

Bank Runs: Theories and Policy Applications

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Abstract

In the present paper, I review the foundations of bank runs, and of the incentives of the economic agents to join them, as a base for discussing possible regulatory interventions to alleviate their effects. To this end, I study both self-fulfilling as well as fundamental runs, and propose a reconciliation of the two approaches, via the introduction of “global games”. My policy conclusions highlight the role of competition and liquidity requirements to tame self-fulfilling runs. Moreover, market incompleteness and the increasing complexity of modern financial systems justify the imposition of liquidity requirements, in the presence of systemic aggregate liquidity risk.

(JEL: E21, E44, G01, G20)

Introduction

Bank runs are not only a phenomenon of the remote past:¹ in fact, they may occur whenever long-term illiquid assets are financed by short-term liquid liabilities, and the providers of short-term funds all lose confidence in the borrower’s ability to repay, or are afraid that other lenders are losing their confidence. There exists a wide consensus that many U.S. money market funds have experienced runs after the bankruptcy of Lehman Brothers in 2008 and, more generally, that the financial crisis of 2007-2009 can be interpreted as a run of financial intermediaries on other financial intermediaries (Gorton and Metrick 2012). The empirical literature shows that, during that period, the U.S. endured a peak-to-trough decline in real per capita GDP of 4.8%, with a widespread impact on asset markets, housing markets, government debt and unemployment (Reinhart and Rogoff 2009, 2014). These numbers justified a massive government intervention,² as well

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1. In the period 1825-1929, the U.S. economy experienced seven major bank runs, and twenty non-major ones (Jalil 2015). Afterwards, no episode was registered, up until 2008.
2. In 2008-2009, the U.S. Treasury invested more than \$400 billion in the “Troubled Asset Relief Program”, to rescue several financial and non-financial corporations hit by the financial crisis. In

as the introduction of new forms of financial regulation, in particular through the liquidity ratios of Basel III, with the explicit objective of taming the adverse effects of bank runs in the future. However, a rigorous discussion of these policies and of their effectiveness cannot prescind from an equally rigorous evaluation of the foundations of bank runs, and of the incentives of the economic agents to join them.

The aim of the present paper is to describe a theory suitable to jointly analyze these themes. To this end, I take as starting point the seminal work of Diamond and Dybvig (1983). This is the standard workhorse model for the analysis of the economics of banking, as it offers a rationale for the existence of a banking system – as a mechanism to pool risk and allocate resources in an economy hit by idiosyncratic liquidity shocks – as well as a natural framework to study bank runs. With this tool in hand, I study bank runs emerging from self-fulfilling expectations of banks’ depositors, as well as from extreme fluctuations of the fundamentals of the economy. The first approach speaks to those who argue that bank runs are a consequence of illiquidity, caused by extrinsic events (like sunspots or panic attacks) completely independent from the observed state of the economy. In contrast, according to the second approach, bank runs are a consequence of insolvency, caused by fundamental shocks affecting the returns on banks’ investments. To reconcile these two points of view, I conclude by introducing the “global game” approach, where runs are expectations-driven, but also explicitly depend on banks’ risk profiles, and on the underlying state of the economy. For each of these approaches, I will sketch the main findings of the literature, and their policy implications.

The Diamond-Dybvig Model

I start my analysis with a description of the Diamond-Dybvig model. This framework focuses on banks engaging in liquidity and maturity transformation, through illiquid long-term loans and liquid short-term deposits, which are the main components of banks’ asset and liabilities in the real world.

The economy lives for three periods, labeled $t = 0, 1, 2$, and is populated by risk-averse agents, all with an endowment $e = 1$ at date 0, and nothing afterwards. At date 1, each agent draws an idiosyncratic type θ , which is private information to herself, and takes value 0 with probability $1 - \pi$, and 1 with probability π . The idiosyncratic types affect the point in time at which each agent enjoys consumption, according to the welfare function

the same period, the Federal Reserve, through its liquidity facilities, extended credit to the U.S. financial system for around \$1.5 trillion.

