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Liquidity Risk and Bank Runs Models

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Abstract. The 2007-2009 global financial crisis has taught hard liquidity risk management lessons to academics, bankers and regulators. Consequently, academics and bankers have developed new liquidity risk models on both micro and macro levels designed to prevent, predict or ameliorate future crises. The Basel Committee on Banking Supervision, a global regulator, published new liquidity standards for internationally active banks in December 2010 (known as "Basel III"). In this paper, we discuss liquidity risk standards newly introduced into the Basel III proposal. However, we expect that proposed liquidity regulations are not sufficient and will not prevent financial markets from future crises due to their delayed implementation and strong pressure from the banks' lobbyists. We also deal with economic models of bank runs that focus on the behaviour of depositors in case of sudden withdrawals causing liquidity shortage for banks. Specifically, we looked at two main groups of bank run models: models explaining bank runs as self-fulfilling prophecies (the Diamond and Dybvig model) and models relating bank runs to business cycles (the Zhu models, the Irasema model and the Chari and Jagannathan model). The paper demonstrates that insurance of deposits might be a suitable tool for prevention of bank runs, which matches historical experience.

Keywords: Bank Run, Basel III, CRD IV, Diamond and Dybvig model, liquidity risk

1. Introduction

The 2007-2009 global financial crisis has taught hard liquidity risk management lessons to academics, bankers and regulators. Consequently, academics and bankers have developed new liquidity risk models on both micro and macro levels designed to prevent, predict or ameliorate future crises. The Basel Committee on Banking Supervision, a global regulator, published new liquidity standards for internationally active banks in December 2010 (known as "Basel III"). In this paper, we discuss liquidity risk standards newly introduced into the Basel III proposal. We also deal with economic models of bank runs that focus on the behaviour of depositors in case of sudden withdrawals causing liquidity shortage for banks. We demonstrate our findings on a case study of Northern Rock, a UK bank hit by a bank run in September 2007. The paper continues as follows. In Section 2 we review basic terms related to liquidity risk and bank runs. Section 3 looks in more detail at two main groups of bank run models: models explaining bank runs as self-fulfilling prophecies and models relating bank runs to business cycles. Section 4 concludes the paper.

2. Basic Terms

The definition of liquidity risk can be written in many ways, as it is not so easy to separate this risk from all other risks and still capture all of its drivers. BIS (2008) defines banks´ liquidity as is the ability of the bank to fund increases in assets and meet obligations as they come due, without incurring unacceptable losses. This definition is related to the funding liquidity problems of the bank, but when defining liquidity in general, we should always distinguish its two main types: market liquidity defines how difficult is to trade assets while funding liquidity defines how difficult is to obtain funding.

The pending turmoil started as a credit crisis from mid-2007 until August 2008, became a liquidity crisis in late 2008, and was then followed by an economic crisis in 2009, a sovereign debt crisis in 2010 and a crisis of Europe since 2011 (Teply et al., 2012). Following negative lessons from the 2008-2009 global crisis, a revision of Basel II was needed to reflect the current trends in the world financial markets. For more details on Basel II and the global crisis we refer to, for instance, Jakubik and Teply (2011), Matejasak et al. (2009), Cernohorsky et al. (2010), Rippel and Teply (2011), Rippel et al. (2012), Serdarevic and Teply (2011) or Starova et al. (2010). As a result, a new proposal Basel III includes requirements for higher quality, constituency and transparency of banks´ capital and risk management, regulation of OTC markets and an introduction of new liquidity standards for internationally active banks (BIS, 2010). Capital Requirement

Directive IV (CRD IV) dated July 2011 is the EU´s implementation of Basel III, there are still fierce discussion over this regulation, however. The European Banking Authority is responsible for the CRD IV implementation in the EU and should publish a detailed report until July 2013.

