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A review and synthesis

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Abstract in English

The financial crisis has put systemic risk firmly on the policy agenda. In such a crisis, an initial shock gets amplified while it propagates to other financial intermediaries, ultimately disrupting the financial sector. We review the literature on such amplification mechanisms which create externalities from risk taking. We distinguish between two classes of mechanisms: contagion within the financial sector and pro-cyclical connection between the financial sector and the real economy. Regulation can diminish systemic risk by reducing these externalities. However, regulation of systemic risk faces several problems. First, systemic risk and its costs are difficult to quantify. Second, banks have strong incentives to evade regulation meant to reduce systemic risk. Third, regulators are prone to forbearance. Finally, the inability of governments to commit not to bail out systemic institutions creates moral hazard and reduces the market's incentive to price systemic risk. Strengthening market discipline can play an important role in addressing these problems, because it reduces the scope for regulatory forbearance, does not rely on complex information requirements, and is difficult to manipulate.

Key words: Financial markets, Contagion, Systemic risk

JEL code: G01, G28

Abstract in Dutch

Door de financiële crisis staat systeemrisico centraal op de beleidsagenda. Bij zo'n crisis verspreidt een schok zich naar andere financiële instellingen. De schok wordt daarbij versterkt, waardoor het financiële systeem in gevaar komt. We geven een overzicht van de literatuur over dergelijke versterkingsmechanismen die externaliteiten creëren van de risico's die banken nemen. We onderscheiden twee typen mechanismen: besmetting binnen de financiële sector, en de procyclische connectie tussen de financiële sector en de reële economie. Regulering kan systeemrisico verminderen door externaliteiten in te perken. Hierbij spelen echter verschillende problemen. Ten eerste zijn systeemrisico en de kosten ervan moeilijk de kwantificeren. Ten tweede hebben banken prikkels om regulering van systeemrisico te ontduiken. Ten derde staan toezichthouders bloot aan de verleiding om te laat in te grijpen. Ten slotte kunnen overheden zich moeilijk eraan committeren om systeembanken niet te redden. Hierdoor hebben markten geen prikkel om systeemrisico te beprijzen. Het versterken van marktdiscipline kan helpen om deze problemen te verminderen, omdat het toezichthouders disciplineert, niet afhangt van complexe informatievereisten en moeilijk te manipuleren is.

Steekwoorden: financiële markten, besmetting, systeemrisico

Contents

Preface

The financial crisis that engulfed the world in 2007-2008 started when the US housing market deteriorated. This relatively small shock spiralled out of control as problems propagated to other financial intermediaries and got amplified along the way. To prevent a total meltdown of the financial sector, governments had to step in with unprecedented support. These events have put systemic risk firmly on the policy agenda.

The essence of systemic risk lies in the negative effects that one bank's problems have on other banks. The mechanisms that lie behind these effects, however, are ill understood, empirically as well as theoretically. This document reviews the literature on systemic risk and identifies the generic problems faced by governments when trying to address systemic risk.

We conclude that effective regulation should strengthen market discipline, reduce the scope for regulatory forbearance, not rely on complex information requirements, and be difficult to manipulate. A combination of prompt corrective action and systemic risk levies may be an effective way to achieve these goals.

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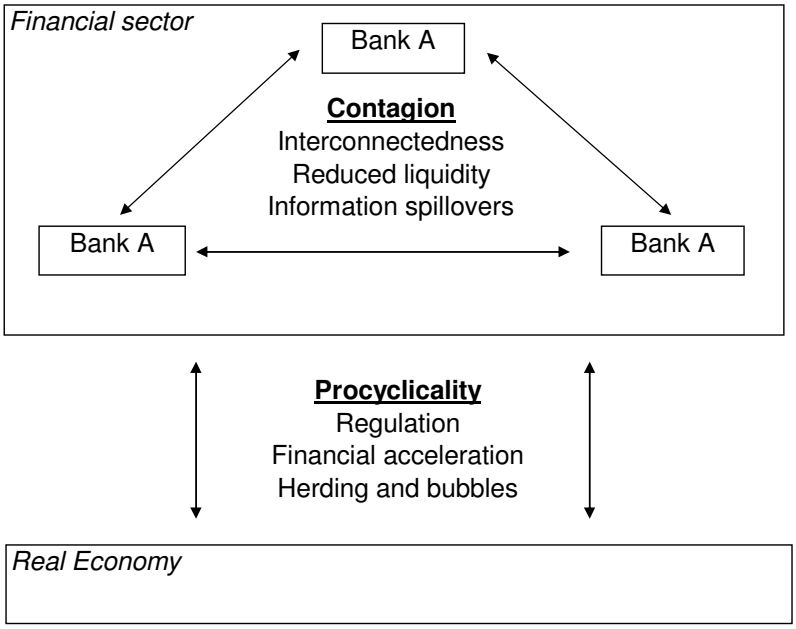
Summary

The recent – near catastrophic – events in the financial sector show that containing 'systemic risk' should lie at the root of the regulation of banks. It may therefore come as a surprise that, in spite of its relevance, no generally accepted definition of the term systemic risk exists. We argue that the difference between financial intermediaries and other firms should be at the core of a definition of systemic risk and provide a review and synthesis of the literature on systemic risk from this point of view.

Systemic risk is the probability that a systemic crisis arises. A systemic crisis has three important characteristics: first an initial shock, second a propagation and amplification mechanism, and third disruption of the financial sector. It is generally accepted, although by no means trivial, that banks differ from other firms because of the existence of propagation and amplification mechanisms whereby one bank's problems may propagate to other banks. If individual banks do not internalise the external effects of their own risk taking on other banks, they impose a negative externality on the financial system as a whole. As a consequence, from a social welfare point of view banks invest too little in reducing the probability or the effect of shocks, resulting in too much systemic risk. Because such a disruption of the financial sector is very costly for society, the existence of these externalities creates a rationale for government intervention and regulation of bank risk taking.

This study focuses on the propagation and amplification mechanisms that create externalities from individual banks' risk taking decisions. We identify two different channels through which externalities from risk taking may arise: first, contagion within the financial sector, and second, pro-cyclical connection between the financial sector and the real economy. Each channel has a number of amplification mechanisms that can play a role. Contagion within the financial sector arises through interconnectedness, reduced liquidity and information spillovers. The procyclical connection between the financial and the real sector arises from regulation, financial acceleration, and herding and asset-price bubbles. Figure 1.1 summarizes these channels and propagation mechanisms.

Figure 1.1 Systemic risk: contagion and procyclicality



Contagion

We define contagion as the propagation of shocks experienced by one bank to other banks through mechanisms within the financial sector. The literature identifies roughly three ways in which such propagation may arise.

First, financial distress may spread through direct and indirect interconnections between banks, created by intricate web of financial contracts that connects financial intermediaries. Problems faced by one bank then lead to a loss for other banks. Such interconnections are ubiquitous in the financial sector. This distinguishes the financial sector from other industries where firms are generally not interconnected in this way.

Direct contractual connections may for example be due to credit lines that facilitate the transfer of money from one bank to another, they may result from counter-party credit exposure on derivatives, or they may be caused by loans in the interbank market that allow banks to insure against liquidity shocks. Interdependencies can also be indirect, because of a common exposure to borrowers or lenders.

Most of these exposures arise endogenously in response to the shocks to their liquidity needs that financial intermediaries experience. Such shocks occur for example because depositors withdraw funds, because borrowers default on their loans, because new investment opportunities arise, or because the value of banks' assets decreases. Interconnections arise as a natural response to the opportunities for diversification and the need for insurance resulting from these shocks. The existence of interconnections does not immediately imply the existence of externalities, though. If banks price the risk of exposure into their contracts, then what may look like an externality ex post can simply be a correctly priced exposure to risk ex ante.

Second, financial distress may spread if one bank's problems negatively affect the ability of other banks to obtain funding when they unexpectedly need liquidity. Banks are vulnerable to such a 'liquidity freeze' because of the mismatch between long-term assets and short-term liabilities on their balance sheet. Liquidity freezes may result from fire sales, adverse selection, or liquidity hoarding.

One way for banks to obtain liquidity is by selling assets. By definition, fire sales arise if selling assets reduces the market price of these assets. Fire sales arise naturally when holding liquid assets yields a lower return than investing them. Banks that hold excess liquid assets will then require a reward for doing so. The reward comes in times of distress when assets are sold to these banks at a discount, i.e., at fire sales prices. In that case, one bank's decision to sell assets negatively affects other banks' ability to obtain liquidity by selling assets. This creates a fire sale externality.

Another potential explanation for liquidity freezes depends on the presence of asymmetric information. In the classic example, adverse selection arises if a potential buyer does not know whether he is dealing with a good car, or a bad car (a 'lemon'). If a shock exacerbates or creates adverse selection, this may lead to a lemons problem, where buyers require a mark-up because they don't know whether they are buying a good asset or a lemon. This leads to higher prices or even a total freeze of the market. Alternatively, shocks may increase lenders' uncertainty on their own ability and that of other banks to assess whether they are dealing with a good or a bad borrower. Lenders are therefore subject to a winner's curse, which may become unmanageable in bad times.

Finally, a shock can lead to a liquidity freeze if it triggers liquidity hoarding. In that case, banks hold on to excess liquidity, because they expect fire sale prices to drop even further, or strategically withhold liquidity from banks in need, expecting that they will benefit if this weakens future competition.

Third, shocks can also spread from bank to bank through informational spillovers. Bank runs can spread because a run on one bank implies information about other banks that allows rational agents to update their beliefs. For example, if the value of different banks' assets is correlated, rational agents observing a bank run will conclude that other banks may also be in trouble. Alternatively, an unexpected bankruptcy can reveal information about the quality or intensity with which central banks or creditors monitor banks' management. As a consequence, creditors may downgrade their assessments of other banks' robustness. Also, when one bank is scrambling for cash and appears unable to obtain it, this may reveal the existence of an aggregate liquidity shortage. This may then cause other banks to start hoarding liquidity.

Procyclicality

Procyclicality refers to the feedback loop between the financial sector and the real economy. Several potential feedback mechanisms connect the financial sector and the real sector. These feedback mechanisms can strengthen a financial crisis once it gets going, making a crisis harder

to contain. They work the opposite way in good times, causing banks to take on too much risk, for example by increasing leverage or the risk of their loan portfolio.

First, regulation can drive procyclicality, thus enhancing the systemic externalities. Capital requirements are proportional to the risks on banks balance sheets. However, measurement difficulties often result in too low risk estimates in good times and too high-risk estimates in bad times. Procyclicality results if under- or overestimates are not corrected for. In addition, when regulation requires banks to hold a higher capital ratio during economic downswings, reflecting the increased potential credit losses in their portfolios, they may respond by reducing credit. This will reduce investment and consumption. Fair Value Accounting (FVA) can pose problems if assets' market values no longer reflect fundamentals. Fair Value Accounting involves reporting assets and liabilities on the balance sheet at fair value and recognizing changes in fair value as gains and losses in the income statement. The main point is that market prices can deviate from fundamentals. This may happen, for example, when asset bubbles emerge, when markets freeze and become illiquid or when herding causes investors to neglect fundamentals. FVA then causes changes in these distorted prices to be reflected in banks' balance sheets and profit and loss accounts. In a downturn: the immediate recording of fair value reduction on assets reduces banks' capital base, hence their lending and their demand for securities.

The second source of procyclicality is financial acceleration. The basic mechanism of financial acceleration is that during an economic contraction the value of available collateral and the level of pledgeable income decrease. This reduces firms' ability to borrow and lowers investment. As a result, firms' prospects are worsened, resulting in a downward spiral of lower assets prices, less borrowing and less investment.

Regulation

The benefits of creating systemic risk accrue privately, but the costs of a crisis are borne socially. This disparity makes regulation of systemic risk necessary. We divide policy measures that aim to reduce systemic risk into three broad categories: incentive regulation, structural regulation, and ex post crisis intervention.[1]

Incentive regulation tries to change the incentives of financial intermediaries so that they internalise the external effects of their risk taking. Ex ante price regulation, as it is sometimes referred to, can take the form of taxation, capital requirements, insurance. Policymakers can also change banks' incentives by giving banks' financiers stronger incentives to discipline banks, i.e., by increasing market discipline.

Structural regulation tries to limit systemic risk through quantity regulation, such as putting quantitative restrictions on bank characteristics that are thought to be related to systemic risk or

[1] Other categorisations are of course also possible. Of course, a particular policy measures may belong to different categories, depending on its exact nature. For example, measures that fall in the category 'ex post crisis intervention' often have ex ante effects. For expositional purposes, however, we put these policy measures in one category.

limiting the activities that banks are allowed to perform, and structural measures, such as regulation rating agencies, increasing the transparency of markets, or reducing competition.

Finally, ex post crisis intervention tries to dampen the mechanisms that spread problems once a crisis occurs. It includes the lender of last resort function of central banks, deposit insurance, bank-specific bankruptcy rules, contingency plans such as living wills, and prompt corrective action. Table 1.1 the policy measures and the issues involved in their implementation.