$W(c_1, c_2, \theta) = \theta u(c_1) + (1 - \theta)u(c_2)$. Clearly, those agents whose realized type is $\theta = 0$ are only willing to consume at date 2, and those whose realized type is $\theta = 1$ are only willing to consume at date 1. Thus, I interpret the types θ as “liquidity shocks” and the probability π as “liquidity risk”. Moreover, I refer to the agents as late (or patient) and early (or impatient) consumers, respectively.

Being risk averse, the agents would like to insure themselves against liquidity risk. However, we make the simplifying assumptions that they are isolated, and markets are incomplete.³ Thus, the only channel left is through the banking system. The economy is populated by a large number of banks, operating in a perfectly-competitive market with free entry. At date 0, the agents deposit their endowments, and the banks offer them a deposit contract $\{d_1, d_2\}$, stating how much they can withdraw and consume at date 1 and 2, depending on their reported types. To finance the deposit contract, the banks invest the deposits (the only liability on their balance sheets) into two assets: the first one is a storage technology (analogous to liquidity or cash) that yields 1 unit of consumption at date $t + 1$ for each unit invested at any date t , and is a cheap – although not remunerative – way to roll over resources from one period to the next; the second one is a long-term asset, that yields $R > 1$ units of consumption at date 2 for each unit invested at date 0, but only $r < 1$ units at date 1. This long-term asset can be interpreted as a loan to a production unit, that takes time to mature and is partially illiquid, or can be liquidated before maturity, with a low recovery rate equal to r . Competition and free entry ensure that the banks have incentives to look after their depositors in order to attract them and survive into operation. In other words, in a competitive banking equilibrium, the banks choose a portfolio allocation between storage and loans and a deposit contract so as to maximize the expected welfare of their depositors, subject to their budget constraints.

In such an environment, Diamond and Dybvig (1983) show that the competitive banking equilibrium is equivalent to the “first best” allocation, where a benevolent social planner, who wants to maximize the expected welfare of the agents, perfectly insures them against liquidity risk. In such an equilibrium, the banks give the depositors an amount of late consumption lower than what they would get if they invested all their endowments in the long-term asset ($d_2 < R$), in exchange for an amount of early consumption higher than what they would get from mere storage ($d_1 > 1$), and the fact that the agents are risk averse implies that this transfer is welfare-improving. Moreover, such a consumption allocation satisfies the

3. The hypothesis of market incompleteness is crucial for the the results of the Diamond-Dybvig model: if the agents were allowed to trade in a complete market for state-contingent claims, banks would be redundant (Allen and Gale 2004). However, it is easy to show that the competitive banking equilibrium dominates an “autarkic” equilibrium, where the agents independently choose their portfolio allocations, and rebalance them in a secondary asset market.

incentive compatibility constraint $d_1 \leq d_2$, that ensures truth-telling when the realizations of the idiosyncratic types are private information. To sum up, a perfectly-competitive banking system with free entry, holding long-term illiquid loans financed by short-term liquid deposits, allow an efficient allocation of resources, in the presence of idiosyncratic liquidity risk.

Self-fulfilling Bank Runs

According to Diamond and Dybvig (1983), the fact that the banks offer a deposit contract equivalent to the first best makes them intrinsically fragile. To see that, assume that a bank, at date 0, commits to offer the equilibrium deposit contract $\{d_1, d_2\}$ to all withdrawers and liquidate the long-term asset to fulfill this obligation. Under this hypothesis, the economy exhibits two equilibria: one where only the early consumers withdraw at date 1, and one where also all late consumers withdraws at date 1, and store to consume at date 2. This second equilibrium may occur whenever all late consumers expect that all the other late consumers withdraw, and know that the bank does not have sufficient resources to pay d_1 to all withdrawers. In this case, the bank is subject to a “run”. To see this more intuitively, notice that, if a late consumer expects no other late consumer to run, she clearly prefers to withdraw at date 2, as $d_1 \leq d_2$. However, if she expects all the other late consumers to run, a late consumer would prefer to join the run (and get $X + rY$) rather than waiting until date 2, when she gets 0, as the banks have liquidated all the long-term assets in portfolio. In other words, according to this narrative, bank runs are an exclusive consequence of depositors’ self-fulfilling expectations about the behavior of the other depositors and bank illiquidity, not of fundamental shocks affecting the value of banks’ assets.