The liquidity framework concentrates primarily on two key ratios. First, the Liquidity Coverage Ratio (LCR) focuses on short-term resilience of a bank and is designed to instruct banks to keep adequate level of assets which can be turned into cash to cover liquidity needs for 30 days under the worst-case stress scenario. Second, the Net Stable Funding Ratio (NSFR) deals with medium and long-term resilience of a bank and implies that available sources should be higher than sources required limiting the over-reliance on short-term sources of funding. However, we agree with Teply et al. (2012) who expect that the Basel III regulation of funding liquidity is not sufficient and will not prevent financial markets from future crises due to its expected calibration, delayed implementation and strong pressure from the banks' lobbyists.

3. Bank Runs Models

A bank run appears when many depositors (including bank providing interbank funding) are afraid, that their bank can become insolvent. In general, these clustered withdrawals have strong consequences on the banking sector, as banks are investing in illiquid assets while on the other hand their liabilities are liquid. We can find examples of how bank runs played an important role and were a common feature of crises throughout the whole history from early banks. The examples include The Great Depression in early 1930´s or a bank run on the Northern Rock in September 2007 as it serves as an illustrative example. In June 2007 Northern Rock reported total assets of GBP 113 billion and shareholders' equity of GBP 2.2 billion. Under Basel II, a predecessor of Basel III, the bank reported Tier 1 capital of a 'healthy' 11.3% of risk-weighted assets (RWA), but only 2% of its total assets. However, in September 2007 liquidity of the bank dried up and it suffered the first bank run on a British bank since 1866. As a consequence, Northern Rock´s regulatory capital fell below 10% of the GBP 23 billion that the authorities had to support it (Blundell-Wignall et al., 2008).

A bank run is usually defined as an act of panic, what correspond to the above-mentioned definition. When looking at the reasons for withdrawal of some depositors, that on the basis of reasonable thoughts withdraw their money, because they are worried. This fact probably should not be qualified as panic behaviour. On the other hand, we speak about a bank run only in the case of sudden withdrawals by a huge number of clients. However, one question remains: how many of them are just reacting on the acts of others. This question divides economic models explaining the process of bank runs into two groups. The first group includes explaining the bank runs as self-fulfilling prophecies; in other words these models imply that the depositors are irrational. The second group of models relates bank runs to business cycles.

3.1. The Diamond and Dybvig Model

In this part we look at key concepts that are modelling the situation of bank runs and the resulting equilibrium. Moreover, we elaborate on the options, how to manage or avoid bank runs and describes overall consequences of this liquidity risk. One can distinguish economic models in this area by some main features. The Diamond and Dybvig model belongs to the group of self-fulfilling prophecies and makes a core for other new developed models that by altering some assumptions created also models where bank runs are related to business cycles. The Diamond and Dybvig model (1983) shows that bank deposit contracts can provide allocations superior to those of exchange markets, offering an explanation of how banks subject to runs can attract deposits. This model tries to cover three important points. First, the demand deposits are issued by banks because they give a bank a competitive advantage and satisfy the different time needs of consumption among people. Second, these demand deposit contracts create an equilibrium where all depositors are panicking and withdraw their deposits. Finally, bank runs can make fail even healthy banks which can cause real economic problems. Illiquidity of assets means the reason for banks vulnerability to runs as well it is the reason for banks´ existence. This model includes illiquidity of assets by assuming economy's risk less production activity, which for one period creates just small output per unit of input. The main and final consequence of bank runs implies destruction of optimal risk-sharing among depositors and so reduction in social welfare, which is done via interruption of production that is disrupted by recalled loans.

The Diamond and Dybvig model uses three periods (T = 0, 1, 2) with one homogenous good. In Period 0, a depositor places money to a bank. The productive technology is without yield in Period 1, but with a yield only in Period 2 (yield R > 1). The interruption by a bank run stops the production and the value equals to the initial investment. There are two types of agents: Agent 1 consumes everything in Period 1 and Agent 2 consume only in period two, so for the utility function can be written:

$$U(c_1, c_2, \theta) = u(c_1), \textit{if the agent is of type 1 at state } \theta$$
$$U(c_1, c_2, \theta) = \rho u(c_1 + c_2), \textit{if the agent is of type 2 at state } \theta \quad (1)$$