Table 1.1 Policy measures to address systemic risk

Type	Measure	Issues
Incentive regulation	Taxation	Calibration, Politicians' opportunism, industry lobbying
	Capital requirements	Calibration, one instrument with too many goals, regulatory capture, limited scope
	Insurance premium	Calibration, pricing incentives, payout trigger, moral hazard
	Market discipline	Irrational market behaviour, implicit governments guarantees
Structural regulation	Portfolio restrictions	Loss of economies of scope, gaming of regulation
	Quantity regulation	Inefficiencies, triggers risk shifting
	Product standardisation	Gaming of regulation, increased cost of tailored products
	Increased transparency	Treatment of non-standard contracts, central counterparty risk,
Ex post crisis intervention	Lender of last resort	Pricing of liquidity, distinguishing illiquidity from insolvency, moral hazard, regulatory forbearance
	Deposit insurance	Pricing, moral hazard, implicit government guarantees, role of private insurers
	Prompt corrective action	Regulatory capture, time-inconsistency problem, trigger-levels
	Living will	Implicit government guarantees, international coordination, trigger variable
	Bank-specific bankruptcy laws	Treatment counterparty risk, distinguishing good and bad assets, credibility, international coordination

We identify four generic problems interfere with effective regulation of systemic risk. First, systemic risk may be inherently difficult to quantify. Measurement of systemic risk is difficult because the externalities that create systemic risk only materialize under extreme circumstances. As a consequence, any measure of systemic risk will be very imprecise and will have large error margins. In addition, regulators face substantial information asymmetry when assessing systemic risk created by banks' strategic decisions. This implies that one should be cautious of policy measures that require a precise measurement of systemic risk or systemic externalities.

A second obstacle is the robust incentive for banks to evade regulation meant to reduce systemic risk. Such regulation effectively taxes the originators of risks for their contribution to systemic risk. Evading such a tax is, of course, profitable because it allows banks to take on additional risk at the expense of other banks and, ultimately, the taxpayers. This implies that policymakers should look for policy measures that are easy to enforce and hard to circumvent.

A third problem is that regulators are prone to forbearance when it comes to systemic risk. When designing measures that allow regulators to intervene at an early stage, the incentives for regulators to postpone intervention or to take insufficient measures should be taken into account. Providing for more external scrutiny in the assessment of systemic risk can reduce the scope for regulatory forbearance.

A final point is that systemic risk is to some extent created by the inability of governments to commit not to bail out systemic institutions. The government's time-inconsistency problem creates a private benefit for banks from becoming too systemic too fail. Policies that tie regulators' hands can reduce this problem.

Conclusion

The policies that try to reduce systemic risk should meet several requirements. First, they should give financial intermediaries the incentive to reduce systemic risk. Second, they should give regulators sufficient incentives to intervene and reduce governments' time-inconsistency problem. Third, they should not depend on complex information, but instead be easy to enforce and difficult to manipulate. Finally, they should increase market discipline.

Strengthening market discipline and making optimal use of information generated by markets can help to overcome the measurement problem, prevent regulatory gaming, reduce the scope for regulatory forbearance, and address governments' time-inconsistency problem. Policy measures that contribute to this goal include prompt corrective action, a bank-specific bankruptcy regime, a living will, and isolating crucial parts of the financial system.

1 Introduction

Sparked off by a deflating bubble in the US housing market, the financial crisis has put the spotlight firmly on systemic risk. When systemic risk materialized, initially localized problems spiralled out of control and brought the financial system to the brink of collapse. As the first world wide financial crisis since the 1930s has made painfully clear, such a near collapse imposes large costs on society. To prevent a total meltdown of the financial system, governments have spent large sums of money by purchasing assets, providing or guaranteeing liquidity, recapitalizing banks, and lowering interest rates. According to the International Monetary Fund (IMF), governments spent about 30 percent of global GDP on such rescue operations. In spite of this massive government intervention, the real economy went into a recession because banks were no longer able to efficiently allocate capital and had to reduce their supply of credit.

It is generally accepted that these – near catastrophic – events demonstrate that containing 'systemic risk' should lie at the root of the regulation of banks. It may therefore come as a surprise that, in spite of its relevance, no generally accepted definition of the term systemic risk exists. In its broadest sense, it refers to any type of risk that threatens the functioning of the financial system as a whole. In a narrower sense, it highlights the inherent fragility of banks and the effect that a banking crisis has on the real economy. Where some focus on the risks posed by macro-economic developments, others point to the mechanisms responsible for propagating problems from bank to bank.

In our view, the potential for one bank's problems to negatively affect other banks lies at the core of these different concepts of systemic risk. This is also the central difference between banking and other economic activities, where firms usually benefit if a competitor goes bankrupt.[2] If individual banks do not internalise these external effects of their own risk taking on other banks, they impose a negative externality on the financial system as a whole. As a consequence, from a social welfare point of view banks invest too little in reducing the probability or the effect of shocks resulting in too much systemic risk. This study reviews the theoretical and empirical literature on systemic risk as well as the policy measures that aim to contain it. We identify two important channels of systemic risk: contagion within the financial sector and the procyclical connection between the financial sector and the real economy.

Contagion can quickly erode the stability of banks. We define contagion as the propagation of problems encountered by one bank to other banks through mechanisms within the financial sector.[3] This definition encompasses two crucial aspects. First, a problem at one institution

[2] The costs of a collective failure of banks are not the essential difference between the banking sector and other sectors in the economy. When bakeries or car manufacturers collectively go bankrupt, this also imposes large costs on society.

[3] The term contagion is used with different meanings. Rochet and Tirole (1996) use the term systemic risk as a synonym for contagion, and define the latter as "the propagation of an agent's economic distress to other agents linked to that agent through financial transactions". This definition comes closest to ours. Pericoli and Sbracia (2003) use it to describe the geographical spread of crises between countries or markets. Allen and Gale (2007) define financial contagion as 'the process by which a crisis that begins in one region or country spreads to an economically linked region or country'.

adversely affects other financial institutions. Second, this relationship results from propagation over time instead of the simultaneous effect of common shocks. The mechanisms behind interbank contagion are still ill understood. A lack of data makes it difficult to distinguish empirically between contagion and spurious correlations due to exposure to common risk factors. Therefore, the relevant literature consists mostly of theoretical models that describe how small shocks to the financial system could lead to big problems. In essence, these models show how the fragile funding structure of individual banks, the informational asymmetry inherent in the nature of banking and the network of financial contracts and transactions between banks can conspire to bring banks to a collective standstill. An important question is whether and how different mechanisms of contagion introduce a fundamental market failure that creates a rationale for government intervention. Consensus among economists on this issue is still lacking.

A second important channel for systemic risk is the feedback mechanisms that connect the financial sector and the real sector, generally referred to as procyclicality. These feedback mechanisms can intensify a financial crisis once it gets going, making a crisis more difficult to contain. They work the opposite way in good times, causing banks to take on too much risk, for example by increasing leverage or the riskiness of their loan portfolio.

All these mechanisms have played some role in spreading the financial crisis. Procyclicality contributed to the build-up of risks. The crisis started with an asset bubble in the US housing market that was fuelled by cheap credit. Explicit and implicit government guarantees allowed bankers to make a safe bet by collectively riding the bubble. Banks increased their leverage and more and more funded themselves with short-term wholesale debt. When the bubble burst, the feedback mechanisms fuelled the crisis. Bank runs spread, as investors inferred from some banks' problems that other financial institutions should also be in trouble. Interbank rates rose to unprecedented heights when banks started hoarding liquidity and refused to lend money to potentially unsafe competitors. As a consequence, banks were forced to sell assets. The ensuing fire sales may have combined with accounting rules to create a downward spiral. Procyclicality again played its role as banks became reluctant to extend loans, firms started cutting back on costs by reducing inventories, shedding jobs, and shelving investment plans. The ensuing recession further reduced the value of banks' assets, triggering a new round of contagious fire sales and causing banks to become even more reluctant to extend credit.

Because markets will fail to provide the socially optimal level of financial stability, governments regulate banks through banking supervision, capital requirements, deposit insurance, lender of last resort facilities, and bank crisis resolution. Pre crisis regulation focussed on reducing banks' exposure to idiosyncratic risks. The idea is that the risk of a systemic crisis, i.e., a collective failure of banks, can be adequately addressed by reducing the risk of failure of individual banks. This point of view does not take into account the external effects of one bank's risk taking on other banks. Characteristics that may seem innocuous from

a disaggregate point of view may create systemic concerns when considered at an aggregate level.

But regulation of systemic risk is not easy. Four generic problems interfere with the effective regulation of systemic risk. First, banks took on systemic risk as a way to evade regulation. By guaranteeing off-balance sheet vehicles, banks were circumventing capital regulation, which did not fully account for such off-balance sheet risks. By directly buying securitised subprime mortgages, banks were effectively writing disaster insurance and counting the premium as profits. Indeed, regulatory arbitrage of systemic regulation is very profitable because the downside is borne entirely by the taxpayer. The scope for such arbitrage may be large, because of the considerable information asymmetry between regulators and regulated when it comes to systemic risk. The key point is, therefore, to devise measures that are hard to game.

Second, systemic risk may be inherently difficult to quantify. It requires an answer to the question: how much more likely becomes the failure of bank B, if bank A takes on more risk? Measurement of systemic externalities is difficult because these externalities have to be measured in normal times, but their detrimental effect only materializes under extreme circumstances. In addition, a calibration of government policies that price these external effects, also requires a quantification of the effect of a collective failure of banks. This implies that one should be cautious of policy measures that require a very precise measurement of systemic risk or systemic externalities.

A third problem is that regulators are prone to forbearance when it comes to systemic risk, i.e., a regulator may be tempted to gamble for resurrection. When a regulator spots an incipient crisis, he has to decide whether or not and how to intervene. In making this decision, a regulator weighs the private benefits of intervention against the private benefits of non-intervention. These private benefits do not necessarily coincide with the public benefits of intervention. Commitment problems, limited liability, career concerns and herding incentives may distort a regulator's decisions.

Fourth, the inability of governments to commit not to bail out systemic institutions may to some extent create systemic risk. When systemic risk materializes, there will be immense pressure on politicians to provide liquidity to markets and recapitalize or nationalise banks. The government's time-inconsistency problem creates a private benefit from becoming too systemic too fail. Policies that tie regulators' hands can reduce this problem.

In chapter 2, we briefly discuss our definition of systemic risk and the empirical evidence on the costs of financial crises. Chapter 3 reviews the existing theoretical and empirical literature on contagion, paying special attention to illiquidity. In chapter 4, we discuss the procyclicality of banks' balance sheets. Chapter 5 we address the policy measures that policymakers can use to address systemic risk and identify the generic problems that interfere with the effective regulation of systemic risk. We do not discuss macroeconomic policy measures that address

macroeconomic imbalances and lax monetary policy, two of the culprits for the abundance of capital that fuelled the bubble in US housing prices.

As a final remark, we would like to emphasize that both theoretical as well as empirical research on these topics is ongoing. In addition, a lively debate between academics, policy makers, regulators, and practitioners has erupted on how to regulate systemic risk. This document therefore necessarily represents a snapshot of the current state of affairs.

2 Systemic risk

2.1 What is systemic risk?

The financial system, consisting of financial intermediaries and financial markets, intermediates between those with an excess of funds (for example consumers saving for future consumption) and those with a temporary lack of funds (for example firms wanting to invest in productive activities). If markets were complete and efficient, financial markets would be able to provide the same services as banks do. In that perfect world, banks would be redundant. In the words of Freixas and Rochet (1997): 'Banks are useless in an Arrow-Debrue world'. Financial markets are, however, plagued by information asymmetry. The literature on financial intermediation argues that banks are a way to overcome these informational problems. The costs of adverse selection can be reduced if borrowers form coalitions. Investors can address moral hazard by appointing a delegated monitor. Banks can aggregate the liquidity needs of firms and consumers.

In a systemic crisis, the financial sector is disrupted to such an extent that it can no longer efficiently perform these functions. According to Mishkin (1999), a financial crisis, "occurs when shocks to the financial system interfere with information flows so that the financial system can no longer do its job of channelling funds to those with productive investment opportunities". In practise, a systemic crisis arises after the financial system has experienced some sort of shock, which subsequently gets amplified as it propagates through the financial system. Shocks may be idiosyncratic, for example when a single bank fails due to bad management or fraud, or systematic, for example when a recession hits all banks at the same time. Mishkin (1999) identifies four basic sources of shocks: (1) deterioration in financial sector balance sheets, (2) increases in interest rates, (3) increases in uncertainty, and (4) deterioration in non-financial balance sheets.

In our view, a systemic crisis has three important characteristics: first an initial shock; second an amplification mechanism; and third disruption of the financial sector.[4] Systemic risk is the probability that such a crisis arises. Systemic risk can therefore be reduced by reducing the probability of a shock, by damping the amplification mechanism or by isolation crucial parts of the financial system.

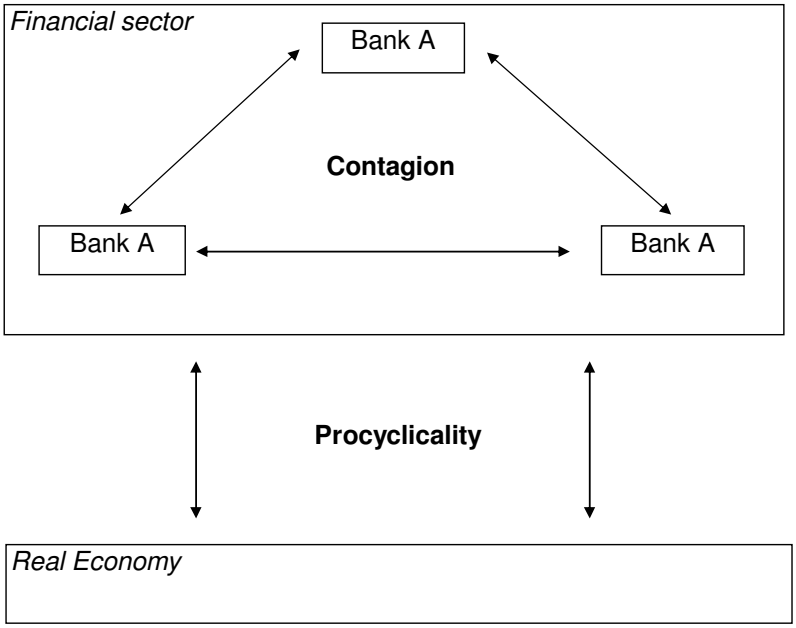
Note that in our definition, in contrast to the definition given by Mishkin (1999), systemic risk necessarily involves an amplification mechanism. Our study focuses on these mechanisms, which create externalities from individual banks' risk taking decisions. We identify two different types of amplification mechanisms that play a role in systemic risk: contagion within the financial sector and pro-cyclical connection between the financial sector and the real

[4] Note that in our definition, the probability of a shock to the financial system that hits many banks at the same time, but which doesn't involve some propagation mechanism, does not contribute to systemic risk.

economy. This view of systemic risk as consisting of contagion and procyclicality is schematically summarized in Figure 2.1 below.[5]

To the extent that these amplification mechanisms introduce external effects from risk taking, individual banks will take too much risk and invest too little in reducing the probability or the effect of shocks. Thus, from the perspective of the society as a whole, the banking sector will be too sensitive too shocks and will take on too much systemic risk. This creates a rationale for government intervention and regulation of bank risk taking.