Clearly, this explanation relies on the commitment of the banks to offer the equilibrium deposit contract.⁴ To relax this assumption, assume that the banks, at date 0, choose the portfolio allocation $\{X, Y\}$ and deposit contract $\{d_1, d_2\}$ taking into account the strategic decision of the depositors about whether to run or not at date 1. Moreover, assume that, at date 1, the banks serve the depositors on a first-come-first-served basis (i.e. according to the so-called “sequential service constraint”). In this way, a run might affect the fraction of the depositors who are served, and the portfolio allocation between storage and the long-term asset. To see that more clearly, write the budget constraint of a bank subject to a run at date 1 as $X + rY = \delta d_1$, where δ is the fraction of depositors that can be served, given the portfolio allocation $\{X, Y\}$ and the amount of consumption d_1 stated in the deposit contract.

4. In fact, if they committed to not liquidate the long-term asset (a policy often referred to as “suspension of convertibility”) the run equilibrium would not exist.

Cooper and Ross (1998) show that a run equilibrium exists if and only if δ is lower than 1, i.e. the bank is not able to serve all depositors in the case of a run. Put differently, if such a condition is satisfied, banks are illiquid, and the economy exhibits two equilibria: a run equilibrium and a no-run equilibrium. Then, the depositors coordinate a choice between the two in accordance with the realization of an extrinsic event – a “sunspot” – completely uncorrelated to the fundamentals of the economy, and happening with some exogenous probability q . Sunspots are seen as a way to account for depositors’ animal spirits, panic attacks, or self-fulfilling expectations, and have been extensively employed in the literature on financial crises to model self-fulfilling runs (Peck and Shell 2003).

In turn, a bank, knowing the equilibrium selection mechanism and the probability of the sunspot q , chooses a portfolio allocation $\{X, Y\}$ and deposit contract $\{d_1, d_2\}$ at date 0 so as to maximize the expected welfare of its depositors, subject to its budget constraint. However, notice that δ , the fraction of depositors who are served at a run, also regulates the existence of the run equilibrium itself, and depends on the portfolio allocation and deposit contract. Thus, at date 0, a bank can choose them so as to rule out the run equilibrium, and be completely run-proof. More formally, a bank calculates two portfolio allocations and deposit contracts, either with possible runs (i.e. such that $\delta < 1$) or run-proof (i.e. such that $\delta \geq 1$), and then chooses in equilibrium those that maximize the expected welfare of its depositors. In the first case (possible runs), the incentives to provide more risk sharing against a run (that would increase d_1) are higher than the incentives to serve the highest possible number of depositors (that would lower d_1 so as to increase δ). Thus, a bank chooses a higher amount of storage than in a benchmark equilibrium without runs: in other words, a run generates a credit tightening. In the second case (run-proof), instead, a bank is able to provide the first-best allocation of resources if the recovery rate of the long-term asset is sufficiently high to ensure that $\delta \geq 1$; otherwise, it makes the contract run-proof by lowering d_1 , i.e. by reducing risk sharing, and, in extreme cases, by also cutting credit and holding excess storage. These results highlight that, when facing the possibility of self-fulfilling runs, a bank’s choice between being run-proof or not essentially boils down to finding the correct balance between (i) providing risk sharing against consumption fluctuations during a run and (ii) minimizing the probability of its occurrence.

