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The safer, the riskier: A model of financial instability and bank leverage[☆]

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ABSTRACT

We examine the role of bank leverage to explain why the 2007–2008 financial crisis unfolded at a time when the economy appears to be less fragile to crisis risks. To this end, we extend the model introduced by Diamond and Rajan (2012) to a variant where the probability of financial crises varies endogenously. In our model, aggregate liquidity shock plays a key role in precipitating a crisis because high liquidity demand in a highly leveraged banking system is likely to expose the economy to greater crisis risks. We consider an example of a "safe" environment where liquidity demand tends to be low on average. Using numerical analysis, we show that the "safer" environment could incentivize banks to raise their leverage, resulting in a banking system that is more vulnerable to liquidity shocks.

1. Introduction

A consensus on the 2007–2008 crisis is that, with hindsight, the banking sector had been exposed to high risks of insolvency before the crisis took place. Conversely, there was a widely-held perception in the run-up to the crisis that the banks were placed in a "safe" environment.[1]

Relatedly, a notable fact is that funding liquidity for banks, was quite affluent before the crisis. Gorton and Metrick (2012a, 2012b) point out that the market for repurchase agreements (repo), which provides short-term funding for banks and other financial institutions, rapidly grew in the periods prior to the 2007–2008 crisis. In the meantime, prices of funding liquidity remained at a quite low level. For example, the TED spread, an indicator of funding liquidity, declined to historically low levels in the early 2000s and leveled off until 2006.[2] Fig. 1 plots the TED spread, together with net repo funding to banks and broker dealers from 1998:Q1 to 2008:Q4. The combination of the low prices of funding liquidity and expanding short-term funding markets implies that demand for funding liquidity by banks was low relative to the supply. In the presence of such abundant liquidity or relatively low demands for liquidity, banks can feel safe, standing a distance away from risks of financial crises. A key question is why the financial crisis unfolded at a time when the banking sector was considered surrounded by such a "safe" environment.

This paper aims to explain how a "safer" environment can increase the probability of bank runs. A key to understand this "the safer, the riskier" case is the banks' endogenous risk-taking. We show that the banks' risk-taking with higher leverage offsets, or even dominates, the exogenously improved environment in terms of the bank run probability. In particular, a "safe" environment, represented by a low demand for funding liquidity, incentivizes banks to raise their leverage. The increased leverage can result in a higher risk of bank runs.

Our model is based on the framework of bank runs developed by Diamond and Rajan (2001, 2012). In Diamond and Rajan (2001), banks' commitment to repaying demandable deposits works as a disciplinary device for banks to raise funds. While the maturity transformation promotes financial intermediation, such funding via demandable

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[1] For example, Reinhart and Rogoff (2009, p.208) noted that the 2007–2008 financial crisis came as a surprise from the viewpoint of investors because "the financial meltdown of the late 2000s was a bolt from the blue, a 'six-sigma' event."

[2] Other similar indicators of funding liquidity, such as LIBOR-OIS spread and repo rates remained at low levels as well.

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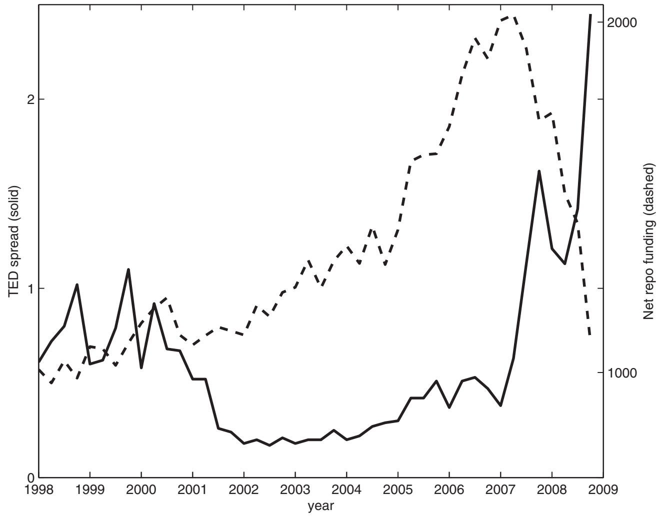

Fig. 1. TED spread and net repo funding to banks and broker dealers. Note: The solid line represents the TED spread (the spread between 3-month LIBOR based on US dollars and 3-month Treasury Bill rate) from the Federal Reserve Economic Data. The unit is percent. The dashed line shows net repo funding to banks and broker dealers taken from the Financial Accounts of the United States deflated by the Consumer Price Index for All Urban Consumers (All Items). The unit of net repo funding is billions of 2005 US dollars.

liabilities exposes banks to some risks of bank runs. Using a simplified framework of Diamond and Rajan (2001), Diamond and Rajan (2012, hereafter DR) demonstrated how and why low interest rate policies deployed by a central bank raise banks' leverage and endanger the financial stability. In this paper, we use DR's framework for a different purpose, that is, to answer the above-mentioned key question. To assess the effect of "safe" environment for banks, two distributions for liquidity (preference) shocks are compared: the "risky" and "safe" distributions in the sense that the depositors' demands for liquidity are high or low, on average. Our finding that "the safer, the riskier" implies that the bank run probability can increase even in the absence of any policy intervention, which is in a sharp contrast to the main focus of DR.

