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Experimental evidence of bank runs as pure coordination failures

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ABSTRACT

We investigate how coordination requirement, measured by the coordination parameter, affects the occurrence of miscoordination-based bank runs in controlled laboratory environments. We identify an indeterminacy region of the coordination parameter such that games with the parameter within the region have varying coordination outcomes and exhibit persistent path dependence. Experimental economies with the parameter above (below) the region stay close or converge to the run (non-run) equilibrium. Switches between the two equilibria occur even with fixed economic fundamentals. The experimental results are well accounted for by a version of the evolutionary algorithm that uses experimentation rates estimated from the experimental data.

1. Introduction

A bank run is the situation in which a large number of depositors, fearing that their bank will be unable to repay their deposits, simultaneously try to withdraw their funds even in the absence of liquidity needs. Bank runs were frequently observed in the United States before the establishment of the Federal Deposit Insurance Corporation in 1933. The enactment of the deposit insurance program has greatly reduced the incidence of bank runs. However, a new wave of bank runs has occurred across the world during the recent financial turmoil. Examples include the runs on Northern Rock in September 2007, on Bear Stearns in March 2008, on Wamu in September 2008, on IndyMac in July 2008 and on Busan II Savings Bank in February 2011.

The theoretical literature on bank runs is largely built on the seminal paper by Diamond and Dybvig (1983) (hereafter DD). The bank is modeled as a liquidity insurance provider that pools depositors' resources to invest in profitable illiquid long-term assets, and at the same time, issues short-term demand deposits to meet the liquidity need of depositors. The term mismatch between the bank's assets and liabilities opens the gate to bank runs.

There are, broadly speaking, two opposing views about the cause of bank runs. The first view (represented by DD) is that bank runs are the result of pure coordination failures. The bank run model in DD has two self-fulfilling symmetric pure-strategy Nash

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equilibria. In one equilibrium, depositors choose to withdraw only when they need liquidity. In the other equilibrium, in fear that the bank will not be able to repay them, all depositors "run" to the bank to withdraw money irrespective of their liquidity needs. The run forces the bank to liquidate its long-term investment at fire-sale prices and makes the initial fear a self-fulfilling prophecy. As a result, even banks with healthy assets may be subject to bank runs. The competing view (represented by Allen and Gale, 1998) is that bank runs are caused by adverse information about the quality of the bank's assets.

To empirically test the competing theories of bank runs is challenging. Real-world bank runs tend to involve various factors, which makes it difficult to conclude whether the bank run is due to miscoordination or the deterioration of the quality of the bank's assets. There are some attempts to empirically test the source of bank runs, nonetheless with mixed results. For example, Gorton (1988), Allen and Gale (1998) and Schumacher (2000) show that bank runs have historically been strongly correlated with deteriorating economic fundamentals, which erode away the value of the bank's assets. In contrast, Boyd et al. (2001) conclude that bank runs may often be the outcome of coordination failures.

An experimental approach has the advantage that it is easier to control the different factors that may cause bank runs in the laboratory. In this study we focus on coordination failures as a possible source of bank runs. To that goal we fix the rate of return of the bank's long-term asset throughout the experiment to rule out the deterioration of the quality of the bank's assets as the contributing factor to bank runs.

The specific design of the experiment is inspired by Temzelides (1997), who applies the evolutionary algorithm to a repeated version of the DD model. He proves a limiting case in which as the probability of experimentation approaches zero, the economy stays at the non-run equilibrium with probability one if and only if it is risk dominant, or less than half of patient consumers are required to coordinate on "wait" so that "wait" gives a higher payoff than "withdraw".[1] Following Temzelides (1997), we conjecture that the coordination parameter, measured as the fraction of depositors choosing to wait that is required to generate enough complementarity among depositors who wait so that they earn a higher payoff than those who withdraw, affects the decision of depositors and in turn the occurrence of bank runs. We are particularly interested in three questions. How does the coordination parameter affect the level of coordination and the frequency of bank runs? Does the path followed by the coordination parameter influence the performance of the economy? Will the economies switch between the equilibria even if the economic fundamentals are constant, and if yes, how does the switching behavior depend on the coordination parameter?

To answer these questions, we run 20 sessions of experiment. In every session a group of 10 subjects acts as depositors deciding whether to withdraw money or wait. A session consists of 7 or 9 phases, and each phase runs for 10 periods. The level of coordination requirement is fixed in each phase but varies across phases ranging from 0.1 to 0.9. The ordering of the coordination parameter is either increasing, decreasing or random.

We have three main findings. The first is that bank runs occur more frequently when the coordination task is more difficult. In particular, we can describe the coordination results in three regions of the coordination parameter values. In the non-run region, where the parameter is ≤ 0.5, all experimental economies stay close or converge to the non-run equilibrium. In the run region, where the parameter is ≥ 0.8, all experimental economies stay close or converge to the run equilibrium. The economies perform very differently and may stay close or converge to either the run or the non-run equilibrium if the coordination parameter falls into the indeterminacy region, where the parameter is equal to 0.6 or 0.7. Second, some order effect is detected, especially in games characterized by a coordination parameter that lies in the indeterminacy region. The experimental economies tend to achieve better coordination outcomes and have less bank runs when the level of coordination requirement increases gradually over time, as compared to the case where the parameter decreases or changes in a random pattern. Third, we observe intra-phase switching between the run and non-run equilibria even if the economic fundamentals are constant within each phase. The switches tend to occur when the coordination parameter is ≥ 0.5.

Finally, we evaluate how the evolutionary algorithm can be used to explain the experimental data. Temzelides (1997) proves a limiting case where the probability of experimentation approaches zero and predicts an indeterminacy point of 0.5 for the occurrence of bank runs. The limiting case does not provide a satisfactory explanation of the experimental data, which suggest an indeterminacy region located above 0.5. We show that a modified version of the evolutionary algorithm, which uses experimentation rates estimated from the experimental data, is successful in explaining the behavior of subjects.

The rest of the paper is organized as follows. In Section 2, we discuss related experimental studies on bank runs and coordination games. Section 3 describes the theoretical framework that underlies the experiment, the hypotheses and the experimental design. Section 4 presents the experimental results and the major findings. Section 5 develops the evolutionary algorithm and evaluates its power in explaining the experimental data. Section 6 concludes and discusses directions for future research.

2. Related literature

In this section, we discuss related experimental research on bank runs and coordination games.

There have been several previous studies of bank runs in controlled laboratory environments, including Madiès (2006), Garratt and Keister (2009), Schotter and Yorulmazer (2009) and Klos and Sträter (2013). Madiès (2006) provides the first experimental study of miscoordination-based bank runs within the framework of the DD model. The paper's emphasis is on

[1] Ennis (2003) also discusses risk dominance as an equilibrium selection device in the context of the DD model of bank runs.