An Empirical Study on the Effect of the Differentiated Deposit Reserve Policy

Based on the comparative analysis of large and small commercial banks' liquidity

Yan Dawen*, Hu Yaxing, Yi Zhe and Pan Yue
School of Mathematical Sciences
Dalian University of Technology
Dalian, China
e-mail:dawenyan@dlut.edu.cn
* Corresponding Author

Abstract—To evaluate the effect of the differentiated deposit reserve policy, based on the Difference in Differences model, this paper empirically analyzes the difference of changes in current ratio between large and small banks due to the raise of the deposit reserve ratio. The main conclusions drawn are as follows: the deposit reserve policy has a significant impact on the liquidity levels of commercial banks in China. Since the differentiated policy implementation, small-scale banks exceed large-scale banks in the increment of current ratio by 2% with only policy factor considered, which means small banks are more positively affected by the new policy. Nevertheless, with other factors added, the liquidity increment of the large-scale banks goes beyond by 0.14% in comparison with small banks. Combined with the fact that the liquidity of small banks is lower than the large ones, it illustrates that the adjustment of the current deposit reserve policy has not made up for the liquidity gaps between large and small banks and the liquidity condition that small banks will confront would be quite severe.

Keywords-differentiation of deposit reserve ratio; policy analysis; commercial bank; liquidity level; difference in differences model

I. INTRODUCTION

There is no doubt that commercial banks' liquidity is an essential aspect of understanding solvency. In 2013, commercial banks in China suffered form "shortage of money" twice thereby stressing the urgency of managing liquidity risk. At the same year, Basel Committee focused on setting up global standard to monitor the liquidity risk.

In addition to the banks' individual factors, the intervention of an external policy would definitely go a long way to influence the liquidity level. Changes of deposit reserve ratio (DRR) would impact the lending ratios, alter bank's balance sheets and further deliver the effect on liquidity [1,2]. Therefore, reasonable policy is necessary for liquidity and sustainability in bank management. A series of studies have discussed the relationship between bank liquidity risk management and deposit reserve policy (DRP). Friedman (1983) argued that DRP overuse would impede loan growth, resulting in unsteady development of banks [3]. Frederic (2012) observed that when excess reserve was too little, the raise of DRR would cause bank liquidity crisis [4]. Guo Caixia (2008) pointed out that the liquidity controlling system that the Central Bank has adopted through DRP has a positive

influence on stabilizing Chinese financial market [5]. De Haan and Van De End (2013) discussed the influence of a change in DRR on bank's liquidity coverage ratio and found that most banks are inclined to increase liquid assets' ratio to meet the requirements of liquid liabilities when DRR is raised [6].

Currently, DRP is still a common tool of monetary policy in China. Before June 2008, when the DRR was non-differentiated for large and small banks, upward DRR made the financing and asset growth strongly limited for small banks, while large banks were little affected [7], consistent with [8,9]. In the second half of the same year, the Central Bank of China implemented differentiated deposit reserve policy and kept the DRR of large banks always higher than small ones no matter the ratio rises or declines. Although existing researches have revealed that the deposit reserve policy is closely related to the bank's liquidity level, there still exists a knowledge gap of whether the differentiated DRP can better benefit liquidity of small-scale banks and enhance their competitiveness.

This paper applying the Difference in Differences (DD) model with causal variable of current ratio (CR) and explanatory variables of policy dummy and six financial indexes empirically analyzes after the implementation of differentiated DRP, the difference of changes in CR between four large banks and eight small banks when the DRR is raised. The main purpose is to investigate the influence of the differentiated DRP on the liquidity of different scales of banks, especially medium and small-scale banks. It is beneficial for the supervised institution to further perfect the DRP and promote the liquidity of the whole commercial banking to run smoothly.

II. METHODOLOGY

DD model as an econometric method has been widely used in policy analysis [10-12]. Assumed that Y_{it} represents current ratio (current assets/current liabilities) of the i-th bank at the moment of t affected by DRP, T_t be an indicator variable equal to 1 if the time is after the adjustment of deposit reserve ratio and zero otherwise, P_i be also an indicator variable equal to 1 if the i-th sample is small banks (treatment group) and zero otherwise (control group), $T_t \times P_i$ stand for the cross-effect of time and policy, ε_{it} represent the error term and assume it following a normal distribution $N(0, \sigma^2)$. Then the DD model without other impact factors [13] is

$$Y_{it}=\alpha_0+\alpha_1 T_t+\alpha_2 P_i+\alpha_3 T_t \times P_i+\varepsilon_{it} \quad (1)$$