In a calibrated dynamic general-equilibrium version of this model, Mattana and Panetti (2016) assume that the banks follow an “equal service constraint”: all the depositors who withdraw get an equal share of the available resources, even in the case of a run.⁵ In this environment, the banks

5. The equal service constraint resembles some contractual arrangements observed in the real world: money market mutual funds, for example, serve their depositors pro-rata. Despite equal

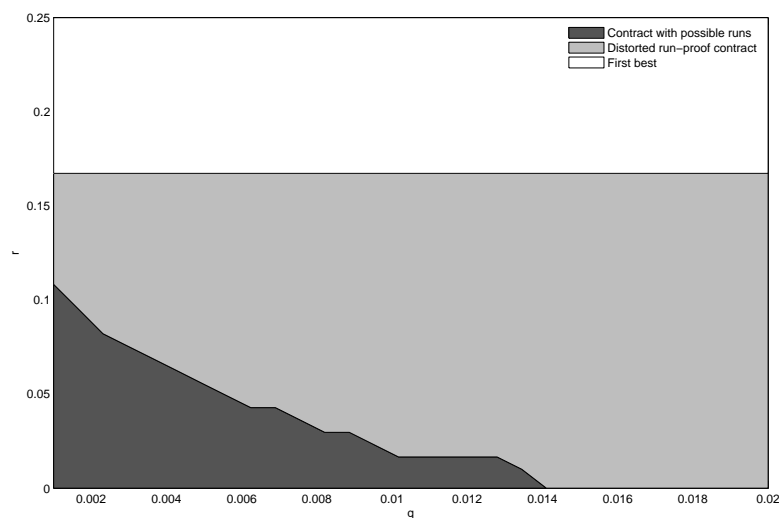


FIGURE 1: The competitive banking equilibrium, for different values of the probability of the sunspot q (on the x-axis) and recovery rate r (on the y-axis). Source: Mattana and Panetti (2016).

can offer a run-proof contract equivalent to the first-best only when the recovery rate r is above 17%, as showed in Figure 1. For values below that threshold, the banks distort the allocation of resources with respect to the first best: whenever the probability of the sunspot q and the recovery rate r are both sufficiently low (in the calculations, below 1.4% and 11%, respectively), the risk-sharing motivation dominates the objective of preventing a run, and the banks choose a contract with possible runs; above those values, instead, the opposite is true, and they choose a distorted run-proof contract.

This conclusion leads to two compelling arguments for policy. First, the message of Diamond and Dybvig (1983) is that bank runs are an inevitable consequence of liquidity and maturity transformation. Thus, government intervention, in the form of deposit insurance and central banks' liquidity assistance via the discount window (coupled with sophisticated interbank markets), is necessary to ensure that solvent banks stay liquid. The present results provide a complementary argument: in the presence of extrinsic uncertainty, that might trigger bank runs, competition and free entry in the banking system provide the correct incentives for banks to find the right balance between risk sharing and the willingness to avoid runs, even in the absence of government assistance. The second argument refers to the costs

service being technically different from sequential service, the distortions that they impose on the equilibrium portfolio allocation and deposit contract are similar.

of policy intervention: assume that a regulator wants to impose a liquidity requirement, with the objective of making the banks always run-proof ($\delta \geq 1$), irrespective of the levels of recovery rate and probability of the sunspot.⁶ What would the cost of such a policy be? From what said above, this constraint would distort the competitive banking equilibrium only when the recovery rate and the probability of the sunspot are both so low that the risk sharing motivation dominates the objective of avoiding a run, as in any other case the banks is already run-proof. Thus, making the banks always run-proof would come at the cost of lower risk sharing. Quantitatively, the welfare costs are decreasing in both the recovery rate and the probability of the sunspot, and are in any case below 0.16%.⁷ Arguably, this is a small number: the only comparable work (Van den Heuvel 2008) finds that the welfare costs of capital requirements are one order of magnitude higher.

Fundamental Runs

Modeling self-fulfilling bank runs is indisputably appealing, and is also corroborated by some early studies on the U.S. National Banking Era (Friedman and Schwartz 1963) as well as more recent ones of the 2007-2009 financial crisis (Foley-Fisher *et al.* 2015) and some experimental evidence (Arifovic *et al.* 2013). However, the drawback of this approach is that it relies on exogenous extrinsic uncertainty (i.e. the sunspots). Put differently, it is difficult to argue that bank runs are completely disconnected from the circumstances of the real economy. For example, Gorton (1988) argues that the bank runs of the U.S. National Banking Era could have been predicted by a leading indicator based on the level of business failures. This observation reminds us that, while bank runs are often a consequence of bank illiquidity, they might also originate from insolvency issues. These arguments have given rise to the so-called “business-cycle view”, according to which bank runs are a consequence of variations in the fundamentals of the economy, that make banks unable to meet their commitments.