Figure 2.1 Systemic risk: contagion and procyclicality



2.2 The cost of systemic crises

At the basis of governments' concern with systemic risk lie the high social costs associated with a systemic crisis. Most times governments have to bail out the weak banking system by large-scale recapitalization and nationalization operations at tax payers' expense. According to Laeven and Valencia (2008) in about 85 percent of the banking crises the government had to recapitalize a bank, while in more than 57 percent of the cases the government even has to nationalize a domestic bank. The average fiscal cost of a systemic banking crisis is about 14 percent of GDP the first five years after the start of the crisis.

Empirical evidence also shows that financial crises are often very costly in terms of output. Cerra and Saxena (2008) estimate that the permanent output loss due to a crisis varies from 4 to 16 percent of GDP. Claessens et. al (2008) find that recessions associated with credit crunches and house price busts tend to be deeper and longer than other recessions. The median

[5] De Bandt and Hartmann (2000) call these horizontal externalities and vertical externalities, respectively.

cumulative loss in GDP of 13 recessions associated with both a credit crunch and a house price bust is 6.7 percent. Reinhart and Rogoff (2008) compare data from the 18 bank-centred financial crises with the 2007 US sub-prime crisis. For the five most catastrophic cases (which include episodes in Finland, Japan, Norway, Spain, and Sweden), the drop in annual output growth from peak to trough is over 5 percent, and growth remained well below pre-crisis trend even after three years.[6]

Abstracting from the potential effects on other banks, the failure of a single bank (as opposed to the failure of multiple banks resulting in a banking crisis) may also be costly to society. If a bank develops relationship-specific abilities to restrain its borrowers' moral hazard, its failure will result in a real loss of value of the bank's loan portfolio.[7] Investments financed by bank loans may have to be liquidated. The liquidation value of a loan is lower than its continuation value if some of this value is bank-specific. Also, if banks have private, non-verifiable information about the creditworthiness of their borrowers, these borrowers may no longer be able to acquire funding for profitable investments if their bank has collapsed. If a particular bank incorporates part of a market infrastructure, like payment- or settlement systems, such infrastructure may temporarily break down when a bank goes bankrupt. Finally, bank failures may impose negative externalities on bank customers. Uninsured depositors may be locked out of their deposits while the bank is restructured, and borrowers may fail to receive due lines of credit.

[6] The pre-crisis growth rates are a result of the rapid credit expansion in these years. So, it is hard to compare the pre-crisis and the post-crisis economic growth rates. Besides a stock effect resulting from a temporarily lower growth rate, a crisis may also lead to permanently lower growth rates. It remains unclear whether, and if so to what extent, such a flow effect exists.
[7] If a bank sells its loans below their actual value it incurs a loss. However, this amounts to transfer from the bank's creditors to the new owners of the loans.

3 Contagion

In the years preceding the crisis, banks increased their leverage and their reliance on short-term funding. The flip side of increased leverage is reduced equity. Consequently, a small drop in value of a bank's assets can force it to recapitalize. Increased reliance on short-term funding implies that a large fraction of a bank's financiers can withdraw their funds quickly. A bank will then either have to sell assets or attract new financiers. Both developments therefore make banks more sensitive to shocks to their balance sheets.

By itself, however, increased sensitivity of individual banks to shocks due to higher leverage or greater reliance on short-term funding does not imply a higher probability that a large number of banks get into trouble at the same time, i.e., increased systemic risk. Indeed, in most markets a firm benefits if one of its competitors goes bankrupt. If a car manufacturer goes bankrupt, the suppliers of car parts will compete more vigorously to supply the remaining car manufacturers, lowering input costs, and the retail market for cars will become less competitive, raising retail prices. In most markets, if firms choose higher risk, that is their business.

Why are banks different? It is generally assumed, although by no means trivial, that banks are different because one bank's problems may propagate to other banks, spreading initially localised problems throughout the financial system. If individual banks do not internalise the effects of their own risk taking on other banks, they impose a negative systemic risk externality on the financial system. As a consequence, from a social welfare point of view, banks invest too little in reducing the probability or the effect of shocks resulting in too much systemic risk. This increases the probability that a large number of banks get into trouble at the same time. Because such a collective failure of banks is very costly for society, the existence of these externalities creates a rationale for government intervention and regulation of bank risk taking.

The question remains, however, what mechanisms lie behind these externalities? This section aims to summarize the theoretical and empirical literature on this issue. The literature identifies a number of potential mechanisms for shocks experienced by one bank to propagate to other banks, which can be roughly grouped into three classes.

First, the problems faced by bank A may lead to a loss for bank B because some of its assets drop in value. Such a negative effect on bank B's asset prices may occur directly or indirectly. Direct effects arise due to bilateral contracts or exposure. As bank A becomes more likely to default on its payments, the value of such contracts decreases. Indirect effects arise due to exposure to mutual borrowers or creditors.

Note, however, that even though problems may propagate from one bank to another through these interconnections, this does not immediately imply the existence of externalities. For example, assume that links between banks arise because of bilateral contracts that insure banks against liquidity shocks. The links between banks then arise endogenously. Because banks price the risk of a liquidity shock, what may look like an externality ex post can simply be a correctly priced exposure to risk ex ante.

Second, even if bank B's assets are unaffected, the problems faced by bank A may negatively affect bank B's ability to fund itself. This happens if bank A's problems cause conditions for recapitalisation or refinancing of bank B's short-term debt to tighten. As we will see, this may be caused by adverse selection due to asymmetric information, fire sales due to incomplete contracts or liquidity hoarding due to market power. Externalities then arise because a bank doesn't take into account the effects on other banks of its decision to sell assets or to withhold liquidity from the market.

Third, shocks can also spread from bank to bank through informational spillovers. For example, bank runs can spread because a run on one bank implies information about other banks that allows rational agents to update their beliefs. More generally, one bank's problems may generate adverse information about other banks. This can be information about the intensity with which central banks or creditors monitor banks' management, the value of banks' assets[8], or an event that reveals the existence of an aggregate liquidity shortage.

Below, we review the theoretical literature that describes various mechanisms for these channels of contagion. We pay particular attention to papers that focus on the current crisis. For a pre-crisis review of the literature, see de Bandt and Hartmann (2000). For more recent post-crisis reviews see Wagner (2009) or Allen et. al (2009).

3.1 Interconnectedness

A first way in which financial distress may spread is through direct and indirect interconnections between banks. Such interconnections are ubiquitous in the financial sector, in contrast to most industries where firms do not seem to be interconnected through an intricate web of financial contracts.[9]

Direct interdependencies arise from interbank on-balance and off-balance sheet exposures. These direct contractual connections may be due to payment and settlement relationships, for example credit lines that facilitate the transfer of money from one bank to another through the large-value payment system. They can also result from the cross holding of deposits for clearance, regulatory or insurance reasons. Another source may be counter-party credit exposure on derivatives, or loans in the interbank market that allow banks to insure against liquidity shocks.

Most of these exposures arise endogenously. Why do banks choose to be interconnected? One reason is that banks experience shocks to their liquidity needs, for example because depositors withdraw funds, because borrowers default on their loans, because new investment opportunities arise, or because the value of their assets decreases. Because these shocks are (to

[8] If correlations in underlying value across banks exist.

[9] Subcontracting in non-financial industries may also imply interconnections. Subcontracting, however, mostly occurs between vertically related firms, whereas interconnections between banks are horizontal.

some extent) uncorrelated, banks can reduce the amount of liquid assets they have to hold by pooling their liquidity needs. Interbank connections are one way of doing this.

On the one hand, such interbank connections allow for more efficient risk sharing between banks exposed to idiosyncratic shocks. When liquidity is scarce, it is efficient for banks with a temporary surplus of funds to provide liquidity to banks that temporarily need it. This reduces the vulnerability of individual banks.

However, these links may allow problems faced by one bank to spread to other banks. Interconnectedness played an important role in the decision of the US government to bail out the investment bank Bear Stearns and the insurer AIG. For example, the chairman of the Federal Reserve, Ben Bernanke, declared that 'Global banks and investment banks would have suffered losses on loans and lines of credit to AIG, and on derivatives with AIG-FP. The banks' combined exposures exceeded $50 billion. Money market mutual funds and others that held AIG's roughly $20 billion of commercial paper would also have taken losses. In addition, AIG's insurance subsidiaries had substantial derivatives exposures to AIG-FP that could have weakened them in the event of the parent company's failure.'[10]

In the presence of interbank contractual relations, if one bank fails other banks will have to write down their claims on the failing bank. This may create fragility in two ways. First, a shock pushing one bank towards bankruptcy will decrease the value of connected banks' assets, reduce their capital levels, and therefore increase the likelihood that they will face bank runs. Second, if regulation or market discipline demand a minimum level of bank capital, a shock may force it to attract new capital, reduce its lending, or sell assets.

A number of papers explicitly model how interconnections can lead to contagion. Dasgupta (2004) argues that the cross holding of deposits can lead to contagious effects. Such cross holding may be motivated by imperfectly correlated regional liquidity shocks, clearance or regulatory reasons. The depositors of a bank receive some information about the state of fundamentals in their region, and update their beliefs about eventual returns on bank deposits. This may result in runs on that bank. Conditional on the failure of a debtor bank, a creditor bank fails for a wider range of its own fundamentals than if the debtor bank survived. Consequently, there are regions of fundamentals in which a creditor bank fails if and only if the debtor bank fails. Thus, interbank deposits lead to contagion by triggering the failure of the creditor bank.

Allen and Gale (2000) consider a model where regional banks hold claims on banks in other regions as insurance against regional shocks to consumer liquidity needs. If these regional shocks are uncorrelated, i.e., there is no aggregate uncertainty, an interbank market yields optimal liquidity insurance. The interconnectedness resulting from these interbank claims, however, may create the potential for interbank contagion. When hit by a liquidity shock, banks can choose to either liquidate their claims on other banks or their long-term assets. Only the latter option creates liquidity. Thus, liquidating long-term assets exerts a positive externality on

[10] Statement for the Committee on Financial Services of the US House of Representatives, March 24, 2009. AIG-FP refers to AIG Financial Products.

other banks. Liquidating long-term assets, however, is costly and banks prefer to liquidate their claims on other banks. Whether contagion occurs depends on the pattern of cross holdings of deposits. If the network is complete, in other words, every bank is directly connected to every other bank, then interconnections make the financial system more robust against shocks. An incomplete network, however, introduces fragility because a liquidity shock that could be absorbed if spread over all regions, can end-up disproportionally hitting some regions, triggering bank runs and bankruptcy.

Freixas et al. (2000) show how shocks can spread through the payment system.[11] In the model different banks operate in different regions. Banks' depositors from one region may want to withdraw cash to spend on consumption in another region. As a consequence, banks run liquidity risk because they can suddenly be confronted with large cash withdrawals. Interbank credit lines allow banks to cushion these shocks and reduce the cost of holding liquid assets. If depositors from one region wish to consume at some other region, but believe that the corresponding bank at that location does not have enough cash, they turn to their home bank instead. As a result, the home bank may be obliged to liquidate some of its assets. The problems of this bank may then trigger depositors from other regions that wanted to withdraw to turn to their home bank as well. Consequently, a solvency shock can cause the entire system to collapse. Note that there is an externality since depositors force their home bank to liquidate because they do not trust the quality of the assets of the corresponding bank.

Interdependencies can also be indirect, because of a common exposure to borrowers or lenders, or because banks endogenously choose to hold correlated portfolios. Wealth effects coupled with risk aversion may also lead to contagion if a group of investors lends to the same set of borrowers. Suppose investors lend to the same two borrowers. Each borrower might face a self-fulfilling crisis where investors withdraw their money because they expect others to do the same. Such a crisis reduces the investors' wealth, which increases their risk aversion. In turn, this increases their incentive to withdraw their investments from the other borrowers (Kyle and Xiong, 2001, Goldstein and Pauzner, 2004).

The literature on systemic risk and interconnectedness treats the network of interconnections largely as exogenous. Of course, in reality, the web of contractual relations that interconnects financial intermediaries arises endogenously in response to idiosyncratic shocks. Banks choose to diversify or write insurance contracts, and they will price the risks involved. Because the links between banks are endogenous, what may look like externalities ex post may actually be a correctly priced exposure to risk ex ante.

