# LIQUIDITY AND CRISES

Edited by

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Elena Carletti
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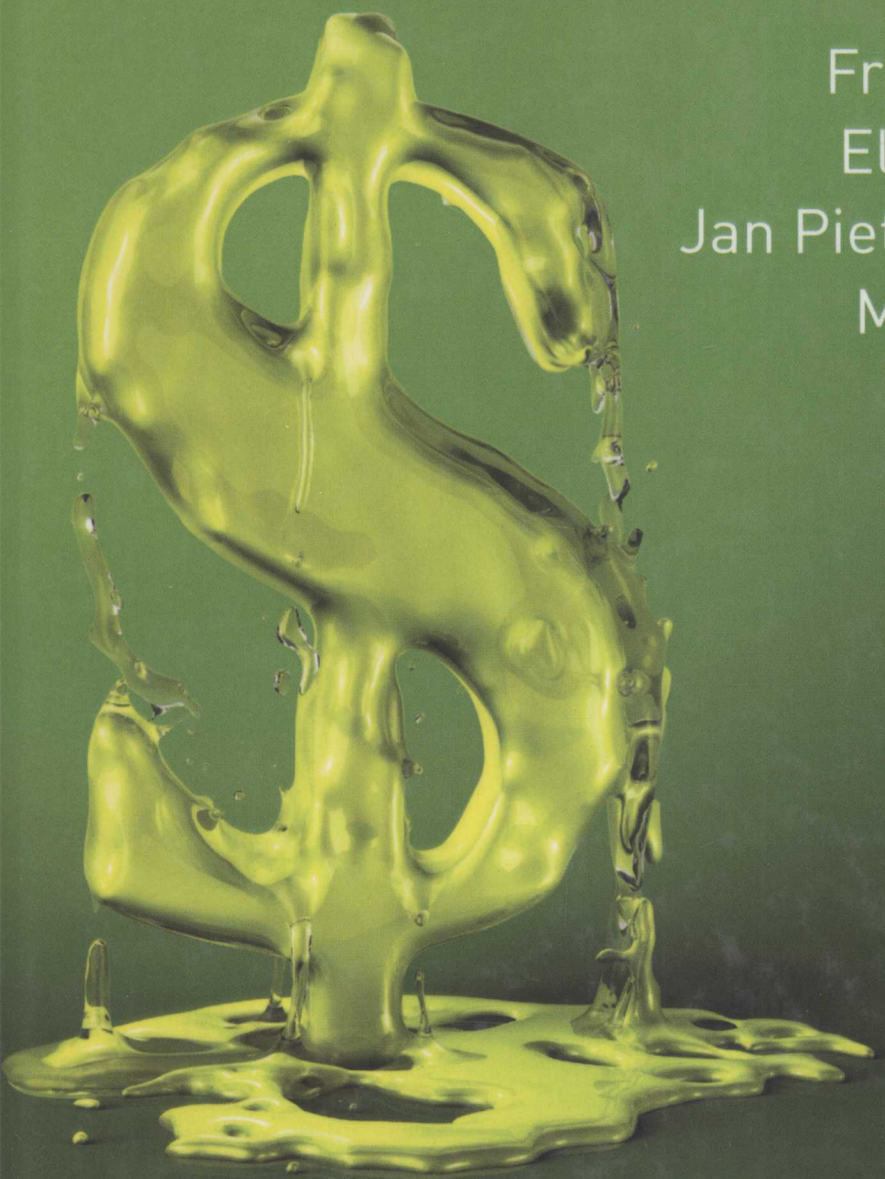