To see that more clearly, assume that the return on the long-term asset R (which represents the aggregate state of the economy) is a random variable that is realized at date 2, but about which all depositors get a perfectly-informative signal at date 1. Moreover, assume that the banks serve their depositors according to the equal service constraint, and are exogenously constrained to offer an “incomplete” deposit contract, in which the amount

6. Arguably, this is the only policy intervention that can be discussed in the present framework, as the equilibrium determination relies on the realization of an extrinsic event like the sunspot.

7. The welfare costs are calculated in consumption equivalents, i.e. the constant proportional increase in consumption that the “regulated” banking equilibrium would need in order to ensure the same expected welfare as the unregulated equilibrium.

of early consumption d_1 is independent of the aggregate state of the economy. Under these hypotheses, Allen and Gale (1998) show that, in a competitive banking equilibrium, the patient depositors are all happy to wait until date 2 to withdraw, whenever the signal about the aggregate state is sufficiently “good” (i.e. R is high). Conversely, when the signal is sufficiently “bad” (i.e. R is low), all late consumers attempt to withdraw at date 1, thus triggering a “fundamental run”. Interestingly, the corresponding consumption allocation is equivalent to the first best, where a benevolent social planner offers a complete contract $\{d_1(R), d_2(R)\}$, fully dependent on the realization of the aggregate state of the economy R . This happens because, in this economy, it is efficient from a welfare perspective to share the resources equally among all bank depositors, whenever the aggregate state is sufficiently low, and to give a constant amount of early consumption, whenever the aggregate state is sufficiently high. In a competitive banking equilibrium, this can be achieved with an incomplete deposit contract, coupled with the possibility to have fundamental runs, during which the depositors are served according to the equal service constraint and get the same amount of consumption, irrespective of whether they are early or late consumers.

Thus, we get the rather surprising result that a competitive banking equilibrium with fundamental runs, under the hypotheses described above, is efficient. Equally surprising is the robustness of this result. In a follow-up paper, Allen and Gale (2004) study an environment where the banks face aggregate liquidity risk, and can hedge against it by buying and selling assets in a complete market for state-contingent claims at date 0, and in a secondary market at date 1. In this set-up, the banks, when exogenously constrained to offer an incomplete deposit contract, default if hit by a negative shock, and the corresponding consumption allocation is again efficient. Hence, the common conclusion of these two papers is that, in an economy with both idiosyncratic and aggregate liquidity risk, there is no justification from a welfare perspective for the introduction of financial regulation: there is no way through which a regulator can avoid bank insolvency and make some depositors better off, while keeping all others at least as well off. However, this result crucially depends on the completeness of asset markets: in fact, if markets were incomplete, liquidity regulation would allow a regulator to indirectly manipulate the equilibrium price in the secondary market, and improve welfare.

Arguably, the incompleteness of the deposit contract plays a crucial role for these results. This is a fair assumption for many reasons, such as legal arrangements, or asymmetric information between banks and depositors, or transaction costs. However, digging into the microfoundations of this incompleteness leads to some interesting considerations. Panetti (2013) studies a Diamond-Dybvig model with aggregate liquidity risk: the fraction of early consumers π that each bank faces is random. Moreover, the total fraction of early consumers in the whole banking system can be either

fixed or random, implying non-systemic or systemic aggregate liquidity risk, respectively, and its distribution is known at date 0, when the banks choose the portfolio allocation and the deposit contract. Importantly, the depositors can borrow and lend among themselves in a bond market at an interest rate \hat{R} , without being observed by their banks. The unobservability is a plausible assumption because, in this way, the depositors can extend their investment opportunities beyond traditional banks and towards market-based “new financial intermediaries”, which is a phenomenon that has been extensively observed in the recent past (Guiso *et al.* 2002). Moreover, because of this unobservability, the deposit contract becomes *endogenously* incomplete, as the ratio between late consumption and early consumption $d_2(R)/d_1(R)$ in the deposit contract does not depend on the realization of aggregate liquidity risk. Under these assumptions, whenever the economy faces non-systemic aggregate liquidity risk, interbank market trades allow the banks to avoid default. However, the competitive banking equilibrium is inefficient, because of the presence of a pecuniary externality in the bond market that makes the interest rate \hat{R} too high, and that the banks do not internalize. Therefore, a regulator can indirectly lower the interest rate and increase total welfare by imposing minimum liquidity requirements, that can be either bank-specific or one-size-fits-all.

