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### Three essays on banking

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# Chapter 1

## Introduction and Summary

The 2007-2009 financial crisis has shown that financial distress in banking system is a common threat in both developed and emerging economies. Losses in US subprime credit market spilled over to other markets through various channels (e.g., assets fire sales, illiquidity or interbank linkages), leading to the failure of hundreds of lenders since the onset of the crisis. One important mechanism through which the mortgage crisis amplified into a severe financial crisis was runs on financial institutions. Lenders such as Fortis Bank, Northern Rock, or Washington Mutual have experienced bank runs which caused erosion of their capital. Excessive withdrawals were triggered by concerns about the lenders' well being. However, the panic run in the financial sector has corresponded only to some extent to the classical bank runs of 19th century in which retail depositors withdrew their money fearing that others would do the same and bank would become insolvent.

One lesson that stands out from the recent events is that short-term funding of highly leveraged financial institutions, coupled with the reliance on the originate-and-distribute business model, in which the originators of loans pool them and afterward sell them via securitization, instead of holding the loans on their balance sheets until they are repaid as in traditional banking model, has perverse consequences. On one hand, it led to a decline in lending standards. On the other hand, it left

financial intermediaries exposed to modern types of runs. One prominent example is the liquidity runs and the demand for additional collateral by wholesale lenders, which forced massive distressed liquidation not predicted by the standard risk models. Wholesale financiers have exacerbated liquidity problems during Bear Sterns and Northern Rock episodes, when short-term creditors terminated their contracts and denied lending. In addition to the drying up of liquidity in short-term capital markets, counterparties demanded for extra collateral, as it happened during AIG episode. Bank runs have also occurred when large uninsured depositors have depleted their accounts during Fortis and Washington Mutual debacles.

In addition to the coordination failure by retail depositors in the form of premature withdrawals and bank runs (and other modern types of runs of debt-holders), banks can also be vulnerable to coordination failure from the asset side of their balance sheet. If borrowers believe that their bank will become distressed because of defaults by others, they may delay or even default on their loans. Commonly held beliefs that other borrowers will default may therefore create an amplification mechanism of bank problems and lead to a situation where borrowers are unable to coordinate on repayment, and thus fail to ensure bank survival. The borrowers' coordination problem has received less attention yet. Anecdotal evidence from developing countries and transition economies suggests that in circumstances when financial environment is characterized by inadequate bankruptcy laws and inefficient judiciary system, where bankruptcy and restructuring frameworks are deficient and creditor rights are poorly defined or weakly enforced, borrowers have a strong incentive to default on their obligations. For developed economies, the harmful effects of strategic defaults have become clear during the recent period of distress - with mortgage market being an important sector where banks have become subject to runs by their borrowers. In contrast to depositors withdrawing their own money, coordination failure resulting from borrowers strategically delaying or defaulting on loan payments involves a breach of contract. It will therefore be confined to situations

of diffused financial distress, as in the recent crisis. Because of its relevance to the stability of the banking system and its potential to amplify downward trends, a more thorough understanding of borrowers' coordination failure is warranted. Identifying the factors that drive borrowers' strategic default is important for banking system stability and allows for improvements with respect to the choice and the timing of regulatory measures.

The recent global financial turmoil has also revealed the need to rethink fundamentally how financial system is regulated. The policy debate on financial reform has focused on raising capital ratios of financial intermediaries. The recently adopted Basel III rules double the minimal capital ratio and, beyond that, create incentives for banks to hold excess capital in the form of conservation and countercyclical buffers. However, one of the lessons from the recent crisis is that banks are exposed to tail risks which, when realized, may trigger losses in excess of almost any plausible value of initial capital. Such risks can result from the reliance on wholesale funding, the underwriting of AIG-type contingent liabilities likely to be called during market panic, exposures to highly-rated senior structured debt standing to lose value in periods of extreme economic stress, as well as undiversified leveraged exposures to inflated housing markets. Since tail risks can wipe out almost any initial capital, it is unclear whether traditional capital regulation is effective in addressing it. This highlights the importance of understanding how higher capital ratios would affect bank's investment incentives.

An important motivation for the analysis done in this thesis follows from the larger picture described above and consists of the following open questions about debtors' behavior in credit markets and optimal regulation of banks: (1) is strategic default of borrowers a relevant threat for banks' solvency in times of distress, (2) what is the role played by information regarding banks' solvency in creating financial fragility, (3) how does regulatory disclosure rules affect borrowers' repayment decisions, (4) and do these rules have a different impact in different stages of the

business cycle, (5) does the safety net of a lender of last resort contribute to financial fragility, (6) does solvency regulation (in form of capital requirements) remain an efficient regulatory instrument in the presence of innovative financial instruments which created significant tail risks in the recent years. This thesis is composed by three different essays in banking which address the above questions. The first two essays deal with strategic behavior of borrowers. The third essay explores the relation between bank capital and risk-taking.