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# Contributors

**Viral V. Acharya**, New York University

**Franklin Allen**, University of Pennsylvania

**Sudipto Bhattacharya**, London School of Economics

**Ricardo Caballero**, Massachusetts Institute of Technology

**Elena Carletti**, European University Institute

**Juan Carlos Cordoba**, Rice University

**Amil Dasgupta**, London School of Economics

**Giovanni Dell'Ariccia**, International Monetary Fund

**Casper de Vries**, Erasmus University Rotterdam

**Douglas W. Diamond**, University of Chicago

**Andrea L. Eisfeldt**, Northwestern University

**Mark J. Flannery**, University of Florida

**Xavier Freixas**, Universitat Pompeu Fabra

**Craig H. Furfine**, Northwestern University

**Douglas Gale**, New York University

**Itay Goldstein**, University of Pennsylvania

**Gary Gorton**, Yale University

**Philipp Hartmann**, European Central Bank

**Bengt Holmström**, Massachusetts Institute of Technology

**Cornelia Holthausen**, European Central Bank

**Lixin Huang**, Georgia State University

**Nobuhiro Kiyotaki**, Princeton University

**Jan Pieter Krahnen**, Goethe University Frankfurt

**Arvind Krishnamurthy**, Northwestern University

**Guido Lorenzoni**, Massachusetts Institute of Technology

**Robert Marquez**, Boston University

**John Moore**, University of Edinburgh

**Raghuram G. Rajan**, University of Chicago

**Rafael Repullo**, The Center for Monetary and Financial Studies

**Marla Ripoll**, University of Pittsburgh

**Jean-Charles Rochet**, Swiss Banking Institute

**Stefan Straetmans**, Maastricht University

**Jean Tirole**, Toulouse School of Economics

**Marcel Tyrell**, Goethe University Frankfurt

**Christian Upper**, Bank for International Settlements

**Xavier Vives**, IESE Business School, University of Navarra

**Andrea Worms**, Deutsche Bundesbank

**Tanju Yorulmazer**, Federal Reserve Bank of New York

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# 1 An Introduction to Liquidity and Crises

Franklin Allen, Elena Carletti, Jan Pieter Krahnen, and Marcel Tyrell

## Introduction

Financial crises have occurred for hundreds of years. However, the fact that they often appear without warning is something that most people have apparently forgotten in the recent past. Hence the financial crisis that started in the summer of 2007 came as a surprise to many observers. In particular, it was astonishing to see that a breakdown in just one part of the housing market, i.e. the US subprime mortgage market, did lead to a systemic crisis that escalated and spilled over to financial markets all over the world. Thus, the financial crisis, that began in the US, did not only spread to Europe but became global, even affecting emerging markets and less developed countries that resisted the bad lending practices, did not purchase toxic assets, and did not allow their banks to engage in excessive risk taking through derivatives.

One important reason for the global impact of the 2007 financial crisis is massive illiquidity in combination with an extreme exposure of economically and politically relevant parties to liquidity needs and market conditions. As a consequence, many financial instruments could not be traded anymore, investors ran on a variety of financial institutions particularly in wholesale markets, financial institutions and industrial firms started to sell assets at fire sale prices to raise cash, and central banks all over the world injected huge amounts of liquidity into financial systems.

But what is liquidity and why is it so important for firms and financial institutions to command enough liquidity? This handbook brings together classic articles and recent contributions to this important field of research. In this introduction we will provide an overview of the book and review each section in turn, thereby drawing connections to some of the most recent academic literature on liquidity and crises.

We start in Section 1 with a discussion of liquidity and interbank markets. Section 2 considers the public provision of liquidity and regulation. Money, liquidity and asset prices are covered in Section 3. Section 4 is concerned with contagion effects in financial crises. Section 5 considers financial crises and currency crises. Finally, Section 6 concludes.

## 1. Liquidity and Interbank Markets

Interbank markets play a key role for the functioning of financial systems. They should ensure an efficient liquidity transfer between surplus and needy banks. They are the focus of central banks' implementation of monetary policy and a smooth functioning of interbank markets is essential for maintaining the financial stability of the overall financial system. Despite this key role they play and despite the potentially significant effect their functioning has on the whole economy, there was, at least in the past, relatively little work studying interbank markets. That might be related to the fact that until Bryant (1980) and Diamond and Dybvig (1983) developed a consistent framework with banks performing an important role in terms of maturity transformation, i.e. collecting demand deposits and raising funds in the short-term capital market and investing them in long-term assets, there was no theory in which interbank markets could be an important part of an optimal financial arrangement.