These conclusions change when the economy faces systemic aggregate liquidity risk, that prevents interbank markets to clear. To see that, assume that only two aggregate states are possible at date 1: aggregate liquidity risk can be either systemically high or systemically low, with some known probability. Under this scenario, at date 0, the banks choose a very low amount of liquidity whenever the ex-ante probability of high aggregate liquidity risk is systemically low, and default at date 1 if systemic liquidity risk is actually realized. On the contrary, banks hoard liquidity at date 0 whenever the ex-ante probability of high aggregate liquidity risk is systemically high, and at date 1 roll it over to date 2, if systemic liquidity risk is actually not realized. More interestingly, the competitive banking equilibrium is again inefficient because of the pecuniary externality on the bond market: the interest rate \hat{R} is too high when the ex-ante probability of high aggregate liquidity risk is systemically low, and too low when the ex-ante probability of high aggregate liquidity risk is systemically high. Hence, a regulator can improve total welfare by imposing countercyclical liquidity requirements: a *minimum* liquidity requirement whenever the probability of high aggregate liquidity risk is systemically low, or a *maximum* liquidity requirement whenever the probability of high aggregate liquidity risk is systemically high. The indirect effect of this policy is to lower the incidence of both bank default and liquidity hoarding on the competitive banking equilibrium.

The Global Game Approach

So far, I have described two competing theories about bank runs: one based on self-fulfilling expectations leading to illiquidity, and one based on fundamental shocks leading to insolvency. However, in practice, distinguishing illiquidity from insolvency is controversial, if only because the evaluation of the solvency of a financial institution essentially depends on the assessment of its assets.⁸ These considerations are particularly important in the light of government intervention: as argued above, there are cases in which a financial regulator facing insolvency should not intervene, but the common practice of central banks, based on the doctrine of the “lender of last resort”, is to provide support to solvent but illiquid banks.⁹ These considerations call for a theory that reconciles self-fulfilling and fundamental runs and, at the same time, provides a criterion to distinguish them and a rationalization of government intervention. This is the aim of one of the most promising branches of the literature on banking and crises, based on the “global game” approach (Morris and Shin 1998).

To show it in more detail, I slightly modify the environment of the previous section. As before, a bank offers uncontingent early consumption d_1 , and the return on the long-term asset is random: it takes the value R with probability p , and 0 with probability $1 - p$, where p is a random variable uniformly distributed over the interval $[0, 1]$ and represents the aggregate state of the economy. However, differently from above, the signal that the depositors receive at date 1, about the realization of the state, is not perfectly informative, but “noisy”: it takes the form $\sigma = p + e$, with e representing a small but positive idiosyncratic noise, uniformly distributed over the interval $[-\varepsilon, +\varepsilon]$. In this environment, Goldstein and Pauzner (2005) show that a fundamental run (where all late consumers withdraw at date 1) happens whenever the signal is below a certain threshold $\underline{\sigma}$, at which all late consumers are indifferent between withdrawing at date 1 or 2, irrespective of the behavior of the others. The existence of this threshold, together with an “upper dominance region”, where the signal is so good that there is no run for sure, is enough to ensure the existence of an equilibrium in the intermediate region. There, absent noisy signals, the economy would exhibit two equilibria (run and no-run). However, the fact that the signals are noisy breaks the possibility for the late consumers to coordinate, in the sense that they cannot directly infer the behavior of the others from their own behavior. Thus, in the intermediate region, there

8. As an example, the New York Times reported (September 29, 2014) that, while Lehman Brothers had valued its real estate portfolio at around \$50 billion in 2008, the CEO of Bank of America (who at the time was considering a bid on Lehman) “asserted that Lehman had a \$66 billion hole in its balance sheet”.