Each essay is distinct from the methodological point of view. In the first essay (chapter 2 of the thesis) I develop a theory for the collective strategic defaults of borrowers. I form the model in the context of the global games methodology first introduced by Carlsson and van Damme (1993) and later refined by Morris and Shin (1998). Global games are games of incomplete information in which an agent's incentive to take a particular action increases as more and more agents take the same action (i.e., individual actions are strategic complements). This realistic approach does not depend on common knowledge and helps to resolve the issue of multiple equilibria. Common knowledge, introduced in theoretical models through perfect public information, can create self-fulfilling beliefs which might destabilize an economy. Sudden crises without any fundamental reason might arise in such unstable economy due to changes in beliefs of market participants. In global games approach, a small amount of noise can be stabilizing and can pin down a unique equilibrium with agents playing threshold strategies. Using an iterated deletion of strictly dominated strategies, the unique Nash equilibrium can be derived. In the second essay (chapter 3 of the thesis), experimental economics methods are used to investigate empirically two factors which might have a significant impact on debtors repayment incentives. Experiments are extensively used to test the validity of economic theories and to test new markets mechanism. Several experiments have been successfully conducted to examine the impact of information sharing and long-term banking relationships on borrower and lender behavior (Brown et al. 2004, Brown and Zehnder

2007, 2010, Fehr and Zehnder 2009). Similarly, to study the causes of depositors and currency runs, theoretical accounts have been tested in controlled laboratory settings with clear identification of causal effects (Garratt and Keiser 2009, Heine-  
mann et al. 2004, Madies 2006, Schotter and Yorulmazer 2009). Finally, in the third essay (chapter 4 of the thesis) a theoretical model for bank investment decision is presented. The model is close in spirit to asset substitution literature. In a stylized representation of the actual banking system, the bank operates in a prudential framework based on a minimal capital ratio, and has access to tail risk projects.

In general, this thesis contributes to the understanding of debtors repayment incentives in the presence of uncertainty (or imperfect information) and derive policy implications about the lender of last resort and banking regulation (in particular, about capital requirements and disclosure rules). Next, I will give a short description for each of the three essays.

The first essay, “*Collective Strategic Defaults: Bailouts and Repayment Incentives*”, studies a model of borrowers strategic defaults, and discusses the role of a lender of last resort and the bank’s screening effort incentives.<sup>1</sup> The crucial ingredient of the model I introduce here is that borrowers hold common prior beliefs about the state of their bank fundamentals (i.e., non-performing loans) and they also receive noisy signals about these fundamentals. I argue that banks may be subject to risk of failure even when they have strong fundamentals due to a coordination problem among debtors. This happens in a framework in which on one hand, banks understand that their assets choice will affect central bank intervention policy, while on the other hand the central bank (acting as a lender of last resort) recognizes the opportunity cost of forgone intermediation if the bank is closed. Debtors decide not to repay their loans if the signals they receive about bank fundamentals are above some threshold level (i.e., bank fundamentals are bad). Observing a high signal

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<sup>1</sup>This essay was partially completed while I was visiting IDEI Toulouse, whose hospitality is greatly appreciated. I gratefully acknowledge financial support from ENABLE.

induces a borrower to believe that other borrowers have also received high signals. Hence, the borrower infers that is very likely that other borrowers will stop repaying. Subsequently, if enough borrowers refuse to pay back, their actions would trigger bank's failure.

Since the bank failure is socially costly (i.e., it destroys relationship value for borrowers who repay their loans), there is scope for regulatory intervention. The lender of last resort can bail out the bank by providing the necessary amount of liquidity which will preserve bank's enforcement ability. However, I argue that ex-post bailout takes place only if the proportion of non-performing loans and the cost of providing liquidity are not too high. I also show that the presence of the lender of last resort mitigates the strategic behavior of debtors and reduces the extent of bank failures. Interestingly, when the intervention cost of providing liquidity is low, two counterbalancing effects take place. First, lower intervention cost induces moral hazard, with banks screening less their potential borrowers. Second, it increases the threshold in fundamentals that triggers collective strategic default. Put differently, a lower cost of intervention makes banks to behave less prudent and also makes debtors to behave less aggressive (i.e., knowing that the intervention of the lender of last resort is more likely when the cost of providing liquidity is low, borrowers will refrain from defaulting).