While we model banks funded by demand deposits following the classic literature of banking, the banks in our paper can refer to broader financial intermediaries that raise funds via short-term debts (e.g., a repo) and invest them in longer-term assets, by maturity transformation. (See Diamond and Rajan, 2001.) The lower price for funding liquidity in the pre-crisis periods can be translated into a model of classic banking where fewer depositors (i.e., suppliers of short-term funding for banks) come to banks to withdraw their deposit. In the same spirit, Gorton and Metrick (2012b) point out that the "run on repo" which happened in the 2007–2008 financial crisis was a systemic bank run. In line with this view, we focus on the aggregate liquidity shock that affects depositors as the liquidity suppliers for banks. As a result, we can assume that "bank runs" and "financial crises" are interchangeable in our very stylized model.

In comparison with the early studies discussing the mechanism of financial crises, this paper relies neither on contagion nor externalities.[3] In a similar spirit of DR, there are a number of studies arguing that the growing expectations of bank bailouts or the low interest rate policy by the central banks might be responsible for the crisis.[4] We do not claim that all these factors did not play critical roles for the 2007–2008 crisis. Rather, this paper provides an example where the crisis probability rises even without these factors such as policy interventions and externalities.

The rest of the paper is organized as follows. Section 2 introduces the model. In Section 3, we discuss the main numerical results with some robustness checks. Section 4 concludes.

2. The model

2.1. Setup

We consider a variation of the economy developed by DR in which the bankers are intermediating the funds from households to entrepreneurs via maturity transformation. Most of the assumptions are maintained in line with the original DR model except for the households' preference and the flow of their income. In DR, households' utility function is given by $U(C_1, C_2) = \log(C_1) + \log(C_2)$, where C_t is consumption at date t. Also, DR assume that the random shock arises from the uncertainty over expectations on future income and consider finite discrete aggregate states. By contrast, we eliminate uncertainty with respect to households' income while incorporating a more straightforward random shock regarding liquidity preference into our model. Specifically, households' utility function is given by $U(C_1, C_2) = \theta\log(C_1) + (1 - \theta)\log(C_2)$, where θ is a continuous random variable with a support $\theta \in (0, 1)$. Here, θ can be interpreted as a "liquidity shock," which indicates how much liquidity is needed at date-1 consumption. Seemingly, the utility function takes the same form as the expected utility in Allen and Gale (1998). However, we emphasize that there is neither an early consumer nor a late consumer in this economy. Our model includes only a single type of households, who are subject to perfectly correlated liquidity shocks across households. In our model, θ is the only source of the aggregate uncertainty, which precipitates a crisis in this economy. The utility function provides the advantage that we can focus on aggregate uncertainty and an endogenously changing crisis probability in a straightforward manner.

Following DR, we assume three types of agents: (i) households, (ii) entrepreneurs, and (iii) bankers. As assumed by DR, while the households are risk averse, the entrepreneurs and bankers are risk-neutral.

The economy lasts for three dates ($t = 0, 1, 2$). At date 0, households are born with a unit of a good. By assumption, no household consumes at date 0. Rather, they deposit all the date-0 endowments into banks. Bankers compete to offer the most attractive promised deposit payment D to households (per unit of endowment deposited). Then, bankers lend the households' endowment to entrepreneurs. Each entrepreneur invests a unit of the good to launch a long-term project at date 0. These transactions are settled before the realization of the liquidity shock.

At date 1, the liquidity shock θ is realized. Households determine the date-1 withdrawal w_1 to smooth out their consumption, given the realized θ (and their fixed endowment at dates 1 and 2). Turning to entrepreneur's project, each of the projects yields a random output $\tilde{Y}_2$ at its completion at date 2. Outcomes of projects follow a uniform distribution with a support $[0, \overline{Y}_2]$. In this model, there is no aggregate uncertainty in $\tilde{Y}_2$, and thus the financial stability entirely relies on the aggregate uncertainty in θ. If a project is prematurely liquidated, the project produces $X_1(< 1)$ at date 1. If each banker needs to liquidate all projects to meet a high liquidity demand (i.e., full withdrawal of the

[3] The role of contagion for understanding crises is emphasized by Allen and Gale (2000), Dasgupta (2004), Allen and Carletti (2006), and Acharya and Yorulmazer (2008), Allen et al. (2006), and Castiglionesi et al. (2012). Lorenzoni (2008) and Jeanne and Korinek (2010) develop models in which financially constrained borrowers take on more risks due to pecuniary externalities. Stein (2012) and Gersbach and Rochet (2012) discuss pecuniary externalities in models with banks.

[4] Examples include Farhi and Tirole (2012), Jiménez et al. (2014), and Maddaloni and Peydró (2011). The low interest rate policy is closely related to the risk-taking channel of monetary policy. Angeloni et al. (2014) introduce demandable deposits as a disciplinary device in Diamond and Rajan (2001) into their dynamic stochastic general equilibrium model and study the monetary transmission in the model with endogenous probability of bank runs.