9. See Alves *et al.* (2015) for a recent empirical analysis of the role of the lender of last resort in Portugal.

exists a unique equilibrium, where all late consumers, after observing their own signal, create posterior beliefs about the aggregate state and the signals received by the other late consumers, and based on these decide whether to run or not.

In particular, in the intermediate region the late consumers follow the threshold strategy “run if the signal σ is below the threshold σ^* ”, at which they are indifferent between withdrawing at date 1 or 2 *given* their posterior beliefs. Put differently, in this intermediate region runs are self-fulfilling, i.e. based on negative expectations about the aggregate state of the economy, but not on negative fundamentals per se: banks are solvent but illiquid. More importantly, both thresholds $\underline{\sigma}$ and σ^* are endogenously determined, and positively depend on the amount of early consumption d_1 stated in the deposit contract at date 0. Thus, the banks here face again a trade-off between higher risk sharing and higher probability of a bank run: the higher the amount of risk sharing that a bank promises (i.e. the higher d_1), the higher the probability that it is not going to be able to pay the amount stated in the deposit contract, either because of bad fundamentals (high $\underline{\sigma}$) or because of bad expectations (high σ^*).

The uniqueness of the equilibrium and the endogeneity of the two thresholds allow us to fully interpret the role played by financial regulation in this environment. Intuitively, a regulator would not find convenient to intervene when the signal falls below $\underline{\sigma}$, as a fundamental crisis is efficient. However, it would intervene in the case that the signal falls between $\underline{\sigma}$ and σ^* , where illiquidity is only a consequence of bad expectations. In a framework similar to the present one, Rochet and Vives (2004) show that liquidity requirements solve the expectations problem, but might be too costly in terms of forgone bank returns. Therefore, they should be complemented by the provision of central bank liquidity, through the discount window. This conclusion supports the main prescription of the doctrine of the “lender of last resort”: central banks should lend freely to solvent but illiquid banks. However, according to the classic view by Bagehot (1873), liquidity should be provided at penalty rates, and against good collateral. On those lines, Allen *et al.* (2015) analyze the case for limiting central bank liquidity interventions in a model with runs as global games. The authors show that injecting liquidity into the banks in the case of a run, in order to reduce its likelihood ex-ante, might have the unintended consequence of increasing banks’ moral hazard. Thus, the optimal liquidity injection should never fully prevent runs.

Conclusions

The aim of the present paper has been to describe the foundations of bank runs, and of the incentive of the economic agents to join them, as a base

to discuss government interventions to tame their adverse effects.¹⁰ The main lesson that we can draw is threefold. First, bank runs are not an inevitable byproduct of liquidity and maturity transformation, as argued by Diamond and Dybvig (1983), and a lot can be done against them: in particular, competition in the banking system provides the right incentives for banks to avoid risky investment strategies, that might harm depositors' savings and give rise to self-fulfilling runs. This message is particularly important in our current economy, as unsecured deposits represent a large and increasing share of total bank liabilities, both in the U.S. and around the world (Peristiani and Santos 2014), and the so-called "shadow banking system" provides liquidity and maturity transformation without access to deposit insurance and central bank discount windows. Second, government intervention can make the banking system more resilient to self-fulfilling runs, either ex post, via central banks' emergency liquidity assistance, or ex ante, via liquidity requirements. However, while the former should always be partial, in order to tame banks' moral hazard, the latter should be preferred, as its costs are quantitatively small. Finally, there are many cases where government intervention against fundamental runs is not justifiable from a welfare perspective. Nevertheless, market incompleteness and the increasing complexity of modern financial systems, where "traditional" banks coexist with new market-based intermediaries, calls for a further tailoring of financial regulation, especially in the face of systemic aggregate liquidity risk.