The seminal paper by Bhattacharya and Gale (1987, reprinted in this handbook) is the pioneering theoretical study in this area. In the spirit of the Diamond-Dybvig model, where consumers, who are subject to privately observed preference shocks, put their money in the bank in exchange for a deposit, they analyze a setting in which individual banks face privately observed liquidity shocks due to the proportion of depositors wishing to make early withdrawals. In addition to this liquidity demand shift, each bank has private information about the fraction of its portfolio of liquid assets. Since the liquidity shocks are imperfectly correlated across intermediaries, banks coinsure each other against liquidity shocks through an interbank lending market. Bhattacharya and Gale show that even in the absence of an aggregate liquidity shock over the intermediary sector as a whole, banks are induced to under-invest in liquid assets and free-ride on the common pool of liquidity. The main reason is the lower return which liquid assets yield. Therefore, one can have aggregate liquidity shortages notwithstanding the presence of an interbank market. Hence, as Bhattacharya and Gale suggest, a central bank can mitigate this problem by (even imperfectly) monitoring banks' asset choices. However, they argue one would not expect to achieve the first-best, as in such an asymmetric information setting it seems unrealistic to assume that a central bank can elicit perfect knowledge of the quality of the assets in overall bank portfolios. In addition, in such a framework pumping liquidity into the banking sector at large does not guarantee it will end up at the banks which need it most.

It is fair to say that the Bhattacharya-Gale model provided an extremely promising start to a research program, one that seriously examined the implications of microeconomically founded financial intermediation theory for the functioning of financial markets and financial intermediaries, optimal liquidity provision and financial fragility. First of all, it appears to be the case that market liquidity varies with the state of the economy. Thus, one can observe countercyclical variations in spreads between liquid and illiquid assets over the business cycle, liquidity crises being released by economic downturns, and in cross-sectional studies a positive relationship between industrial productivity and the liquidity of the respective asset markets. Eisfeldt (2004) (reprinted in this handbook), develops an interesting model to understand these features of liquidity in asset markets. She analyzes an economy with long-term risky assets that vary in quality. Illiquidity is a consequence of adverse selection as investors want to realize part of the value of the long-term assets early on by issuing claims against the assets in a pooled market. It follows that the equilibrium price is given by the average quality of the claims sold. Hence, the term "liquidity" refers here to the cost of transferring expected future payoffs into current income. This framework allows her to draw a connection from the degree of adverse selection to market liquidity. As the claim price is an increasing function of the portion of high-quality assets sold in

the market, it is the case that the higher the fraction of high-quality claims traded, the less adverse selection there is in the market and the more liquid is the asset market.

However, what basically determines the degree of adverse selection and hence the liquidity of the asset markets? In principle, in a market setting it is the amount of trade for reasons other than private information, such as consumption, investment, or portfolio rebalancing motives, which can ameliorate adverse selection. Eisfeldt finds that, in particular, a higher productivity of the economy increases liquidity. High productivity leads to a high relative return on risky assets, and this induces more investment in large-scale risky projects at all income levels. Investors then self-insure less with riskless assets, the outcome of risky projects has a higher impact on the income of investors, and more claims to high quality projects are sold in the market because of motives such as consumption and new investment. Essentially, a high productivity does increase the fraction of high quality assets traded and the amount of trade for reasons other than private information. Both factors reduce adverse selection problems and cause liquidity to increase.

In addition, there is an interesting feedback mechanism at work: liquidity enlarges the impact of productivity on investment. Of course, investment increases with productivity, but liquidity amplifies this effect since higher liquidity makes long-term risky investment even more attractive. Of course, we should observe the opposite effects in economic downturns. Even though literally taken the framework provided by Eisfeldt was not developed to analyze banking markets and financial crises, the basic mechanisms she studies have a more general appeal. It appears quite natural to interpret the liquidity squeeze in the interbank market in terms of the mechanics of her model.