Although interconnections between banks seem to be an obvious source of externalities, models that treat the web of interconnections as endogenous and that can guide us in assessing

[11] See also Freixas and Parigi (1998), who compare contagion in net and gross payment systems. In a net payment system, banks extend credit to each other and settle at the end of the day. In a gross payment system, banks settle transactions on a one-to-one basis with central bank money.

the policy consequences of interconnectedness are largely absent.[12] An exception is a recent paper by Allen et al. (2010). They consider the systemic risk resulting from overlapping portfolio exposures and investigate when different network structures are stable. They show that there does not exists a monotonic relationship welfare and between interconnectedness. We should therefore be careful in drawing policy conclusions on the optimal level of interconnectedness or the type of interconnections. There may be better reasons than interconnectedness to save entities such as AIG. We turn to those next.

3.2 Liquidity

A bank depends on liquidity when it has to refinance its short-term debt, attract capital to manage temporary liquidity shortages, or when it has to deleverage by shrinking the asset side of the balance sheet. We can distinguish between two types of liquidity: market liquidity and funding liquidity. Funding liquidity is the ability to attract new investors by issuing new wholesale deposits, long-term bonds or equity. Market liquidity is the ability to sell assets or to use them as collateral that can be offered to external financiers.[13] Assets can be sold directly if they are easily tradable, or through securitization if they are information-sensitive. The value of information sensitive assets changes with the arrival of new information (Gorton and Pennachi, 1990). Thus, information sensitive securities create an incentive to gather information. Such assets create information asymmetry between informed and uninformed buyers. This is not the case for information insensitive assets. Securitization can be seen as a way to create an information insensitive asset out of multiple information sensitive assets (Huang et al., 2009).

Reduced funding liquidity or reduced market liquidity creates problems for banks that face liquidity needs. We will see below, however, that a bank's failure or its response to shocks may reduce liquidity available to other banks. This is an important second mechanism for contagion.

Such liquidity freezes have been the defining aspect of this financial crisis. Markets broke down in several waves. In the first wave, when the high risk of subprime mortgage-backed securities became apparent, market liquidity as well as funding liquidity dried up for structured investment vehicles. When a correlated increase in mortgage payment delinquencies hit the market for securitised loans, the market value of these mortgage-backed securities plummeted as potential buyers became increasingly uncertain about their value. On 31 July 2007, two Bear Stearns hedge funds filed for bankruptcy, and Bear Stearns blocked investors from withdrawing from a third fund. On 7 August 2007, BNP Paribas halted withdrawal from three investment funds and suspended calculations of net present value of these funds. Lenders withdrew from

[12] Castiglionesi et. al (2010) investigate how increased financial integration affects financial intermediaries' incentives to hold liquidity. Under integration, banks hold less liquid assets, an effect which is stronger if there is less aggregate uncertainty. They assume the interbank market to be complete in the sense that they assume that all banks contract with all other banks. Leitner (2005) characterizes optimal networks. In his model, linkages create the threat of contagion, which allows agents to commit to help each other, but may also be the cause of collapse of the entire system. Hence linkages that create the threat of contagion may be optimal.

[13] See Brunnermeier and Pedersen (2009) on the distinction between funding and market liquidity.

the sale and repurchase market (the "repo" market) that was essential in financing the off-balance sheet vehicles used to securitize mortgages.

In the second wave, the interest rates at which banks were able to borrow money in the interbank market rose substantially. To prevent bankruptcy of their 'shadow banks' the banks that originally set-up these investment vehicles to arbitrage regulation had to step in and the risk of their off-balance liabilities materialized. Banks that were suspected of having a large exposure to these problems experienced runs in the wholesale market and the market for short-term debt. Such a run resulted in the failure of Bear Stearns, halfway march 2008. As uncertainty about the value of banks' securitised assets and their off-balance sheet liabilities grew, interbank interest rates started to rise. This created a lemons problem (Akerlof, 1974): although on aggregate it was clear that some banks should be in trouble, nobody knew exactly the exposure of individual banks to these risks. Lenders had to take into account that they might be lending money to a bank with toxic assets and increased their interest rates. Thus, the lemons problems in the interbank market reduced banks' ability to ensure liquidity through interbank lending.[14]

The failure of Lehman Brothers on 15 September 2008 triggered the final wave. When the US government refused to bailout Lehman Brothers, the interbank market froze completely. Banks were no longer able or willing to lend to each other. This posed great problems for banks that relied on the interbank market to roll over their short-term debt.[15]

In this section, we review the theoretical literature on market freezes and reduced liquidity. This literature identifies several mechanisms. Market freezes and reduced liquidity can arise as a consequence of fire sales, adverse selection, or liquidity hoarding. See also Tirole (2009) for a concise overview.

Fire sales

Fire sales arise if selling assets reduces the market price of these assets. This is also referred to as cash-in-the-market-pricing. The sale of assets may reduce prices because the number of potential buyers of assets is limited (Allen and Gale, 1998), because assets need to be sold to outside investors who are at a disadvantage in employing these assets (Shleifer and Vishny, 1992), or because buying more assets increases risk-aversion (Kyle and Xiong, 2001).

The central question now becomes how fire sales negatively affect other financial institutions. Problems may arise as a consequence of asymmetric information. Agency problems may lead banks to include a loss-threshold into their contracts with traders (Morris and Shin, 2004), or investors to withdraw their money when a fund's value falls below a certain level (Vayanos, 2004; Wagner, 2006). An initial drop in asset prices due to fire sales may then trigger

[14] Alternatively, the value of holding on to liquidity may have risen because of the prospect of future fire-sales or increased uncertainty about liquidity shocks.

[15] For those who want more detail, several excellent reviews exist of the sequence of events that created a situation where financial markets could only function with widespread explicit government support (Gorton, 2008; Hellwig, 2008; Calomiris, 2008; Brunnermeier, 2009; Greenlaw et al. 2008; Tirole, 2008)

further sell-offs by traders or fund managers of other financial institutions who try to pre-empt their competitors by selling their assets, lowering prices even further.

In a setting where traders create liquidity by smoothing intertemporal discrepancies in the demand for securities, traders' funding, i.e., the capital and the margins they are charged, may depend on market liquidity. Brunnermeier and Pedersen (2009) show that, if drops in assets market liquidity lead to increased margin requirements or losses on traders' positions and traders are margin constrained, a drop in market liquidity forces traders to reduce trading, reducing liquidity even further. Small shocks to market liquidity can thus feedback into higher margin requirements, resulting in a margin spiral.

Allen and Gale, in a series of papers (1994, 1998, 2000, and 2004) develop a liquidity-based approach to understanding financial crises. When financial markets are incomplete, financial institutions may be forced to sell assets if they face a liquidity shock. Because the liquid asset has a lower return than the risky asset, suppliers of liquidity have to be compensated for holding the liquid asset. They can recoup these costs if they can buy assets at fire sale prices when liquidity shocks hit. Fire sales are an equilibrium phenomenon, where the suppliers of liquidity recoup the opportunity costs of holding excess liquidity. Lower market prices, however, imply that more assets have to be sold in order to meet a particular liquidity needs. This inflicts a negative externality on other banks because it becomes more costly for them to recapitalize when they are hit by a liquidity shock. If enough banks are hit by a shock at the same time, the attempt to obtain liquidity may even be self-defeating and force banks into default.

In Wagner (2006), the fire-sale externality depends on how similar banks are. If banks assets are more similar, then the externalities are stronger. Not only does the probability that both banks have to liquidate assets at the same time increases because assets are similar, but the reduction in prices when fire sales occur will also be larger if both banks are in bad health than when one of the banks is in good health.

Incomplete markets are the driving force behind fire sales. Fire sales arise because banks are forced to sell assets to obtain liquidity. If financial intermediaries were able to contract liquidity contingent on the state of nature, they could prevent such forced sales and fire sales would not occur. Such contracting would be possible in complete markets. The incomplete market for liquidity therefore provides a clear rationale for government intervention.

Adverse selection

Other explanations of reduced liquidity depend on the presence of asymmetric information.[16] Shocks may exacerbate asymmetric information, thereby leading to higher prices or even a total drying-up of markets if the lemons problem becomes unmanageable. In Flannery (1996) shocks increase lenders' uncertainty on their own ability and that of other banks to assess whether they

[16] Cabalero and Simsek (2009) present a model where imploding assets prices increase the complexity of the banks environment: as more banks get into trouble, healthy banks need to understand more and more linkages. When knowledge about these linkages is imperfect, banks uncertainty increases as complexity grows.

are dealing with a good or a bad borrower. Lenders therefore face a winners' curse, which may become unmanageable in bad times.

Heider et al. (2008) focus on the credit risk problem due to asymmetric information about counterparty risk. If banks face liquidity shocks as well as shocks to the quality of their investment portfolios which are both private information, banks that want to lend money to other banks cannot distinguish between a solvent bank that needs additional liquidity and an insolvent bank trying to stay afloat. In such a setting, lending in the interbank market may be subject to a lemons problem. As the severity of the lemons problem increases, the interbank rate rises to a point where the market collapses completely. Their study, however, only explains ex post why markets may have dried up. It doesn't analyse why banks expose themselves to such a risk ex ante and whether such exposure might be optimal or not.

Bolton et al. (2009) study the evolution of liquidity crises in a setting where some investors face uncertain liquidity needs and may want to sell some of their assets. Potential buyers cannot tell whether a sale is due to a sudden liquidity need, or whether the investor is trying to sell a lemon. The asset owners learn more about the quality of their assets as time passes. Thus, the asymmetric information problem becomes worse over time. Investors therefore face a choice between selling early, thus avoiding the lemons problem, and betting on the probability that they will not face any liquidity problem, with the possibility of a much greater price discount in the future.

Dang et al. (2009) observe that a security's information sensitivity varies with the news arriving about the quality of the underlying asset or borrower. The value of debt is insensitive to new information if the prospects of repayment are favourable. A change in the quality of the underlying asset or borrower will not affect the value of debt much. In fact, Dang et al. (2009) show that debt is a least information-sensitive security. If the situation deteriorates, and the probability of default on the debt claim becomes considerable, additional information about the state of the underlying asset becomes valuable. A change in this value may then imply a change in the value of the security, and investors with sufficient capabilities have a strong incentive to acquire such information. As a consequence, the market becomes divided in informed and uninformed investors. In this way, the market for the security can switch from a liquid, symmetric information market where nobody has information on the quality of the security, because it doesn't matter anyway, to an illiquid market plagued with adverse selection, where some have information but others don't. In this sense, 'ignorance is bliss'. Morris and Shin (2009) present a similar argument.

Liquidity hoarding

Liquidity has features of a common good. Indeed, creating liquidity may benefit other financial intermediaries. In Bhattacharya and Gale (1987) banks insure against liquidity shocks through an interbank lending market, but the composition of liquid and illiquid assets in each bank's portfolio as well as the size of each bank's liquidity shock are private information. A bank may

meet depositor withdrawals by keeping excess cash or by selling claims to other banks with excess cash. Since liquid assets yield lower returns, banks under-invest in liquid assets and free ride on the common liquidity pool. Hence, even in the presence of an interbank market, there can be aggregate liquidity shortages.

A related line of thought is explored by Diamond and Rajan (2005), who explore a model where banks experience a liquidity shock because projects' payouts are delayed. To make up for the temporary shortage, banks can choose between attracting new deposits by increasing interest rates and liquidating outstanding loans. Attracting depositors merely reallocates cash from one bank to another. Only liquidating outstanding loans increases aggregate liquidity but in an inefficient way. Although it creates immediate liquidity, it produces only a fraction of the outstanding amount. In addition, increasing the interest rate also decreases the value of banks' assets, because it decreases the present value of the cash flows generated by these assets. Therefore, before banks collectively have enough incentive to produce the desired amount of aggregate liquidity, other banks may become insolvent. The ensuing bank run on the insolvent bank may further increase the liquidity shortage since all assets are liquidated early in an effort to create immediate liquidity.

Diamond and Rajan (2009) argue that bank management facing a liquidity shock will refuse to sell assets at fire sale prices, because, conditional on the bank's survival, the price of the asset will also recover. Even though bank management can take precautionary measures by selling illiquid assets, they prefer holding on to these assets because the states in which the depressed asset value recovers are also the states in which the bank survives. At the same time, the prospect of a future liquidity shock makes excess cash more valuable because it can be used to buy assets at fire sale prices when the liquidity shock hits.[17] By refusing to sell the illiquid asset, the bank's management shifts risk to a third party, in this case their debtholders.

Holmström and Tirole (2009, chapter 7) present a model where banks hoard costly liquidity in order to overbid rivals in the market for distressed assets. Banks with sufficient cash, instead of buying assets of distressed institutions at fire-sale prices now, prefer to wait because they expect to be able to buy them at even lower prices in the near future.

Acharya, Gromb and Yorulmazer (2008) focus on issues arising due to market power and strategic behaviour of liquidity-surplus banks. They investigate what happens if (i) surplus banks that provide liquidity have market power, (ii) there are frictions in the lending market due to moral hazard, and (iii) assets are bank-specific. They show that when the outside options of needy banks are weak, surplus banks may strategically under-provide lending, thereby inducing inefficient sales of bank-specific assets.

[17] Allen,et al. (2008) argue that if interbank markets are incomplete and banks are unable to hedge the idiosyncratic and aggregate liquidity shocks that they face, situations where banks stop trading with each other can be constrained efficient.

3.3 Information spillovers

Shocks can also spread from bank to bank through informational spillovers. For example, bank runs can spread because a run on one bank implies information about other banks that allows rational agents to update their beliefs. More generally, one bank's problems may generate adverse information about other banks. This can be information about the intensity of monitoring, the value of assets if correlations in underlying value across banks exist, or the existence of an aggregate liquidity.