The difference of the variation of index Y between small banks and large banks pre and post the adjustment of DRR with only policy factor is computed by

$$\begin{aligned} Dif &= E(Y_{it}|T_t=1,P_i=1)-E(Y_{it}|T_t=0,P_i=1)-[E(Y_{it}|T_t=1,P_i=0)-E(Y_{it}|T_t=0,P_i=0)] \\ &= (\alpha_0+\alpha_1+\alpha_2+\alpha_3)-(\alpha_0+\alpha_2)-[(\alpha_0+\alpha_1)-\alpha_0] \\ &= \alpha_1+\alpha_3-\alpha_1=\alpha_3 \end{aligned} \quad (2)$$

Equation (2) shows the importance of estimator α_3: with only policy factor considered, if $\alpha_3 \geq 0$, then $Dif \geq 0$, which can be subdivided into three cases: a) $\alpha_3 \geq 0$ also $\alpha_1 \geq 0$, which means after the differentiated policy, the growth in the CR of small banks caused by the raise of DRR ($\alpha_1+\alpha_3$) is larger than large banks (α_1). Compared with large-scale ones, liquidity risk for small banks is relatively lower. b) $\alpha_3 \geq 0$, $\alpha_1 \leq 0$ but $|\alpha_3| \geq |\alpha_1|$, which reflect that with deposit reserve ratio raised, the CR of small banks goes up, while for the large ones it goes down. The liquidity risk that small banks suffered is still lower than large ones. c) $\alpha_3 \geq 0$, $\alpha_1 \leq 0$ but $|\alpha_3| \leq |\alpha_1|$, which illustrates the current ratio of small banks drops relatively less, the adverse impact caused by the deposit reserve policy is smaller. All of above indicate that if $\alpha_3 \geq 0$, i.e. $Dif \geq 0$, the adjustment of policy is more beneficial for small banks.

On the contrary, if $\alpha_3 \leq 0$, i.e. $Dif \leq 0$, small banks are at a comparatively disadvantaged position and large-scale banks can more effectively respond to the change of DRR than small banks. In order to investigate the influence of other factors on the index of Y, some control variables are often added to the right-hand side of (1). Let $Z_{it}=(Z_{it}^{(1)},$

$Z_{it}^{(2)},\ldots, Z_{it}^{(k)})^{T}$ be consist of control variables that influence Y besides the policy factor, k is the number of the index, $Z_{it}^{(j)}$ denote the value of the j-th index of the i-th bank at time t. Y_{it} ,T_t, P_i, ε_{it} are the same as (1). Then the general form of the DD model [13] is computed by

$$Y_{it}=\alpha_0+\alpha_1 T_t+\alpha_2 P_i+\alpha_3 T_t\times P_i+\alpha_4^{T} Z_{it}+\varepsilon_{it} \quad (3)$$

Let Z^{small}_{before}, Z^{small}_{after} represent the mean observation vectors of added explanatory variables of small banks before and after the adjustment of DRR respectively, similarly, Z^{larg}_{before} , Z^{large}_{after} stand for the mean of added explanatory vectors of large banks. Then the difference of changes on current ratio between small and large banks pre and post the raise of the DRR with other factors added is computed by

$$\begin{aligned} Dif&=E(Y_{it}|T_t=1,P_i=1)-E(Y_{it}|T_t=0,P_i=1)-[E(Y_{it}|T_t=1,P_i=0)-E(Y_{it}|T_t=0,P_i=0)] \\ &=\alpha_3+\alpha_4^{T}[(Z^{small}_{after}-Z^{small}_{before})-(Z^{large}_{after}-Z^{large}_{before})] \end{aligned} \quad (4)$$

Where the distinction between (2) and (4) is that (2) shows *Dif*, the difference between the CR changes of large and small banks pre and post the adjustment, is only determined by the difference-in-differences estimator α_3.While taking other indexes into consideration, *Dif* would also be impacted by variation of those added variables, as shown in (4). In both situations, the estimator of α_3 depicts the effect of the climbing DRR on changes of liquidity level of different sizes of banks.

III. DATA AND VARIABLES

As the time that differentiated deposit reserve policy implements is in the late of 2008, this paper selects the time from 2009 to 2012 as the sample interval. All of the indicator data are derived from annual reports of each bank released by Shanghai Stock Exchange (www.sse.com.cn/) or Shenzhen Stock Exchange (www.szse.cn/).