Another very prominent line of research followed in the literature is to develop a deeper and more general understanding of the interaction of financial markets and financial intermediaries. For instance in the Bhattacharya-Gale setup, the characterisation of interbank markets is quite rudimentary and, in addition, interbank markets are not part of an optimal arrangement in their framework. Thus, it is essential to have a framework with both a role for financial intermediaries and for markets modelled from first principles. Allen and Gale (2004a, 2004b, both reprinted in this handbook, 2010), among others such as Diamond (1997) and Fecht (2004), developed such an approach. They argue that in modern financial systems financial markets and financial intermediaries are complementary. Following the argument in Diamond and Dybvig (1983), intermediaries provide an insurance function to consumers against their individual liquidity shocks in their framework. However, individual investors cannot trade directly in the full range of markets since due to information and transaction costs it is too costly for them. That is the reason why markets also play an important role in this environment. Markets allow financial intermediaries (and hence their depositors) to share risk. Intermediaries such as banks and mutual funds can invest in financial markets. They are providing risk-sharing services by packaging existing claims on behalf of investors who do not have access to markets and, of course, are trading these claims on markets. Such a general equilibrium framework allows Allen and Gale a normative analysis of liquidity provision by the financial system.

Consumers deposit funds into banks which provide liquidity insurance such that depositors can withdraw whenever they have liquidity needs. Banks accumulate the funds and lend them to firms to fund long-term investments. There are two types of uncertainty concerning liquidity needs which makes liquidity management on the part of banks quite difficult. The first is that each bank is exposed to idiosyncratic liquidity risk. At any given date its customers may have more or less liquidity needs. The second type of uncertainty is aggregate liquidity risk which banks have to face. In some periods liquidity demand is high while in others it is low, thereby exposing all banks to the same shock at the same time.

What Allen and Gale analyze in such a framework is the ability of banks to hedge themselves against these liquidity shocks. They show in Allen and Gale (2004a) that this crucially depends on the completeness of financial markets. If markets are complete in the sense that for each aggregate state an Arrow security can be traded, then the financial system provides liquidity efficiently as it ensures that banks' liquidity shocks are hedged. In particular, they show that in an environment with complete markets and in which intermediaries can offer complete contingent contracts, the resulting allocation is incentive-efficient. With complete contracts, the consequences of default will be anticipated and therefore included in the contract, so default and financial crises do not occur. If intermediaries can only offer incomplete contracts, a case in point is where banks only offer deposit contracts, default can improve welfare by improving the contingency of contracts. Thus, financial crises do occur in such a model, but are not necessarily a source of market failure. Hence, even in this case with incomplete contracts, the financial system provides optimal liquidity and risk sharing if markets for aggregate risks are complete. A set of complete and perfect financial markets, which includes of course interbank markets, is necessary for an efficient functioning of the financial system. Only missing markets may provide a role for government intervention. If markets are incomplete, then there may be too much or too little liquidity, and government regulation may be welfare-improving.

Allen and Gale (2004b) explore in further detail interesting ramifications of this framework. By using a simplified version of the general equilibrium model introduced in Allen and Gale (2004a), they investigate the role of liquidity in determining asset prices. The incompleteness of markets leads to an inefficient provision of liquidity by the financial system. This can generate cash-in-the-market pricing, which implies that the prices of long-term safe assets can fall below their fundamental value, and leads to financial fragility, which means that even small shocks can have large price effects.