where $1 \geq \rho > \mathrm{R}^{-1}$ and $R_{++} \to R$ is twice continuously differentiable, increasing, and strictly concave and satisfies Inada conditions $u'(0) = \infty$ and $u'(\infty) = 0$. The risk aversion coefficient is always higher than 1. Agents are maximizing, conditional on their information (if any), expected utility $E[u(c_1, c_2, \theta)]$, where each agent has an initial endowment of 1 unit. After providing some trivial algebra it holds for a payoff in Period 2 (depending on total withdrawals at T=1) that:

$$V_2(f, r_1) = \max\{R(1 - r_1 f)/(1 - f), 0\} \quad (2)$$

where f_j is the quantity of withdrawers´ deposits serviced before agent j and f is the total quantity of demand deposits withdrawn. When holds that $r_1 = c_1^{1^*}$, the demand deposit contract is achieving the full-information optimal risk-sharing as an equilibrium. On the other hand another equilibrium is basically a bank run, when the face value of deposits is larger than the liquidation value of the bank's assets Diamond and Dybvig (1983).

To summarize, the pure demand deposit contract is feasible even for positive probability of run and can be altered by a dominating equilibrium. To prevent the bank run equilibrium, suspension of convertibility might help as it creates optimal risk sharing equilibrium for f=t, but only for fixed t. When we let t be random, Diamond and Dybvig (2000) conclude that in case non-degenerating function we cannot achieve optimal risk sharing. Another possible instrument to reach the optimal equilibrium is government deposit insurance. This insurance can be in this model really effective under conditions that there is also an optimum tax that finances the deposit insurance, it achieves the unconstrained optimum as a unique Nash equilibrium. Diamond and Dybvig (2000) use improvement by insurance of deposits as a signal that the government intervention into banking markets can be beneficial.

3.2. Models with Bank Runs Related to Business Cycles

The Diamond and Dybvig model has many drawbacks including assumptions that do not reflect reality. Zhu (2001a) sees these drawback in the following areas: the absence of a specified moment when the bank run occurs, unexplained shift of expectations, the omission of impact of bank runs on bank (in other words how the banks choose the demand deposit contracts). Furthermore, he criticizes the controversial assumption of self-fulfilling banking crises. In order to get ex-post efficient policy that eliminates bank runs, while the liquidation costs are not so high, Zhu (2001b) applied full-coverage insurance scheme, when central bank guarantees depositors the promised interest rates when banks are insolvent. However, this insurance ex-ante cannot achieve the first-best optimum due to moral hazard.

The third model deals with slightly noisy signals. Irasema (1995) found out that in an unique equilibrium, the occurrence of bank runs is determined by the state of the business cycle. Moreover, he answers the question why do banks, when they are maximizing their profits, design contracts that will lead to bank runs under some states. Irasema (1995) concludes that contracts with runs are beneficial if the probability of a bad enough signal about the bank's investments reaching a subset of the depositors is low enough (p.5).

The fourth model developed by Chari and Jagannathan (1998) tries to find more specifically how or which fundamentals are able to trigger bank runs by affecting the agent´s expectations (so called a signal extracting story). There are two groups of agents – informed agents and uniformed agents, what implies a model with asymmetric information on assets return. Uninformed agents try to figure out missing information by looking at the early withdrawals. Chari and Jagannathan (1998) found a unique equilibrium, where a bank run can happen even when no agent has adverse information. This fact results from the misinterpretations of uninformed agents.

4. Conclusion

In this paper we discussed liquidity risk that has been newly introduced into the Basel III proposal. We argue that proposed liquidity regulations are not sufficient and will not prevent financial markets from future crises due to their delayed implementation and strong pressure from the banks' lobbyists. We also focused on mathematical models of bank runs that deal with behavior of depositors in case of sudden withdrawals. Specifically, we looked two main groups of bank run models: models explaining bank runs as self-fulfilling prophecies (the Diamond and Dybvig model) and models relating bank runs to business cycles (the Zhu models, the Irasema model and the Chari and Jagannathan model). The paper demonstrates that insurance of deposits might be a suitable tool for prevention of bank runs, which matches historical experience.

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