Based on the quantity of average total asset from 2009 to 2012, researchers select 12 listed commercial banks and divide them into two groups. Large-scale banks with quantity of total asset greater than 10 trillion include the Industrial and Commercial Bank, Agricultural Bank, China Construction Bank and Bank of China. Small and medium-sized banks with large gaps in assets size compared with large-scale banks include China Merchants Bank, Shanghai Pudong Development Bank, Bank of Communications, China Minsheng Bank, Bank of Beijing, Bank of Ningbo, Industrial Bank, and Shenzhen Development Bank.

As to the definition of DRR adjustment time point, based on the tendency of Chinese DRR from 2008 to 2014 as shown in Fig.1 (sourced from Finance Sina), this paper sets the end of 2009 as well as the end of 2010 to be before the raise of the DRR, the end of 2011 as well as the end of 2012 to be after. The main reason lies in that since the implementation of the differentiated DRP, the starting point of the up-regulation of DRR in small-scale banks is at the end of 2010, while the annual report data is derived from the summary information of that total year. Therefore, it is prudent to regard the end of 2010 as before the raised policy. In addition, at the end of 2011, although DRR decreased, it was only slightly. After that, it remained at a higher position, so these decrements do not affect such decision that sets the end of 2012 as after the raised policy. Data in year 2008 are not added, as in the first half of that year differentiated policy had not been implemented and the annual report data is mixed by the information under non-differentiated policy, influencing the accuracy of the results.

Furthermore, this paper adds other six related financial indexes[1-2] into the DD model as (3), including the Capital Adequacy Ratio(CAR), Net Profit Margin(NPM), Net Interest Margin(NIM), Asset-liability Ratio(ALR), Return on Average Assets(ROAA) and Logarithm of total asset(LTA). Employing the logarithmic form of total assets can neither change the development direction of the index nor bring the inaccurate fitting problem caused by too large order of index' magnitude.

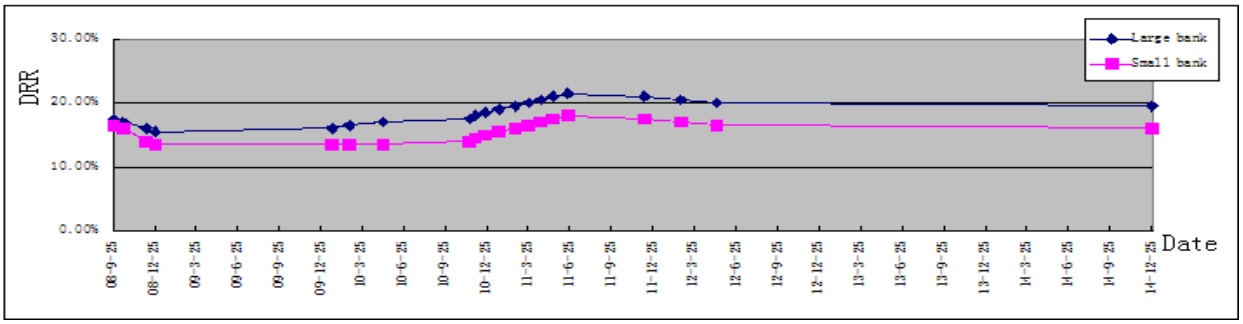

Figure 1. Tendency of deposit reserve ratio

IV. EMPIRICAL RESULTS

A. *The Significance Test of Regression Equation of the Liquidity Level*

Applying EVIEWS 8.0 by the method of OLS we obtain the regression equation of (1), statistical results listed in Tab. I. F=0.90< $F_{0.05}(M,M\text{-}N\text{-}1)=F_{0.05}(3,44)$=2.82 where M represents the number of explanatory variables except constant and N is the sample size of 12 banks in 4 years, so regression equation is insignificant at the significance level of 0.05 which means the linear function of variables T, P, $T\times P$ does not accurately reflect current ratio. Besides DRR, liquidity is also influenced by other important factors.

TABLE I. REGRESSION COEFFICIENTS AND STATISTICAL DESCRIPTION WITH ONLY POLICY FACTOR

Variable	Coefficient α_i	Estimation error	*t*- statistics	*P*-value
C	0.41	0.03	15.04	0
T	0.03	0.04	0.65	0.52
P	-0.03	0.03	-0.85	0.40
T×P	-0.00	0.05	-0.04	0.97
***F*-Statistic = 0.90**		**Sample size N=48**		

Similar with above process, researchers can get the regression equation of formula (3) with other financial indexes added, statistical results listed in Tab. II.