The intuition for this result is as follows. When markets are incomplete, liquidity provision is achieved by selling assets when liquidity is required. That implies, asset prices are determined by the available liquidity or in other words by the cash in the market in case liquidity is scarce. Due to the incompleteness of markets, liquidity cannot be traded in a state-contingent manner and hence suppliers of liquidity can no longer be compensated for the cost of providing liquidity state by state. Instead they must be compensated on average across all states and that causes inefficiency. Providers of liquidity have the alternative of investing in a productive long-term asset. Therefore holding liquidity is associated with an opportunity cost as this has a lower return than the productive long-term asset. Hence, providers of liquidity must be able to make a profit in some states in order to get compensated for holding the liquidity. However, in equilibrium they can only make a profit in those states where liquidity is scarce. In states of abundant liquidity where banks do not need liquidity, liquidity suppliers have to bear the opportunity cost of holding liquidity. Accordingly it must be the case that in states where banks face high liquidity demand, the equilibrium price of the long-term asset is low enough to compensate the liquidity providers for all the other states where they do not make any profit. Otherwise, they will not hold the liquidity in the first place. Hence, prices are low in states where banks need more liquidity. Asset price volatility is a consequence of compensating liquidity suppliers. But from an efficiency point of view there is a transfer from the banks who need liquidity to the providers of liquidity. Negative insurance and suboptimal risk sharing will be the result. Allen and Gale (2004b) show that the only equilibria that are robust in such a setting involve stochastic consumption as well as volatile asset prices.

This framework also builds the cornerstone of further analysis on the structure and behaviour of financial systems in crisis situations. In Allen and Gale (2006) and Allen

and Carletti (2006, reprinted in Section 4 of this handbook, 2010) the standard model of intermediation is extended by adding an insurance sector, where banks and insurance companies do different things. Banks provide liquidity insurance to depositors, and insurance companies pool risks. Again with complete markets and contracts for aggregate risks intersectoral transfers are desirable. They allow risks to be shared efficiently between different industries. However, with incomplete markets and contracts for aggregate risks, Allen and Gale (2006) show how inefficient capital regulation can lead to credit risk transfer as a result of regulatory arbitrage and this in turn can increase systemic risk. Allen and Carletti (2006) analyze how financial innovation can create contagion across sectors and lower welfare relative to the autarky situation where banks face idiosyncratic liquidity risk and hedge this risk in the interbank market. Credit risk transfer can lead to contagion between sectors and increase the risk of financial crises. Allen and Carletti (2008) analyze the effects of mark-to-market accounting when financial markets are incomplete. They emphasize the point made above that in times of financial crisis the interaction of institutions and markets can cause prices in markets to reflect the amount of cash or liquidity available to buyers in the market rather than reflecting future payoffs. However, with mark-to-market accounting the asset price volatility directly affects the value of banks' assets. This can lead to contagion and force banks into insolvency even though they would be fully able to cover their commitments if they were allowed to continue until the assets mature.

Also cross-country bank lending appears to be affected by market imperfections. Freixas and Holthausen (2004, reprinted in this handbook) investigate the scope for interbank market integration across countries when there is better information about the solvency of domestic banks than of foreign banks. In a Diamond-Dybvig type of framework, where consumers want to insure themselves against uncertainty about the timing of their consumption needs by depositing in banks, they analyze the scope for international interbank market integration when cross-country information is noisy.

The timing of consumption needs generates liquidity shocks for the banks, which are present both at the individual and at the aggregate level. Banks can cope with these shocks by investing in a storage technology. However, as this technology yields a lower return than alternative investments, it is efficient for banks to use the interbank market for channelling liquidity. This reduces the amount of liquidity needed in the economy. Because banks are assumed to have some risk of failure, "peer monitoring" is important in improving the efficiency of the interbank market. Banks monitor each other in the interbank market to obtain a signal on the solvency probability of each of their peers. But cross-border information about banks is less precise than home country information.