Suppose that the value of assets is correlated across banks and some depositors are better informed than others about the value of bank assets. Informed depositors can withdraw early when a bank's assets are insufficient to repay all depositors. Uninformed depositors realize this and therefore respond to information about early withdrawals. Failures of other banks can be one such information source (Chen, 1999).

Aghion et al. (2000) consider a free banking system with an interbank loan market facilitated by a central clearing house, where the cash flow realization of each bank is private information and interbank loan offers can not be made contingent on aggregate liquidity. If there is no aggregate liquidity shortage, no failure occurs because other banks can always serve a bank with a shortage. A failure of one of the clearinghouse members thus signals an aggregate liquidity shortage. This may then trigger a run on all the banks in the system.

In Rochet and Tirole (1996) peer monitoring is valuable to control bank moral hazard, but it also introduces a link between banks that may allow a crisis to spread from one bank to another. If one bank fails, creditors assume that other banks have not been properly monitored and a general collapse occurs.

In Acharya and Yorulmazer (2003) banks endogenously choose to hold correlated portfolios because regulators cannot commit not to intervene if too many banks fail at the same time. When bank loan returns have a systematic factor, the failure of one bank conveys adverse information about this systematic factor and increases the cost of borrowing for the surviving banks. This increases the likelihood of joint failure.

Increased homogeneity of banks' balance sheets increases the probability of a joint failure of financial institutions, because it increases the potential externalities on other banks from an individual bank's liquidity problems. Because a shock is more likely to affect multiple banks at the same time, fire sales will be stronger and problems will propagate faster throughout the financial sector. This suggests that encouraging diversity among financial institution may decrease systemic risk (Wagner, 2009).

3.4 Empirical evidence

In this section, we survey the existing empirical literature on systemic events and systemic crises, focusing on empirical analyses of contagion. We divide the studies into micro-level studies which either use balance sheet or payment system data to run simulations and studies that try to infer contagion from market data and use different types of systemic events as an identification mechanism in a regression analysis.

One obvious shortcoming of the whole literature on contagion is the inability to distinguish between the effects of contagion and simple interdependence. Much of the current literature on banking crises and contagion often confounds the effects of real side interdependencies, such as trade links and financial system integration with the effects of "real contagion" (Karolyi, 2003). Future studies, using data on the current crisis will be very helpful in addressing this problem.

3.4.1 Micro-level simulation studies

In general, the simulation literature on banking crises focuses on the potential risk of a banking failure due to contagion. A commonly used empirical methodology to assess financial sector linkages is the network approach which tracks the reverberation of a credit event or liquidity squeeze throughout the banking system via direct linkages in the interbank market. One set of studies focuses on contagion due to balance sheet connections; another set assesses contagion due to connections through the payment system.

The first group of studies use the balance sheet of banks or information from credit registers and simulates the effect of a failure of the largest interbank participant. Some estimate optimal exposure of interbank market participants, others use accounting data. Sheldon and Maurer (1998; United kingdom), Furfine (2003; US), Cifuentes (2003; Chile), Upper and Worms (2004; Germany), Wells (2002; 2004; United Kingdom), Krznar (2009; Croatia), Lelyveld and Liedorp (2006; the Netherlands), Memmel and Stein (2008; Germany), Lubloy (2005; Hungary), Amundsen and Arnt (2005; Denmark), Mistrulli (2007) and Duggar and Mitra (2007, Ireland) measure the level of contagion by simulating the consequences of an individual bank failure given observed or estimated interbank exposures and look at the potential domino effects. The general conclusion of this set of studies is that although the impact of contagion on banking sector default differs between countries and domino effects through interbank credit exposures are possible, the likelihood of large scale banking defaults caused by contagion is relatively small.

However, these studies only focus on the direct effect of contagion and not on the contagion effect through other channels, for example contagion through information spillovers. According to Degryse and Nguyen (2007) the default of some large foreign banks has the potential to trigger significant domino effects in Belgium. The studies mentioned above neglect this aspect. Blavarg and Nimander (2002) conclude that the risk of contagion from abroad in the Swedish banking system mainly arises from foreign exchange settlement exposures. In a number of cases

a loss due to failure of a foreign counterparty of a Swedish bank pushes its capital ratio below the regulatory level. Thus, it is important to take into account such cross-border effects.

Several other studies have tried to simulate the occurrence of contagion by assessing the impact of the failure of a bank in the payments system. This strand of literature makes use of data from large value payment systems. For instance, Furfine (2001) uses Fedwire data to show how the failure of the largest banks in the US payments system would affect the liquidity position of its counterparties. Northcott (2002) follows a similar strategy to assess the likelihood of contagion in the Canadian Automated Clearing Settlement System (ACSS). After examining various scenarios, she concludes that the risk of contagion in the ACSS is very limited. The general conclusion that can be drawn from these simulation studies is that it is difficult to induce large-scale operational contagious banking failures through a default in the payments system or interbank market.

Some studies combine these two approaches. Elsinger et al. (2006) simulate the joint impact of interest rate shocks, exchange rate shocks, and stock market movements on interbank payment flows of Austrian banks. Their simulations indicate that although the likelihood of contagious default is low compared to the total default probability, there are situations in which the majority of the defaults are due to contagion when there is a combined high level of market risk and credit risk. Müller (2006) combines a network and a simulation approach to assess the risk of contagion in the Swiss interbank market and takes account of credit and liquidity effects in bank contagion. He concludes that there is substantial potential for contagion particularly in centralized markets. However, a lender of last resort intervention could reduce spillover effects considerably. These studies indicate that, although the risk of domestic contagion is relatively small, there are large differences between countries in the exposure to potential foreign contagion risk.

Several caveats apply. First, to the extent that detailed information on banks' bilateral exposures is not available, these methodologies make assumptions on the network of interconnections. For example, they may assume that each bank is connected to every other bank. This may be quite different from the actual structure. Consequently, the findings of interbank simulation studies depend on these assumptions and tend to underestimate the risk of contagion (Mistrulli, 2007). Second, these studies do not allow for bank recapitalisation. Such recapitalisation will act as a cushion to soften the shock. These studies may therefore also overestimate a shock's effect. See Nguyen (2003) for issues regarding underestimation or overestimation. Finally, all these studies neglect the existence of externalities of a banking failure. Information spillovers could lead to a domino effect through bank runs or liquidity can dry up be because it may be uncertain which banks are in trouble.

3.4.2 Micro-level event studies

An alternative approach to study contagion risk is to try to measure contagion from market data such as stock prices or credit-default swap spreads. However, studies differ as to what they define as systemic events. Some studies look at extreme variations in prices and define a systemic event as the tails of the distribution of returns. Other studies only look at events where banks failed.

A first group of studies tries to identify contagion from information on historical tail-risk events. One approach focuses on tail-betas and measure the covariation between different banks' share price conditional on a large drop in share prices. The resulting correlation matrix then allows one to derive predictions about individual banks values conditional on a crash in a banking index (see e.g. Hartmann et al., 2006). Gropp et al. (2006) find evidence for both domestic and cross-border contagion within Europe, although domestic contagion seems to dominate cross-border contagion. However, the effect of foreign contagion has increased after the introduction of the euro, which created a more integrated money market. Acharya et al. (2008) use the Marginal Expected Shortfall (MES), which is defined as the average loss by an institution when the market is in its left tail. Adrian and Brunnermeier (2009) introduce a banks CoVaR. This is defined as the Value-at-Risk (VaR) of financial institutions conditional on other institutions being under distress. They claim that the increase of CoVaR relative to VaR measures spillover risk among institutions.

The second set of studies use real-life systemic crises to identify the contagion effect of a banking failure. Some of these event studies test for correlation in bank failures. In general, these studies regress the number of bank failures in some period on the number of bank failures in a later period, provided that all macroeconomic shocks are effectively covered by the control variables. A positive and significant coefficient indicates that bank failures lead to contagion. However, since the safety net provisions in modern financial systems, such as deposit insurance schemes and lender of last resort facilities tend to prevent such a domino effect, these studies are restricted to historical periods of the US when deposit insurance was absent (Brandt and Hartmann, 2000). The empirical results of Grossman (1993), Hasan and Dwyer (1994), and Schoenmaker (1996) all indicate that there was significant contagion within banking failures in the 19th and the beginning of the 20th century in the US. However, Hartmann and Brand (2005) criticize these results. By controlling the correlation for a large set of macroeconomic factor it creates multicolinearity in these factors. Also there is an endogeneity problem which indicates that the relationship between the correlation of bank failures and the macroeconomic factors is probably driven by a third variable. As a result the evidence on contagion is inconsistent. and therefore not convincing.

A different approach to examining contagion in the interbank market during banking a crisis is to compare the normal stock return of a bank to the actually observed returns at the announcement date of the 'bad news' or during a window around this date. The hypothesis is that when there is a failure of bank A the stock price of bank B will react if contagion exists.

Aharony and Swary (1983) analyze the three largest bank failures in US history (Franklin National Bank of New York, US National Bank of San Diego and the Hamilton National Bank of Chattanooga) in an attempt to detect contagion effects on the performance of the banking industry and the economy as a whole. The analysis uses the share prices of three solvent bank groups of different size and of each failing bank to measure their abnormal performance in the weeks surrounding each bankruptcy date. Critical events related to each bank failure are detected for this purpose. A distinction is made between bank failures that might have been caused by adverse activities whose revelation is assumed to be uncorrelated across banks (e.g., fraud) and failures caused by problems common to many banks in the industry. They conclude that the data does not support the 'pure contagion effect' hypothesis.

In contrast, Swary (1986) does find evidence for contagion in the interbank market as a reaction to the Continental Illinois crisis, in terms of both stock price movements and trading activity, especially for the group of banks with a low rate of solvability. Such market reaction could reflect either a bank-run effect or an adjustment to new information revealed in the crisis. The evidence seems to be consistent with investors' reaction in an efficient market that operates under imperfect information and might indeed have led to a bank run and, hence, to a kind of domino effect.

Wall and Peterson (1990) provide evidence consistent with the argument that the bailout weakened market discipline. They evaluated daily returns during the week in which Continental failed, whilst controlling for developments in the Latin American loan market during that week. They find no contagion effects on abnormal returns of other banks. Instead, banks that were heavily exposed to Continental had positive abnormal returns when the government announced a full guarantee of all Continental creditors.

Lamy and Thompson (1986) and Peavy and Hempel (1988) examine contagion effects caused by Penn Square's failure, with mixed results. According to Lamy and Thomson (1986) the failure and subsequent liquidation of Penn Square was interpreted by the market as a conformation of an underlying change of risk of the banking system as a whole. In contrast, Peavy and Hempel (1988) conclude that the market viewed the Penn Square failure as an isolated event that did not significantly affect banks in other regions. .Dickinson et al. (1991) also fail to find evidence of contagion effects arising from the failure of First Republic Bank.

The studies listed above are based on contagion within the US banking system. Other studies include Gay et al. (1991), who investigate the failure of Hong Kong banks, and Jayanti et al. (1996), who investigate the failure of a British bank and two Canadian banks. Gay et al. (1991) find evidence of contagion effects, which they attribute to the absence of an explicit deposit insurance scheme in Hong Kong. Jayanti et al. (1996) focus on the failure of two Canadian banks: Canadian Commercial Bank and Northland Bank. Canadian regulation is relatively stringent, and a deposit insurance scheme operates. The authors find some evidence for significant contagion and conclude that the market is more likely to react negatively when increased regulations are proposed in the wake of a failure. They also examine the failure of the

British bank Johnson Matthey Bankers (JMB) Limited, but fail to find any significant contagion effects in the UK banking sector (Kanas, 2004).

An alternative way for estimating systemic risk is by measuring the tail risk of a bank. The most common used tail risk approach is the value at risk measure which is defined as the risk of a loss over a given period and portfolio with fixed confidence levels[18]. According to Wagner (2009) one major problem of this measure is that it cannot calculate losses larger than the Value at Risk. An alternative measure is to calculate the distance to default. The distance to default is defined as the number of standard deviations by which the expected asset value exceeds the default point.

However, one large disadvantage of the distance to default and VaR measure is that is assumes that banks are working in isolation. These measures do not take into account the direct and indirect linkages of banks at the interbank market. Therefore, Adrian and Brunnermeier (2009) propose a VaR of the financial sector as a whole.

An alternative to these tail risk measures is to estimate the tail-betas (Heartmann et al., 2006). In general this methodology estimates the correlation between assets of various banks at the right tail using data from days where stock market prices have fallen abnormal. In contrast, Acharya et al. (2008) uses the expected shortfall instead of the correlation between the assets to calculate the default risk.

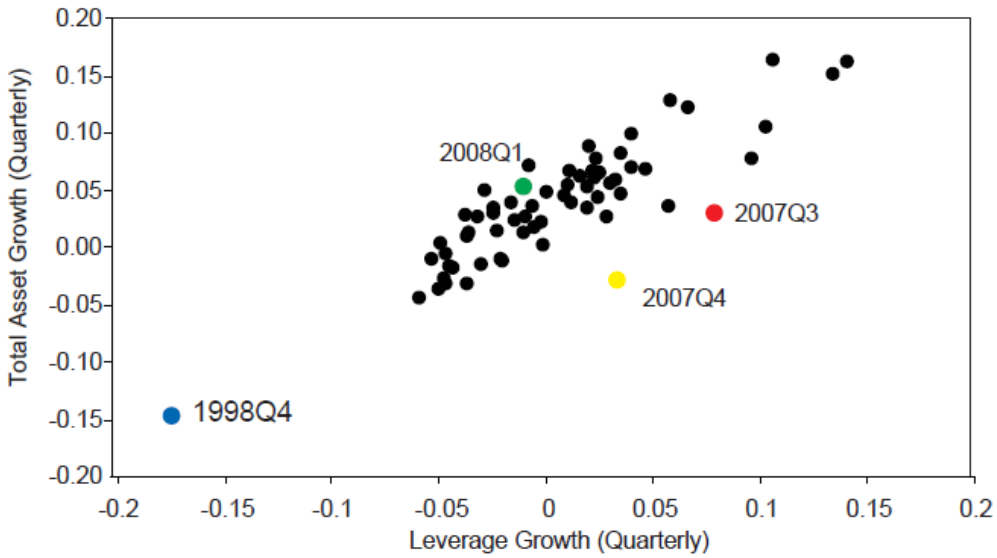
[18] For an extensive survey on Value-at-Risk models see Jorion (2006)

4 Procyclicality

The previous section dealt with the mechanisms of contagion within the financial sector. Just as important, however, is the question of how fluctuations in the financial system and the real sector may reinforce each other, i.e., how credit growth and banks' risk taking can amplify the business cycle and vice versa. This is referred to as procyclicality.