Obviously, F=2.25> $F_{0.05}$ (9, 38) =2.14, so regression equation is significant which means the linear function of these financial indexes could objectively reflect bank's liquidity level. Moreover, according to the hypothesis that error term ε_{it} follows normal distribution $N(0, \sigma^2)$, researchers carry out the residual analysis, seeing Tab. III.

TABLE II. REGRESSION COEFFICIENTS AND STATISTICAL DESCRIPTION WITH OTHER INDEXES ADDED

Variable	Coefficient α_i	Estimation error	*t*- statistics	*P*-value
C	3.65	1.94	1.88	0.07
T	0.02	0.04	0.44	0.66
P	-0.11**	0.05	-2.38	0.02
T×P	0.02	0.04	0.39	0.70
CAR	0.42	1.20	0.35	0.73
NPM	-0.61*	0.33	-1.85	0.07
NIM	-6.18*	3.40	-1.82	0.08
ALR	-2.28	1.88	-1.21	0.23
ROAA	17.54*	10.25	1.71	0.10
LTA	-0.14***	0.04	-3.35	0.00
F*- Statistic =2.25*		**Sample size N=48**		

a. ***, **, and * respectively denote significance at 1%, 5% and 10% level

As shown in Tab. III, skewness is -0.03 and kurtosis is 2.80, close to the normal distribution character with skewness 0 and kurtosis 3, also *P*-value reaches to 0.96, which guarantees the statistical results in Tab. II effective.

TABLE III. RESIDUAL ANALYSIS

Statistics	Value	Statistics	Value
(1) mean	0.00	(4) skewness	-0.03
(2) median	-0.01	(5) kurtosis	2.80
(3)standard deviation	0.06	(6) *P*-value	0.96

B. *Statistical Analysis of the Effect of Deposit Reserve Policy*

Analyze the policy *P*. Data in the fourth column of Tab. II show that |*t*-statistics|=2.38>$t_{0.05}$ (N-M-1) =$t_{0.05}$ (38) =1.69. It indicates that bank's liquidity condition is significantly affected by DRP. Moreover the coefficient of *P* is -0.11 implying that when DRR increases, small banks' liquidity level decreases significantly.

The difference in differences estimator is analyzed. In Tab. II, the estimated coefficient of cross terms $T \times P$ equals 0.02, namely $\alpha_3>0$. According to the analysis of the meaning of α_3 with other factors controlled, this shows after the differentiated DRP implemented even raising the required ratio, the increment of CR in small banks still exceeds large-scale banks' by 2%. Therefore the differentiated policy has a positive effect on liquidity of small banks, but the effect shows no statistically significant advantage on the liquidity of small banks compared with large ones.

The difference of liquidity increment between small and large scale banks is observed with other factors added. Taking the estimated coefficient of cross terms $T \times P$, coefficient vector of added explanatory variables and expected values of explanatory variables for small and large banks before and after the ratio adjustment into (4), then

$$Dif=\alpha_3+\alpha_4^{T}\left[(Z^{small}_{after}-Z^{small}_{before})-(Z^{large}_{after}-Z^{large}_{before})\right] = -0.14\% \quad (5)$$

As Dif= -0.14% <0, the liquidity increment of large scale banks goes beyond by 0.14% compared with small banks. This means when other factors are added, the trivial advantage of small banks derived by the differentiated policy is obscured by other indexes and the liquidity level of small banks is still more severe than the large banks. Therefore, the current differentiated deposit reserve policy has not made up for the gaps in liquidity conditions between large-scale and small-scale banks.

C. The extract and analysis of the significant index

In Tab. II, estimators of coefficient of indexes Net Profit Margin (NPM), Net Interest Margin (NIM), Return on Average Assets (ROAA), and Logarithm of total assets (LTA) are respectively -0.61, -6.18, 17.54 and -0.14 and the value of current ratio is significantly affected by these four indexes with significance level below 10%. Considering lower levels of bank liquidity often accompanying greater interest income, NPM and NIM, both reflecting bank profitability, have significantly negative effect on bank's CR. In addition, ROAA is 17.54, which means with bank's ROAA increasing, CR also increases. The empirical result of LTA shows the growth of bank's asset size does not promote the liquidity but has significantly negative influence. Indexes of CAR and ALR do not have significant impact on the liquidity.