Freixas and Holthausen analyze different interbank lending scenarios. They look at secured repo and unsecured interbank lending markets since both allow banks to cope with liquidity shocks, and they consider under which conditions segmented integrated international interbank markets (co-)exist. They show that a segmented interbank market is always an equilibrium, while the emergence of an integrated international market depends on the quality of cross-border information. Only if cross-border information is sufficiently precise, is integration of markets possible. However, the integration does not always lead to a more efficient outcome. The existence of repo markets appears to be a mixed blessing. On the one hand, a repo market is a perfect medium to channel funds between banks and countries, on the other hand, the secured nature of repo markets reduces the incentives for peer monitoring. Hence, a repo market reduces interest rate spreads and improves upon the segmentation equilibrium, but it can lead to a collapse of the unsecured integrated market, thereby reducing overall welfare.

A similar argument is suggested by Fecht and Grüner (2007) and Leitner (2005). Fecht and Grüner (2007) study the role of secured versus unsecured lending on the interbank market and show that only in states of abundant liquidity, secured interbank lending dominates unsecured lending. However, when aggregate liquidity is scarce, only unsecured lending delivers proper incentive effects. They argue that unsecured lending induces banks with excess liquidity to internalize, at least in part, the costs which their withdrawal decision in the interbank market inflicts on their counterparty. This is in particular the case when withdrawal raises the default risk of the respective counterparty and the counterparty's bankruptcy is costly for the withdrawer. Therefore, in a situation of expected aggregate liquidity shortage, unsecured interbank lending provides stronger incentives not to misreport excess liquidity to the market. Banks are able to mutually insure each other against regional liquidity shocks, however, this comes at the cost of creating stronger contagion risks.

Leitner (2005) also refers to the disciplinary effect of unsecured interbank deposits. He argues that banks intentionally choose fragile or incomplete interbank structures to expose themselves to the risk of contagion in order to credibly commit to bail each other out in the event of an individual crisis. In a related paper, Kahn and Santos (2008) investigate whether banks choose the optimal degree of mutual insurance against liquidity shocks. They show that when there is a shortage of exogenously supplied liquidity, which can be supplemented by bank liquidity creation, the banks generally fail to find the correct degree of interdependence. In aggregate, they become too risky.

There are in addition some very interesting recent contributions to this line of literature that are spurred by the turbulence in the interbank markets in the 2007/2008 financial crisis. These include Allen, Carletti and Gale (2009), Acharya, Gromb and Yorulmazer (2008), Heider, Hoerova and Holthausen (2009), Freixas and Jorge (2008), Freixas, Martin and Skeie (2009), Diamond and Rajan (2009), and Acharya, Gale and Yorulmazer (2009).

Allen, Carletti and Gale (2009) show that the interbank market is characterized by excessive price volatility when there is a lack of opportunities for banks to hedge aggregate and idiosyncratic liquidity shocks. They analyze how the central bank should intervene to restore efficiency. By using open market operations to fix the short-term interest rate, the central bank can prevent price volatility and implement the constrained efficient solution. Thus, the central bank effectively completes the market, a result in line with the argument of Goodfriend and King (1988) that open market operations are sufficient to address pure liquidity risk on the interbank markets. Interestingly, one implication of the model is that situations where banks stop trading with each other can be a feature of the constrained efficient solution implemented by central bank policy if aggregate uncertainty is high. Banks may hoard liquidity because they may need it to meet high aggregate demand. When aggregate demand is low, however, they have enough liquidity to meet idiosyncratic shocks and accordingly do not need the interbank market. As a result the volume in the market falls to zero, but there is no need for central banks to intervene since the freeze is consistent with constrained efficiency.

Acharya, Gromb and Yorulmazer (2008) model the interbank markets as being characterized by moral hazard, asymmetric information, and monopoly power in times of crisis. They show that in such a situation a bank with surplus liquidity has bargaining power vis-à-vis deficit banks which are in need of liquidity to keep funding projects. Surplus banks may strategically provide insufficient lending in the interbank market in order to induce inefficient sales of bank-specific assets by the needy banks, which results in an inefficient allocation of resources. The role of the central bank is to provide an outside option to the deficit bank for acquiring the needed liquidity.