Figure 4.1 shows how leverage growth and total asset growth are correlated. Banks seem to increase their leverage when the value of their assets increases. During an upswing procyclicality may cause banks' balance sheets to become excessively risky, making banks more susceptible to shocks.[19] If a banking crisis hits or a recession occurs, procyclicality may result in a particularly severe economic downturn. Suppose that the quality of banks' assets deteriorates in a downturn. This raises capital requirements, which forces banks to cut back on lending, reinforcing the downturn. As, banks are forced to reduce leverage firms' ability to lend is reduced lowering their level of investment and their market value, and increasing their default probability. To the extent that banks are exposed to these firms declining value, their assets may further deteriorate.

Figure 4.1 **Quarterly Changes in Assets and Leverage of US Investment Banks (Source: Greenlaw et al., 2008)**



Several potential driving forces of procyclicality exist (for an overview see Borio et al, 2001). First, regulation can drive procyclicality. Capital requirements are proportional to the risks on banks balance sheets. However, measurement difficulties may result in excessively low risk estimates in good times and overly high-risk estimates in bad times. Capital requirements may

[19] However, it is important to realize that procyclicality does not necessarily imply excessive risk taking. For example, in a boom the productivity of assets is high whereas the default risk is low, thus the socially efficient level of investment increases.

induce procyclicality results if under- or overestimates are not corrected for. Fair value accounting can pose problems if assets' market values no longer reflect fundamentals. This may happen, for example, when asset bubbles emerge, when markets freeze and become illiquid, or when herding causes investors to neglect fundamentals.

Second, the informational asymmetries that lie at the root of credit rationing may result in procyclicality. Because the level of credit rationing inversely depends on firms' future prospects, the level of credit rationing decreases during an upswing. This fuels investment and strengthens the upswing. During a downturn, however, the level of credit rationing increases, reducing investments and reinforcing the downturn. In the literature, this is known as 'financial acceleration'.

Third, in financial markets rational herding and cognitive biases may increase volatility, lead to greater correlations in asset portfolios, and reinforce asset bubbles. Reputation concerns may lead banks to rationally ride a bubble, because it may be better to fail collectively.

4.1 Effects of regulation

4.1.1 Capital adequacy rules

An important rationale for capital regulation is to decrease excessive risk taking by banks. Capital requirements are thus proportional to the risks on banks balance sheets. In order to set capital correctly, regulators have to measure the risks on banks' balance sheet. When risk regulation requires banks to hold a higher capital ratio during economic downswings, reflecting the increased potential credit losses in their portfolios, they may respond by reducing credit. This response reduces investment and consumption, thereby intensifying the downturn. This then feeds back into the banks' balance sheets, further raising capital requirements, etc.

These feedback mechanisms occur if some conditions are met. First, capital requirements should be binding, i.e., banks capital levels are not substantially above the minimum regulatory level, higher capital requirements then force banks to increase their capital ratios. If banks are forced by market discipline to hold substantially more capital than required, they will not have to raise capital if the regulator risk weights increase. Second, banks should be unable to meet these higher requirements by issuing new equity, or selling liquid assets. Only then will they stop extending credit. Finally, reduced bank credit does not necessarily imply that firms are cut-off of credit. Other sources of financing, for example private equity or corporate debt markets, may be available. If firms are then unable to switch to such alternative sources of finance, the shrinking availability of bank credit will reduce investment and strengthen the recession.

In 1988 the so-called Basel I accord was introduced which included regulations on bank capital. Basel I introduced a minimum capital requirement equal to 8% of banks' risk-weighted total assets. Risk-weighted assets were computed by assigning to each asset category a fixed weight according to presumed degree of risk. In 2008 a new Basel Capital Accord was implemented, Basel II. Because it strengthens the link between risk exposure and capital

requirement this reform of the 1988 Basel Accord has been criticized for potentially making bank lending more procyclical than Basel I: more risk-sensitive capital requirements will respond stronger to changing risks of banks' assets.

Under Basel II, Capital requirements can be computed using two different approaches: the standardised approach and the internal ratings based approach. Whether or not capital requirements are procyclical, depends on how the key input parameters in the two approaches move through the cycle.

The Standardised Approach assigns varying risk-weights to claims on corporates, banks and sovereigns. However, in contrast to Basel I, it provides for greater risk-sensitivity by varying the weights with the external rating assessments of credit risk. This generates procyclicality if the weights increase in downturns, reflecting the deterioration of ratings, and decrease during expansions. Whether generates procyclicality depends on whether the external ratings move with the cycle.

In principle, external credit ratings are measured on a `through-the-cycle' (TTC) basis instead of a 'point-in-time' (PIT) basis. The estimated probability of default should then be based on the probability of default in a downward scenario. The rating will only be adjusted when the prospects of the company or the downward scenario are changed. Hence, this type of rating should produce relatively stable ratings over the cycle and hence mitigate procyclicality. Amato and Furfine (2003) conclude that only investment grades or initial ratings of new established companies co-move with the business cycle.

Second, in the Internal Rating Based (IRB) approach banks provide their own risk estimates.[20] In the Internal Ratings-Based approach banks have to calculate the capital requirement of loans based on four variables: (1) probability of default (PD)[21]; (2) exposure at default (EAD)[22]; (3) loss given default (LGD); and (4) maturity of the loan (M). The PD estimation induces procyclicality because default rates are strongly correlated with cyclical conditions. In the case of the advanced IRB approach, Basel II establishes that banks, in estimating the parameters relevant to capital requirements, must consider borrowers' ability to repay the loan under current conditions but also in potentially adverse cyclical conditions, using data for long enough periods. In other words, the spirit of the regulation requires banks to follow a TTC estimation approach. This should in principle reduce the potential procyclical nature of the PD parameter. According to Panetta et al. (2009) there are some reasons why banks often fail to conform to this spirit, so that all these parameters may end up playing a role

[20] The regulatory framework recognizes two types of internal rating systems. These are the foundation approach and the advanced approach. At the foundation level banks only estimate the PDs while the regulator determines the other factors. At the advanced level a banks estimates all four parameters.

[21] Basel II specifies that the probability of default can be estimated by three different techniques: (i) banks' internal default experience; (ii) statistical default models; (iii) mapping banks' internal ratings onto external ratings.

[22] While for balance sheet items the EAD is a known value, the advanced IRB approach requires banks to estimate EAD for off-balance-sheet items as well. The rationale is that borrowers in trouble tend to have greater recourse to unused credit facilities, so that banks' actual exposure in case of default is likely to exceed the current value of the loan (See also Allen and Saunders, 2003).

in terms of procyclicality. First, the PIT approach is often preferred to the TTC approach because it is easier to implement. Furthermore PDs are not regularly updated and recalibrated but only when the whole system is overhauled, which tends to be associated with cyclical fluctuations. Segoviano and Lowe (2002) present evidence that the implementation of IRB in Mexico caused a cyclical movement of the bank reserves.

As for PD, the Basel II framework requires banks to use prudent and a-cyclical LGD estimates. There is some evidence that collateral values and recovery rates on corporate bond defaults fall in economic downturns. Taylor and Goodhart (2004) argue that for the US market in recessions bond recovery rates may fall up to 25 percentage points from their average non-recession value. They also argue for bank loans that recovery rates are higher in expansions and that the cyclical variations consist in a sharp increase of LGD in recessions, not a reduction in upturns. Acharya et al. (2004) conclude that industry conditions are the primary driver of LGDs. Nevertheless, in a recession many industries are likely to be in weak condition and a bank, with exposure to a range of sectors, is thus likely to experience cyclical movements in LGD levels.

Finally, the dependence of capital requirements on loans' maturity can also induce pro-cyclical effects. During an economic downturn, exposures become de facto less liquid, because borrowers have trouble repaying the loans. Besides, banks tend to reschedule loans to counterparties in temporary difficulties but with good medium-term growth potential. Both effects lengthen the maturity of the loan portfolio and therefore increase capital requirements (See also Gordy and Howells, 2004). According to Bouvatier and Lepetit (2007) and Bikker and Metzemaker (2004) loan loss provision is higher when GDP growth is lower. This negative correlation indicates that there is procyclicality present caused by a fast growth of buffers during a downturn forcing banks to reduce lending.[23] Similarily, Salas and Saurina (2002) and Pesola (2001) find that the provisioning and quality of loans is significant positive related with the business cycle.

4.1.2 Fair value accounting

In response to the financial crisis, international accounting standard setters have been considering whether to move towards or away from uniform reporting of all financial assets at fair value.[24] Fair Value Accounting (FVA) involves reporting assets and liabilities on the balance sheet at fair value and recognizing changes in fair value as gains and losses in the income statement. The International Financial Reporting Standards (IFRS) define fair value as the amount for which an asset could be exchanged, or a liability settled, between

[23] See also Cavello and Majnoni (2002), pain (2003) Arpa et al. (2003, Bikker and Hu (2002) and Laeven and Majoni (2003) which reach similar conclusions.

[24] The EU oriented International Accounting Standards Board (IASB), an independent and privately-funded standard setting body based in London, that develops the IFRS-standard and the US based Financial Accounting Standards Board (FASB) that develops US-GAAP standard.

knowledgeable, willing parties, in an arm's length transaction. The US Generally Accepted Accounting Principles (US-GAAP) use a similar phrasing in its accounting standard IAS 39.

When market prices are used to determine fair value, FVA is also called mark-to-market accounting. Note that FVA differs from pure mark-to-market accounting, where assets are always recorded at market value. Current accounting rules allow banks to deviate from market prices under certain circumstances, for example when market prices no longer reflect an assets fundamental value. In that case, a bank should use valuation techniques and all relevant market information that is available so that these valuation techniques maximize the use of observable inputs (IAS 39). This may imply significant adjustments to an observed price in order to arrive at the price at which an orderly transaction would have taken place (e.g., IASB Expert Advisory Panel, 2008).

Critics of FVA argue that it increases the procyclicality of the financial sector, and thus also the negative externalities from individual banks' risk choices. The main point is that market prices can be distorted by market inefficiencies, investor irrationality or liquidity problems, and that FVA causes changes in these distorted prices to be reflected immediately in banks' balance sheets and profit and loss accounts.[25]

During booms FVA and asset write-ups allow banks to increase their leverage, which feeds back into real economic activity. The mechanism works in reverse in a downturn: the immediate recording of fair value reduction on assets reduces banks' capital base, hence their lending and their demand for securities. As a result, the financial system becomes more vulnerable and financial crises more severe (see e.g., Persaud, 2008, or Panetta et al., 2009).[26]

In addition, the critics claim that FVA can lead to contagion. If a shock hits some banks, these may be forced to sell assets in order to recapitalize. If this induces fire sales, i.e., prices below the fundamental value of an asset, FVA requires other in principle healthy institutions to mark their assets to market. These may then be forced to sell assets as well, triggering a negative feedback spiral.

Proponents of FVA argue that, while concerns about pure mark-to-market accounting in times of financial crisis may be legitimate, FVA as stipulated by the accounting standards IFRS or US GAAP allows deviations from marking-to-market precisely in those circumstances where this may have adverse consequences. Indeed, when fire sales occur and market prices no longer reflect fundamentals, banks may deviate from mark-to-market and instead mark-to-model.

A popular alternative to FVA is Historical Cost Accounting (HCA), which uses the price paid for the asset at the time of its acquisition for balance sheet purposes. According to many banks HCA is superior to FVA. They claim that an asset's market price does not reflect the expected value to the bank accurately. Historical Cost Accounting, however, comes with its

[25] In a world of complete and perfect markets, reporting market values of a firm's assets would be optimal but also superfluous because there would be no consequences for the firm's commercial decisions.

[26] Taylor and Goodhart (2004) list several other features of the specific way that current accountancy rules implement FVA may also increase financial sector procyclicality. Using market estimates of risks, treating of liabilities mostly at cost and the effect of changes in the valuation of goodwill.

own set of problems. For instance, HCA may provide incentives engage in what is known as "gains trading", i.e., selectively selling financial instruments with unrealized gains and keeping those with losses. Because the gains show up in the profit-and-loss statement, but the losses do not, this artificially inflates accounting profits. The concern about banks' ability to engage in gains trading was a major impetus for introducing FVA for financial instruments (e.g., Wyatt, 1991; Schulz and Hollister, 2003).

As a consequence of HCA, the absence of accurate information could reduce banks' ability to finance themselves in good times, if there is no credible alternative for conveying information about a bank's health to the market. Moreover, as long as market prices accurately reflect the fundamental value of assets, lack of transparency under HCA could make matters worse during crises. An important factor in the freezing of the interbank market was the absence of information on banks' exposure to the subprime problems. FVA may provide important information to the market. In addition, the absence of accurate information facilitates regulatory forbearance as regulators can more easily allow insolvent banks to continue operating.