V. CONCLUSIONS

This paper based on the DD model with annual report data of 12 listed commercial banks from 2009 to 2012 empirically analyzes after the implementation of the differentiated DRP the difference of increment in liquidity level between large and small-scale banks pre and post the up-regulation of the DRR. Conclusions are drawn as follows:

The deposit reserve policy has a significantly negative impact on the liquidity level of Chinese commercial banks, especially for small banks. However, due to the growth of capital scale and earnings on average assets, the appearance of the effect of monetary tightening is delayed.

Since the differentiated deposit reserve policy implementation, with the required ratio increased, the increment of the current ratio of small banks exceed 2% than large banks when other factors are not considered, but the positive effect of the differentiated policy, compared with large ones, is not statistically significant at conventional levels. Furthermore, when other factors are added, the trivial positive effect is obscured with the liquidity ratio increment of large banks going beyond by 0.14%. This shows that the differentiated deposit reserve policy will not be enough to make up for the gap between small and large banks and small banks' liquidity circumstance would be more severe relatively. Therefore, policy makers may consider giving more support for small-scale banks.

Multiple factors are closely related to the banks' liquidity level where ROAA has significantly positive effect on banks' liquidity, while NPM, NIM, and LTA

show significant negative impact. The negative relationship between liquidity and total assets may hide such issues as excessive growth of the asset size, assets and liabilities mismatching, which definitely deserves the consideration from both bank managers and regulatory agencies.

ACKNOWLEDGMENT

This work is supported by the Young Scientists Fund of National Natural Science Foundation of China (Grant No.71301017), the Fund for Fostering Talents in Basic Science of the National Natural Science Foundation of China (Grant No.J1103110), the National Natural Science Foundation of China (Grant No.71471027), and the Scientific Research Foundation of Education Department of Liaoning Province (Grant No. L2013040), Doctoral Fund of Liaoning Province (Grant No. 20131017), and the Fundamental Research Funds for the Central Universities of Ministry of Education of China.

REFERENCES

[1] Peng Jiangang, Commercial bank management, 2rd ed., Beijing: China Financial Press, 2009, pp.37-50.

[2] Hu Xiaofan, "Liquidity risk of changes in the new situation of China's banks-based on analysis of macroeconomic and financial situation of rapid change," Financial Accounting, no.10, 2014, pp.53-59.

[3] Milton Friedman, A program for monetary stability, New York: Fordham University Press, 1983, pp.140-186.

[4] Frederic S. Mishkin, Economics of money, banking and financial markets, 10th ed., New Jersey: Prentice Hall, 2012, pp.1-30.

[5] Guo Caixia, "Defects from excess liquidity of monetary policy Instruments," Science and Management, no.4, 2008, pp. 22-28.

[6] L. D. Haan , J. W. V. D. End, "Bank liquidity, the maturity ladder, and regulation," Journal of Banking & Finance, vol.37, no.10, 2013, pp. 3930-3950.

[7] Zhang Junfeng, "The deposit reserve ratio by the impact of the bank's cash flow and Coping," Journal of Commercial Economics, no.34, 2011, pp. 54-55.

[8] L. Ratnovski, "Liquidity and transparency in bank risk management," Journal of Finance Intermediation, vol. 22, no.3, 2013, pp. 422-439.

[9] Yu Ming, " Effectiveness analysis of reserve policy in China," The Journal of World Economy,no.2, 2009, pp. 56-65.

[10] R. M. Goodman, "Effect of cost efficiency reporting on utilization by Physician specialists: a Difference-in-Difference study," Health Services Management Research, vol. 25, no.4, 2012, pp. 173-189.

[11] F. R. McCluer, M. A. Starr, "Using Difference in Differences to estimate damages in healthcare antitrust: a case study of marsh field Clinic," International Journal of the Economics of Business, vol. 20, no.3, 2013, pp. 447-469.

[12] Feng Zeng, J. J. An, R. Scully et al, "The impact of value-based benefit design on adherence to diabetes medications: a propensity score-weighted Difference in Difference evaluation," Value in Health, vol.13, no.6, 2010, pp. 846-852.

[13] Jeffrey M. Wooldridge, Introductory Econometrics: a modern approach, 5th ed., Michigan State University, 2013, pp.451-488.