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Liquidity risk within strategic interactions of a commercial bank with its depositors: theory and evidence

Научный руководитель – Аракелян Арам Амаякович

Нанян Ашот Араратович
Аспирант
Ереванский государственный университет, Факультет экономики и менеджмента, Ереван, Армения
E-mail: ashot.nanyan@gmail.com

Until the onset of financial crisis of 2007, the importance of liquidity buffers had not been taken seriously by some international banking institutions. Moreover, this issue seems to have been overlooked in global regulatory frameworks as well. Indeed, Basel II, for example, only induces banks to develop internal liquidity risk monitoring systems without imposing limits on certain aspects of banking activities. In contrast, Basel III which was adopted after the financial crisis presumes minimum liquidity measures - *Liquidity Coverage Ratio (LCR)* and *Net Stable Funding Ratio (NSFR)* - directed at ensuring maximum repayability of deposits for banks. Thus, taking these observations into account, the current research attempts to conceptualize the optimal trade-off between liquidity and profitability within strategic interactions of a commercial bank with its depositors.

A large body of literature, starting from Friedman and Schwarz (1963) [6], considers liquidity risk in tight association with bank runs. Thus, identifying demand deposits as the main source of insolvency of banks, Diamond and Dybvig (1983) [5] investigate the properties of multiple equilibria generated by them. Going one step further, Jacklin (1987) [7] analyses "positive externalities" of demand deposits, namely, their ability to share risks. This idea is further elaborated on by Bryant (1980) [2] for risk averse depositors. Completing this line of research, Shleifer and Vishny (1992) [8], Allen and Gale (1994) [1] emphasize that in case of a panic banks have to sell their illiquid assets at fire prices. In sum, the extant literature sheds light on how beliefs of depositors and banks can give rise to a bank run and which mechanisms can optimally prevent it. However, to the best of our knowledge, the implications of other economic parameters, such as, interest rates of deposits, loans and refinancing, have not yet been studied and, moreover, existing theoretical structures constructed within the frames of the setting pioneered by Diamond and Dybwig in 1983 are, clearly, not suited for this purpose. Meanwhile, these questions are particularly relevant in view of the identification of basic motives behind the behaviour of withdrawing depositors and crashing banks and the design of optimal central bank policies meant to prevent bank runs.

To analyse these issues, we consider two simple dynamic games played among a commercial bank attempting to optimise its investments, its depositors aiming to satisfy their liquidity demand and a financial regulator seeking to price his only service, namely provision of liquidity through the discount window, in an optimal fashion. Along the lines of Diamond and Dybvig (1983) [5], Cooper and Ross (1998) [3], Deidda and Panetti (2017) [4], we model the bank's liquidity behaviour as a portfolio choice problem where funds are invested in liquid and interest-bearing assets. On the depositor side, in contrast to Deidda and Panetti (2017) [4], we specify a simpler problem which, however, allows for richer comparative statics for liquidity decisions of the bank.

Our first main result suggests that the efficiency of bailout operations of the financial regulator depends on the size of the problematic bank. In particular, if the bank is not sufficiently large then the financial regulator needs to be more prudent once deciding upon the refinancing

interest rate bearing in mind that higher rates generally make the bank hoard more liquidity thereby diminishing the probability of bankruptcy. The second main result addresses one underemphasized question that can be phrased as follows: other things equal, which economic factors lead depositors to run on the bank? Our proposition upholds the common presumption that the wealth level of a depositor plays a critical role in this decision. Put another way, there exists a "certainty equivalent" wealth level that distinguishes low-income early depositors from wealthy late ones. The third main result says that from the perspective of economic outcomes it does matter whether depositors and the bank make decisions simultaneously or sequentially. Specifically, in a Stackelberg type environment, where the decisions are made sequentially, the bank holds more liquidity and the depositors withdraw less money compared to what they would do in a Cournot-type environment where the decisions are made simultaneously. Finally, we bring this theoretical model to the data by testing the prediction according to which liquidity ratio of banks is decreasing in the deposit interest rate since higher interest rates of deposits discourage customers to withdraw more money and this, in turn, relaxes the liquidity constraint confronting banks. Using a panel of 5071 American banks over 32 post-crisis quarters, we find that in small banks every additional percentage point of the deposit rate leads to reduction of the liquidity ratio of a bank by about 0.53 percentage points. However, in large banks this effect is practically insignificant.

Clearly, these findings and the related modelling techniques can potentially be of interest not only to academicians but also to practitioners who manage the liquidity risk in commercial banks or are engaged in the design of efficient macroprudential policies in central banks.

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