Several papers have tried to model the role of fair value accounting theoretically. Allen and Carletti (2008) argue that regulatory capital requirements for banks based on fair-value accounting measures can lead to contagion. As liquidity dries up, cash-in-the-market-pricing causes prices to drop below their net present value. When FVA is used, the changes in market prices directly affect the value of banks' assets. This can force banks to inefficiently sell part of their assets at fire sale prices, or in extreme cases even lead to insolvency. Gorton, He and Huang (2006) study the effect of compensation schemes for traders in principal-agent relationships. They examine when marking-to-market is part of an optimal contract. They note that trader behaviour will affect prices, which in turn will affect the marked-to-market value of their position. Traders may then rationally herd, trading on irrelevant information, causing asset prices to be less informative than they would be without marking-to-market.

Although these studies identify a market failure that can justify government intervention, i.e., incomplete contracts and herding, a drawback is that they do not incorporate the costs of alternative accounting measures such as historical cost accounting. Plantin et al. (2008) try to model the trade-offs between the drawbacks of HCA and those of FVA. A historical cost regime is insensitive to forward looking market prices. This induces inefficient sales due to gains trading. Marking to market uses market information, but this leads to distortions for illiquid assets. They argue that a historical cost regime may dominate the mark-to-market regime from a welfare perspective when assets have a long duration, trade in a very illiquid market, or feature an important downside risk.[27]

In addition, some papers try to calibrate the effect of fair value accounting. The simulation analysis of Enria et al. (2004) of the extension of full fair value accounting to European banks

[27] An interesting question is the economic rationale for government intervention in accounting rules. Why is a mandated disclosure rule combined with self-regulation not sufficient for obtaining an optimal accounting regime? If accounting is a way to credibly reveal information to investors, one might expect firms to be able to commit to optimal schemes without government intervention.

finds the potential for pro-cyclical effects and an increase the volatility of banks' balance sheets. However, they also present empirical results on the effect of introduction of the Capital according to which banks' trading books should be marked-to-market. They look at five EU countries: France, Germany, Italy, Spain and the United Kingdom and find no effect on the volatility of banks' equity returns.

An important empirical question that has not been addressed yet is what role FVA has played in spreading the current crisis. Nevertheless, some studies have tried to measure empirically other effects of fair value accounting. Huizinga and Laeven (2009) show how banks used accounting discretion to overstate the value of their distressed assets. Banks have considerable discretion as regards the classification of assets, valuation techniques and the treatment of loan losses. Huizinga and Laeven claim that this may lead to inaccurate information in times of a financial crisis, which they argue may facilitate regulatory forbearance.

A relevant piece of the puzzle would be that prices were at fire-sale levels and that these low market prices negatively affected healthy banks. Interestingly, Laux and Leuz (2009) observe that banks have not put forward evidence that prices were distorted during the crisis and that this forced them to sell assets, even though banks are in the best position to provide such evidence.

The discussion on what accounting measures to use has been around for some time, and will be around for some time to come. An important issue, however, that deserves more attention is why the difference between HCA ad FVA matters at all. If the information disclosed on the type of assets on the balance sheet is similar, investors can figure out themselves what these assets would be worth under HCA or FVA. This would suggest that from the perspective of a bank's financiers, the difference between the two approaches is immaterial.

4.2 Financial acceleration

A large (macroeconomic) literature has developed the idea that imperfections in financial markets can amplify the business cycle through the availability of bank credit, generally referred to as financial acceleration.[28] In other words, how financial markets may amplify the consequences and increase the persistence of shocks to the economy.

At the hart of this connection between financial markets and the real economy lies credit rationing. In the seminal work of Stiglitz and Weiss (1981) credit rationing arises due to adverse selection. Suppose that lenders face a population of borrowers with investment projects that differ in riskiness. Because of limited liability the borrower bears none of the downside risk. This implies that for a given expected return on a project a borrower's expected payoff increases with increasing risk. Higher interest rates lower the net present value of both safe and

[28] The connection between financial markets and the real economy through banking credit gives rise to the 'credit view', as opposed to the 'money view' of the monetary transmission mechanism.

risky projects, but the expected payoff of a borrower with a safe project becomes negative at lower interest rates than the payoff of a borrower with a safe project. Raising the price of a loan will then attract borrowers with more risky projects. Because the bank bears all the downside risk, the bank chooses to ration credit instead of raising interest rates.

Alternatively, credit rationing may arise because of moral hazard (Bester and Hellwig, 1987), because the quality of projects is unknown and can only be verified by costly state verification (Townsend, 1979, Williamson, 1987), or because of limited commitment possibilities due to the inalienability of human capital (see Tirole, 2006 or Freixas and Rochet, 2008).

In all these cases lenders must be compensated for the agency costs that arise due to asymmetric information. These agency costs introduce a wedge ("the external finance premium") between the cost of funds raised externally and the opportunity cost of funds internal to the firm. By co-investing own funds or pledging collateral, firms can credibly signal the quality of their investment or internalise the costs of moral hazard. Thus, changes in the value of collateral, or the distribution or amount of firm capital will affect the amount of money firms are able to borrow. In this way, imperfections in financial markets can propagate or amplify shocks through the economy.

The basic mechanism of financial acceleration is that during an economic expansion asset prices rise, increasing the value of available collateral and the level of pledgeable income. Higher collateral values and higher pledgeable income increase the availability of credit, which feeds back on the real economy, enhances growth and results in a further increase in asset prices. To the extent that borrowers' net worth is procyclical (because of the procyclicality of profits and asset prices, for example), the external finance premium will be countercyclical, enhancing the swings in borrowing and thus in investment, spending, and production.

Several key papers that use this mechanism in some form to connect the real economy with financial markets are Bernanke and Gertler (1990), Carlstrom and Fuerst, (1997) and Kyotaki and Moore (1997). For an overview of the literature, see Bernanke, Gertler and Gilchrist (1998).

In Bernanke and Gertler (1990), entrepreneurs need to borrow funds because they have insufficient own resources to finance an investment themselves. An entrepreneur can perform a costly evaluation of his investment project ("screen the project") to learn how risky it is, but has no credible way to communicate this information to the lender. A lender is therefore faced with an adverse selection problem. Because borrowers are protected by limited liability, they will select investment projects that are too risky. How much more risky depends on the level of their own funds they have co-invested. As a result, in equilibrium the amount of investment spending and its expected return will depend on the net worth positions of borrowers.

The model of Kiyotaki and Moore (1997) adds feedback through asset prices, resulting in an intertemporal multiplier effect and is based on control over assets instead of costly verification of project returns. In their model lenders can only enforce lending contracts by their claim on the collateral of borrowers. Hence, the maximum amount borrowers can lend is determined by

the value of their collateral, i.e., their capital goods used for production. At the same time, the value of collateral depends on aggregate credit supply. So in this model collateral values, borrowing, and output are interdependent. Any change in the value of collateral will therefore get amplified: a reduction in asset prices will result in less borrowing, which leads to less investment, reducing future income and net present value, and therefore further reducing investment. The mechanism works in the opposite direction during upswings.

Thus far, however, the literature discussed does not incorporate financial intermediaries. In the models discussed, loans are made directly between an investor and an entrepreneur. Financial intermediaries, however, can reduce the scope for moral hazard by more intense monitoring, and thus reduce the need for collateral. Because monitoring is a partial substitute for collateral, incorporating financial intermediaries into the analysis will affect the way in which shocks propagate from the financial to the real sector and vice versa.

One of the few contributions that study the relation between financial markets and the real economy that does include financial intermediation is Holmström and Tirole (1997). They present a static model where both the borrowing capacity of firms and the monitoring capacity of financial intermediaries are limited because of moral hazard. Hence a redistribution of capital across firms, intermediaries and uninformed investors will impact investment, monitoring and interest rates.[29] They investigate the effect of an exogenous shock to monitoring capital, firm capital or investment capital on investment, monitoring and interest rates. In future analysis this type of model will be important in linking the real sector with financial markets. Because of the static nature of their model, however, they can not address propagation or feedback mechanisms.

4.3 Cognitive biases, herding and bubbles

4.3.1 Cognitive biases

Cognitive biases are psychological phenomena that refer to systematic errors that people make in the intuitive judgment of probability. Some of these biases can enhance the procyclicality in the financial system. The most relevant biases for procyclicality are disaster myopia, cognitive dissonance and overconfidence.

Disaster myopia refers to the way in which people estimate probability of events that are unlikely to occur (Bazerman, 2002). In general, research shows that people tend to underestimate the probability of such events occurring, and when they have occurred recently, to overestimate this probability. As a result, the longer time has passed since the last recession, the more likely people will underestimate the probability of a new recession. As a result of disaster myopia, financial markets may become euphoric when capital gains have persisted for quite some time. People may then expect future capital gains as well, and may start looking

[29] Peek and Rosengren (2000) study empirically how shocks to the Japanese banking sector lead to a loan supply shock in US markets. They link that shock to construction activity in US commercial real estate market.

more for short-term capital gains instead of long-term income from assets (Kindleberger, 1996). This will draw more funds to asset markets and increase their prices

Cognitive dissonance refers to the tendency of people to look for confirmation of beliefs that already had (Borio, et al., 2001). This can reinforce procyclicality as people will interpret information in a way that ascertains their beliefs about the sustainability of expansions.

Overconfidence refers to the tendency of people to overestimate their own abilities. For instance, more than 90% of traders thought they were in the top 50% of earning of that group (Camerer, 1989). Together these biases can result in too low risk perception by loan officers, too optimistic views on the future and too high asset prices.

4.3.2 Herding

Managers of companies, banks, or mutual funds may be susceptible to herding. Herding occurs if managers base their investment decisions on what others do rather than on fundamental value of assets. Managers may avoid innovating because staying with the herd results in a more reliable performance measure. They may neglect private information because they are unsure about its value, while they observe other agents making different choices. In general, herding gives rise to inefficient investment decisions. In financial markets it may increase volatility, lead to greater correlations in asset portfolios and reinforce asset bubbles. In this way, it may contribute to systemic risk.

Theories of herding can be divided in two types: those involving irrational agents, and those involving rational agents, see Bikhchandani and Sharma (2001) for a survey of the literature with applications to financial markets.[30]

Different theories of rational herding exist. First, herding can occur due to so-called information cascades. In this case, agents have private but imperfect information about the correct course of action, and gain useful information from observing previous decisions by other agents. In this setting, herd behaviour may arise if the updating of their beliefs leads agents to base their decisions on the information suggested by other agent's actions instead of their own private information (Banerjee, 1992; Bikhchandani, Hirshleifer, and Welch, 1992; Welch, 1992). Once a cascade starts, an individual's action does not reflect her private information anymore. Consequently, once a cascade starts, the private information of subsequent investors is never included in the public pool of knowledge. Instead, individuals, acting in their own self-interest, rationally take uninformative imitative actions. Such behaviour is fragile, in that it may break easily with the arrival of a little new information. It is also idiosyncratic, in that random events combined with the choices of the first few players determine the type of behaviour on which individuals herd (Bikhchandani, Hirshleifer and Welch, 1998).

[30] See Devenow and Welch (1996) for an earlier review. We will not discuss theories that explain herding from irrational behaviour by investors. These have been partly addressed under the header 'cognitive biases'.

Second, herding can arise if agents are rewarded according to their relative performance. This reward can be explicit, for example, due to relative performance contracts. The reward can also be implicit, for example, if an agent's reputation depends on performance relative to other agents. A relative performance contract can be optimal for the principal (the employer of the agent) when there is moral hazard or adverse selection. However, such a contract can make it attractive for managers with low abilities to 'hide in the herd' (Maug and Naik, 1996; Admati and Pfleiderer, 1997). Reputation concerns lead to herding in a similar way (Scharfstein and Stein, 1990; Trueman, 1994; Zwiebel, 1995; Prendergast and Stole, 1996; Graham, 1999).

Let us briefly discuss two important contributions. In Scharfstein and Stein (1990) a manager may have low or high ability. Neither the manager nor his employer knows this ex ante. High ability managers receive informative signals about a project's value. Low ability managers receive random signals. Because managers do not know their own type, they have an incentive to mimic each other. In Zwiebel (1995), managers have to decide whether to innovate or not. Managers know their own ability, but investors do not. If only few managers are able to innovate, sticking with the old technology results in a more reliable benchmark for performance evaluation. Managers with low or high ability choose to innovate, because low ability managers have nothing to lose and gamble for resurrection, whilst high ability managers are able to show their capabilities anyway. Managers with average ability, however, do not innovate because they gain most from a reliable performance evaluation: they have more to lose from downward risk than to gain from upward risk.

A substantial empirical literature on herding behaviour also exists. Hong, Kubik, and Solomon (2000), find that young analysts are more likely than their older counterparts to leave the profession following poor forecast accuracy and bold forecasts. Moreover, they find that young analysts are less bold than their older counterparts, consistent with the predictions of reputation based herding models. Chevalier and Ellison (1999) find similar results for mutual fund managers. Welch (2000) finds that inexperienced analysts are more likely to have their employment terminated as a result of inaccurate earnings forecasts than are their more experienced counterparts. Controlling for forecast accuracy, they are also more likely to be terminated for bold forecasts that deviate from the consensus. Consistent with these implicit incentives, inexperienced analysts deviate less from consensus forecasts. Additionally, inexperienced analysts are less likely to issue timely forecasts and they revise their forecasts more frequently. These findings are broadly consistent with existing career concern motivated herding theories.