The second essay, "*Strategic Loan Defaults and Coordination: An Experimental Analysis*", experimentally investigates the impact of uncertainty about bank and borrower fundamentals on loan repayment.<sup>2</sup> Defaults are observed in real life, but one can not observe whether the default is strategic or not, with strategic defaulters mimicking the behavior of genuine distressed borrowers. Therefore, it is difficult to study empirically strategic default because it is an event hard to identify and to quantify. To overcome identification problems in empirical data, we study a

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<sup>2</sup>Joint work with Stefan Trautmann. I gratefully acknowledge financial support from the Gieskes-Strijbis Foundation and from CIFRA.

coordination game which involves two features which are specific to credit markets. First, borrowers have an imperfect signal about the fundamentals of their bank, (i.e., the number of defaults that would trigger its failure). Second, borrowers are imperfectly informed about the fundamentals of other borrowers, and thus how many of these may be forced to default on their loans. These two sources of uncertainty are natural proxies for the regulatory rules for transparency and disclosure, and for the state of the economy. The design allows us to study whether transparency rules and economic environment affect the incidence of strategic default, and how the two factors interact.

We find clear evidence for strategic default, with both types of uncertainty affecting its occurrence. Surprisingly, we show that more information about bank fundamentals is not always better. When full disclosure reveals bank weakness, it increases strategic non-repayment regardless of economic conditions. Similarly, borrowers default strategically more during downturns when fundamentals of other borrowers are more uncertain, regardless of disclosure rules. Borrowing from the behavioral literature on coordination games we identify concepts that explain the observed variation in repayment. Our results show that repayment decision is very sensitive to the risk dominance properties of the game structure. In particular, both disclosure and uncertain borrower fundamentals make the defaulting equilibrium relatively more risk dominant, leading to more bank failures.

Second, analyzing individual borrower characteristics we find that risk attitudes, in particular attitudes toward financial losses, have a strong and robust influence on repayment decisions. Loss averse borrowers place a higher value on the available cash they hold than on the higher but uncertain future monetary outcome which is conditional on bank survival. Hence, they have a strong preference towards non-repayment, which allows them to avoid the immediate financial loss triggered by potential bank failure.

We also show that negative past experiences strongly affect individual repayment



decisions. People who have experienced more defaults from other borrowers and the subsequent bank failures, are more likely to default strategically. Hence, our findings suggest that in credit markets, similarly to the depositors market, there is the risk of contagion.

The third essay, “*Capital Regulation and Tail Risks*”, revisits the relationship between bank capital and risk-taking.<sup>3</sup> The traditional view is that higher capital reduces excess risk-taking driven by limited liability. There are two key arguments in favor of higher capital. First is the classic notion that capital is a buffer that reduces the risk of insolvency. It also helps to reduce some systemic risk factors, such as uncertainty over counterparty risk, which had a devastating propagation effect during the recent crisis. Second, there is a more sophisticated argument that capital is not just a buffer, but has incentive effects. Higher capital increases shareholders’ losses in bank failure, and hence reduces their incentives to take excessive risk. We show here that the relationship between bank capital and risk-taking may take unintuitive forms in the presence of tail risk projects, with bank risk-taking being non-linear and possibly increasing in capital. This result demonstrates that capital requirements alone may be insufficient to control banks’ preferences when tail risk projects are available to them.

The argument is that while higher capital reduces risk-taking incentives caused by limited liability, in banks this may be dominated by an important opposite effect. Higher capital increases the distance to the minimal capital ratio, allowing the bank to take more risk without the fear of breaching regulatory requirements in case of a mildly negative project realization. We argue that in the presence of tail risks, when high capital ratios by themselves cannot insure against all losses, a highly capitalized bank may start taking a socially excessive level of risk. While a poorly capitalized bank may act risk-averse to avoid breaching the minimal capital ratio (which would

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<sup>3</sup>Joint work with Enrico Perotti and Lev Ratnovski. I gratefully acknowledge financial support from the Gieskes-Strijbis Foundation.

force a costly recapitalization), a bank with higher capital may take more risk as it has a lower probability of breaching the ratio. This result is consistent with the stylized fact that U.S. banks were well capitalized pre-crisis, yet they took significant bets on house prices and on mortgage derivatives. We also find that well-capitalized banks' incentives for taking tail risks are increased in the extremeness of that tail risk (i.e., the availability of projects with heavier left tails). Our results therefore demonstrate the limits of traditional capital regulation in mitigating banks' incentives to take tail risks and support the view that dealing with tail risks requires new regulatory tools (e.g., macro-prudential measures that address systemic risk and negative spirals).