References

- Allen, Franklin, Elena Carletti, Itay Goldstein, and Agnese Leonello (2015). "Government Guarantees and Financial Stability." CEPR Discussion Paper No. 10560.
- Allen, Franklin and Douglas Gale (1998). "Optimal Financial Crises." *Journal of Finance*, 53(4), 1245–1284.
- Allen, Franklin and Douglas Gale (2004). "Financial Intermediaries and Markets." *Econometrica*, 72(4), 1023–1061.
- Alves, Nuno, Diana Bonfim, and Carla Soares (2015). "Surviving the perfect storm: the role of the lender of last resort." mimeo.
- Arifovic, Jasmina, Janet Hua Jiang, and Yiping Xu (2013). "Experimental evidence of bank runs as pure coordination failures." *Journal of Economic Dynamics and Control*, 37(12), 2446–2465.
- Bagehot, Walter (1873). *Lombard Street: A Description of the Money Market*. Henry S. King & Co., London, UK.

10. Given its limited scope, this analysis abstracted from other issues of key importance for bank runs, like the role of asset markets, bank capital, or financial contagion, that are the focus of other equally important branches of the literature.

- Cooper, Russell and Thomas W. Ross (1998). "Bank runs: Liquidity costs and investment distortions." *Journal of Monetary Economics*, 41(1), 27–38.
- Diamond, Douglas W. and Philip H. Dybvig (1983). "Bank Runs, Deposit Insurance, and Liquidity." *Journal of Political Economy*, 91(3), 401–419.
- Foley-Fisher, Nathan C., Borghan Narajabad, and Stephane H. Verani (2015). "Self-fulfilling Runs: Evidence from the U.S. Life Insurance Industry." Federal Reserve Board Finance and Economics Discussion Series No. 2015-032.
- Friedman, Milton and Anna J. Schwartz (1963). *A Monetary History of the United States, 1867-1960*. Princeton University Press.
- Goldstein, Itay and Ady Pauzner (2005). "Demand-Deposit Contracts and the Probability of Bank Runs." *Journal of Finance*, 60(3), 1293–1327.
- Gorton, Gary B. (1988). "Banking Panics and Business Cycles." *Oxford Economic Papers*, 40(4), 751–781.
- Gorton, Gary B. and Andrew Metrick (2012). "Getting up to Speed on the Financial Crisis: A One-Weekend-Reader's Guide." NBER Working Paper No. 17778.
- Guiso, Luigi, Michael Haliassos, and Tullio Jappelli (eds.) (2002). *Household Portfolios*. MIT Press, Cambridge, MA.
- Jalil, Andrew J. (2015). "A New History of Banking Panics in the United States, 1825–1929: Construction and Implications." *American Economic Journal: Macroeconomics*, 7(3), 295–330.
- Mattana, Elena and Ettore Panetti (2016). "A Dynamic Quantitative Macroeconomic Model of Bank Runs." mimeo.
- Morris, Stephen and Hyun Song Shin (1998). "Unique Equilibrium in a Model of Self-Fulfilling Currency Attacks." *American Economic Review*, 88(3), 587–597.
- Panetti, Ettore (2013). "A Theory of Bank Illiquidity and Default with Hidden Trades." In *Essays on the Economics of Banks and Markets*, Institute for International Economic Studies Monograph Series No. 84. Stockholm University.
- Peck, James and Karl Shell (2003). "Equilibrium Bank Runs." *Journal of Political Economy*, 111(1), 103–123.
- Peristiani, Stavros and Joao Santos (2014). "Depositor Discipline of Risk-Taking by U.S. Banks." Liberty Street Economics, Federal Reserve Bank of New York.
- Reinhart, Carmen M. and Kenneth S. Rogoff (2009). "The Aftermath of Financial Crises." NBER Working Paper No. 14656.
- Reinhart, Carmen M. and Kenneth S. Rogoff (2014). "Recovery from Financial Crises: Evidence from 100 Episodes." *American Economic Review*, 104(5), 50–55.
- Rochet, Jean-Charles and Xavier Vives (2004). "Coordination Failures and the Lender of Last: Was Bagehot Right After All?" *Journal of the European Economic Association*, 2(6), 1116–1147.

Van den Heuvel, Skander J. (2008). "The Welfare Costs of Bank Capital Requirements." *Journal of Monetary Economics*, 55(2), 298–320.