specialization. As a result, the profit margin in the banking sector actually improves, not worsens.

Our findings speak to the regulatory sentiment in China where the wholesale funding should be limited to ensure financial stability. Our counterfactual experiment shows shutting down the wholesale funding market will actually reduce bank profit. Though the concern for the run-prone nature of the wholesale funding is well justified, we show there is a trade-off between the wholesale funding and the bank profit that policymakers cannot ignore.

The purpose of this study is to shed light on the role of the interbank market in the retail deposit pricing process. It abstracts from a couple of key issues in the interbank market such as double counting issues and contagion effects during bank runs. In addition, the institutional change in China makes our demand estimation biased. We leave these topics for future studies.

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Notes

[1] Throughout this paper, we refer to the model laid out in Berry et al. (1995) as the BLP model.

[2] For example, it takes time for banks to build ATMs, branches, and develop mobile services.

[3] This paper is conceptually close to Egan et al. (2017) which argues that banks with higher deposit productivity would specialize in the retail deposit market, whereas banks with higher asset productivity will rely on interbank funding.

[4] Choi and Choi (2021) defined wholesale funding in the US as the sum of wholesale deposits (brokered and foreign deposits, as well as large time deposits beyond $100,000), fed funds, repo borrowing, and other borrowed money. Since the data for wholesale deposits is not separately reported in the balance sheet data, we instead narrow our definition to the interbank market defined by China Banking and Insurance Regulatory Commission in 27 April 2014. (http://www.waizi.org.cn/law/7294.html, accessed on 26 February 2022).

[5] Negotiable CDs were only introduced in 2013. So, instead of issuing NCDs, banks attract other institutional funding through interbank deposits.

[6] The risk-neutral assumption follow from Egan et al. (2017).

[7] Here, we refer to a bank as a broad range of financial institutions that are eligible for interbank funding access such as commercial banks, securities companies, trusted companies, mutual funds, and other financial institutions.

[8] This vector of variables proxies bank j's liquidity services such as bank branches, ATMs network, and online banking service

[9] Egan et al. (2017) interprets δ_j as deposit productivity that measures banks' efficiency in absorbing retail deposits.

[10] A quadratic operating cost function is also used in Wang et al. (2020).

[11] We refer to the interest rate that serves as the benchmark for interbank funding as the interbank market rate.

[12] We drop Bank of Hangzhou in our demand estimation since there is only one observation of it in 2014.

[13] The data for Bank of Beijing is missing in 2014.

[14] The model deposit rate and deposit share are the deposit rate and share observed in the data.

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