Rajan (1994) develops a theory of bank herding based on reputation concerns that explains why bank credit policies fluctuate procyclically. If an adverse shock hits the whole sector, a banks reputation is less likely to suffer. A bank's reputation is therefore less sensitive to poor earnings when other banks also admit to poor earnings. This creates an incentive to herd. Acharya and Yorulmazer (2009) develop a theory of bank herding based on performance benchmarking. When banks invest in the same industry, the financiers of the banks can not

distinguish whether performance is due to a systematic shock or due to good performance. When banks invest in different industries, benchmarking results in information about performance. Again, this creates an incentive to herd.

4.3.3 Asset price bubbles

The data show that financial crises are not rare phenomena, but occur relatively regularly.[31] Empirical studies comparing different financial crises show very similar patterns in the run-up to a crisis. Kaminsky and Reinhart (1999) study crises in 20 countries: 5 industrial and 15 emerging ones. They find that financial liberalisation and significant credit expansion preceded most crises, followed by an average rise in the price of shares of about 40% per year above that occurring in normal times. The prices of real estate and other assets also increased significantly.

At some point the bubble bursts and share and real estate markets collapse. The bursting of bubbles is usually accompanied by an increase in non-performing loans, credit losses, and acute liquidity problems within the interbank market. Typically, banks and other financial intermediaries are overexposed to the equity and real estate markets and on average about a year later a banking crisis ensues.

Thus, bubbles are a common precursor to a financial crisis. Also the current crisis was preceded by a bubble in the US real estate market. Economists use different definitions of a bubble. The common element is that asset or output prices increase at a rate that is greater than can be explained by market fundamentals. In other words, a bubble implies that an asset's price cannot be justified by the value of dividends that society expects to earn from this asset class collectively.[32]

Broadly speaking, two approaches to bubbles exist (Camerer, 1989). The first maintains rational expectations. Asset prices contain a bubble if investors are willing to pay more for the asset than they know is justified by the value of the discounted expected future cash flows because they expect they will be able to sell it at an even higher price in the future. Importantly, the pricing is still rational and there are no arbitrage opportunities. In an expanding bubble asset prices can consist of two components: the intrinsic value and a bubble component. To be consistent with rational expectations, this bubble component has to grow exponentially at the discount rate (Blanchard and Watson, 1982).

Tirole (1982) showed under which circumstances rational bubbles can be ruled out: if traders start out with a common set of beliefs, it is common knowledge that all traders are rational and that resources are allocated efficiently prior to trading. Rational bubbles can only arise if one of these conditions is violated.

[31] Reinhart and Rogoff (2008) report that over the past two centuries, the 66 countries they study have experienced 286 banking crises, 105 of which have come since 1945. On average, countries have been in crisis for roughly one year out of every 12.

[32] In popular use a bubble often describes a situation in which the price of an asset increases significantly in a short time and becomes prone to sudden collapse. Some economists also use this definition, for example, Kindleberger (1996, p.13) defines a bubble as "an upward price movement over an extended range that then implodes".

Empirically investigating rational bubbles and discriminating between competing hypotheses is difficult. In surveying the literature, Gürkaynak (2008) concludes that "bubble tests do not do a good job of differentiating between misspecified fundamentals and bubbles".

A complementary literature describes bubbles as driven by irrational, or non-rational, expectations. This is also the way in which the term bubble is commonly used in the popular press. For example, in December 1996 Alan Greenspan famously used the term "irrational exuberance" to describe what he thought drove share prices during the stock market boom of the 1990s.

As we have argued above, people tend to be overconfident in their own abilities, hence the majority of the people may believe that they can benefit from a bubble, because they believe they can sell in time and so will not be 'the one stuck with the hot potato'. It is clearly not possible for everyone to leave the bubble before it bursts. One argument against the development of such bubbles may be that 'rational' investors can bet against them. However, it may be difficult to bet against these bubbles, if other agents are unpredictable, because the unpredictability leads to uncertainty as to *when* the bubble is going to burst, which reduces the possibility of benefiting from the irrationality of others[33].

[33] For instance, margins will have to increase when prices rise further. Given the limited availability of funds this may become binding, and may even lead to a forced reversal of short positions, at a high loss. As Keynes said, "The market can stay irrational longer than you can stay liquid."

5 Regulation

The benefits of creating systemic risk accrue privately, but the costs of a crisis are borne socially. This disparity makes regulation of systemic risk necessary. We divide policy measures that aim to reduce systemic risk into three broad categories: incentive regulation, structural regulation, and ex post crisis intervention.[34]

Incentive regulation tries to change the incentives of financial intermediaries so that they internalise the external effects of their risk taking. Ex ante price regulation, as it is sometimes referred to, can take the form of taxation, capital requirements, insurance. Policymakers can also change banks' incentives by giving banks' financiers stronger incentives to discipline banks, i.e., by increasing market discipline.

Structural regulation tries to limit systemic risk through quantity regulation, such as putting quantitative restrictions on bank characteristics that are thought to be related to systemic risk or limiting the activities that banks are allowed to perform, and structural measures, such as regulation rating agencies, increasing the transparency of markets, or reducing competition.

Finally, ex post crisis intervention tries to dampen the mechanisms that spread problems once a crisis occurs. It includes the lender of last resort function o central banks, deposit insurance, bank-specific bankruptcy rules, contingency plans such as living wills, and prompt corrective action.

Of course, a particular policy measures may belong to different categories, depending on its exact nature. For example, measures that fall in the category 'ex post crisis intervention' often have ex ante effects. Deposit insurance increases moral hazard; deposit insurance with a risk-adjusted insurance premium is also a form of incentive regulation; and prompt corrective action aims to provide incentives ex ante by forcing banks to take costly action when certain indicators cross pre-determined thresholds. For expositional purposes, however, we put these policy measures in one category.

For each type of measure, we discuss the issues that might hamper its effectiveness in reducing systemic risk. Table 5.1 summarises the regulatory measures and corresponding issues discussed in this section.

[34] Other categorisations are of course also possible.

Table 5.1	Policy measures to address systemic risk	
Type	Measure	Issues
Incentive regulation	Taxation	Calibration, Politicians' opportunism, industry lobbying
	Capital requirements	Calibration, one instrument with too many goals, regulatory capture, limited scope
	Insurance premium	Calibration, pricing incentives, payout trigger, moral hazard
	Market discipline	Irrational market behaviour, implicit governments guarantees
Structural regulation	Portfolio restrictions	Loss of economies of scope, gaming of regulation
	Quantity regulation	Inefficiencies, triggers risk shifting
	Product standardisation	Gaming of regulation, increased cost of tailored products
	Increased transparency	Treatment of non-standard contracts, central counterparty risk,
Ex post crisis intervention	Lender of last resort	Pricing of liquidity, distinguishing illiquidity from insolvency, moral hazard, regulatory forbearance
	Deposit insurance	Pricing, moral hazard, implicit government guarantees, role of private insurers
	Prompt corrective action	Regulatory capture, time-inconsistency problem, trigger-levels
	Living will	Implicit government guarantees, international coordination, trigger variable
	Bank-specific bankruptcy laws	Treatment counterparty risk, distinguishing good and bad assets, credibility, international coordination

5.1 Four generic problems

Regulation of systemic risk has to deal with four generic problems: the measurement and pricing of systemic risk, the strategic reaction of market participant to new regulation, the fact that regulators are also subject to principal-agent problems, and governments that lack commitment and have to weigh ex ante discipline against ex post safety.

Quantifying and pricing systemic risk

In general, for many policy measures it is not only necessary to quantify systemic risk, but also to put a price tag on particular levels of systemic risk. Because of several reasons, however, systemic risk is inherently difficult to quantify.

First, measurement of systemic externalities is difficult because the externalities have to be measured in normal times, but their detrimental effect only materializes under extreme circumstances. How much more likely becomes the failure of bank B, if bank A takes on more risk? Take, for example, the measurement of interconnectedness. To quantify the interconnectedness detailed information about banks' exposures and banks' assets, both on- and off balance sheet.

Second, the external effects of an individual bank's risk taking may depend on characteristics of the financial system as a whole, which are much harder to observe that those of individual banks. Take again the example of interconnectedness, here not only the number of interconnections matters, but also the specific structure of the network connecting banks. Are

all banks connected in one big cluster or are there several clusters with key bottleneck banks connecting the different clusters? Or consider liquidity risk .The liquidity risk of a particular funding structure depends on how liquid assets are. If assets are sold easily, such as treasury bills, maturity mismatch is not a problem. As we have seen in the current crisis, however, assets can suddenly switches from being liquid to being illiquid. See section 3.2 for several potential explanations of such a 'market freeze'.

Third, a calibration of government policies that try to price external effects also requires a quantification of the effect of a collective failure of banks. To put the correct price on a bank's contribution to systemic risk, we should know by how much the probability of a crisis increases as a result of this bank's contribution, as well as the costs of this crisis. But interconnectedness, short-term funding and complex tailor-made financial products also have benefits. Short-term funding gives creditors an incentive to monitor and diversification of risk is beneficial. This means that setting a wrong price will be costly.

All this implies that one should be cautious of policy measures that require a precise measurement of systemic risk or systemic externalities. Nevertheless, it is important to identify indicators of systemic risk. Building upon the mechanisms of contagion we've identified, indicators should include: the level of interconnectedness, the potential for information spillovers, the risk of liquidity problems arising, and the potential for procyclical effects when bank capital is hit. This requires detailed information on exposure to other financial intermediaries through the interbank market, the direct contracts with other banks, and insurance contracts such as credit default swaps, the type of assets banks hold on their balance sheets, the duration of bank assets and liabilities and on the loans that banks extend to firms.[35]

Regulatory gaming

A second obstacle is the incentive for banks to evade regulation meant to reduce systemic risk. Such regulation taxes the originators of risks for their contribution to systemic risk. Evading such a tax is of course profitable because it allows banks to take on additional risk at the expense of other banks and, ultimately, the taxpayers. The information asymmetry between regulator and regulated is already huge for regulation of idiosyncratic risk, which requires information on the riskiness of individual banks' loan portfolios. It will be even larger in case of systemic risk, which requires more complex information. This implies that policymakers should look for policy measures that are hard to circumvent. Market based measures of systemic externalities would help in reducing the scope for gaming regulation.

Regulatory forbearance

A third issue is regulatory forbearance. It is hard to give the regulator incentives to intervene in a timely manner. Regulators may be tempted to gamble for resurrection because of their limited

[35] For example, in Belgium or Sweden, banks register their loans in a central credit registry. This type of information would allow governments to analyse of the potential spillover effects when banks' capital is hit.

liability or lured into inactivity by reputation concerns. When a regulator spots an incipient crisis, it weighs the private benefits and costs of intervening against the benefits and costs of not intervening. If these private benefits do not coincide with social welfare, the probability arises that a regulator will either intervene too late or too early.

Several mechanisms may play a role in distorting a regulator's incentives to intervene. First, in order to provide banks with ex ante incentives to be sufficiently prudent, regulators will have to intervene harshly, even if ex post this might seem undesirable. Regulators may find it hard to commit to such a policy. Second, regulators are prone to forbearance when it comes to systemic risk. When a regulator spots an incipient crisis, he has to decide whether or not and how to intervene. When making this decision, the regulator weighs the private benefits of intervention against the private benefits of non-intervention. These private benefits do not necessarily coincide with the public benefits of intervention. Limited liability, career concerns and herding incentives may distort a regulator's decisions. If the downside of non intervention for a regulator is limited (i.e., there is limited liability), for example because he can not be fired, but a substantial upside exists due to career opportunities in the financial sector, then a regulator may be prone to forbearance. Alternatively, intervening when a bank runs into trouble may increase create information about a regulator's ability to monitor banks. If a regulator can influence the market's perception on his capabilities, reputation concerns may give an incentive to postpone intervention. By doing so, the regulator obscures his inaptitude at monitoring, which improves his reputation (Boot and Thakor, 1992). Finally, regulators may have an incentive to herd if their performance is judged against the performance of other regulators. Deviating from other regulators' point of view then increases the probability of getting a bad reputation.

Careful design of institutions and giving market information a role disciplining regulators can help in addressing regulatory forbearance. It is important to further investigate in more detail the incentives that regulators have to intervene when a crisis threatens to disrupt the financial sector, as well as the potentially beneficial role of market information and institutional design

Time-inconsistency problem

A final point is governments' time-inconsistency problem. Time-inconsistency problems arise when policymakers have to weigh ex ante against ex post efficiency of their decisions and are unable to commit themselves to a particular course of action. In case of the financial sector, governments want to discipline banks ex ante, but prevent a systemic crisis ex post. There exists a trade-off between these two goals: bailing out banks in times of a crisis reduces ex ante discipline. If the government ultimately bears systemic risk, banks have an incentive to take such risks as they benefit from the upside, but do not suffer when the downside materializes. If governments cannot commit themselves, they will choose too little ex ante discipline and too much ex post guarantees. As a result, the government's time-inconsistency problem creates a private benefit from becoming too systemic to fail. Systemic risk is therefore some extent created by the inability of governments to commit not to bail out systemic institutions. Policies

that force banks to internalise the external effects of their risk taking decisions or rules that tie regulators' hands can reduce this problem.

5.2 Incentive regulation

Because banks do not take into account the effect of their risk taking on other banks, they take on too much systemic risk. When choosing a particular proportion of short-term debt, arranging insurance against liquidity shocks, or deciding on leverage, a bank takes into account its private benefits but not the social costs. As a result, they become too dependent on short-term funding, grow too big, inefficiently interconnected, or too levered.

Regulation, by putting a price on individual banks' contribution to systemic risk, forces banks to internalise their contribution to systemic risk and provides incentives to choose the socially optimal level of risk. Policy focuses on proxies for a bank's contribution to systemic risk such as size, interconnections, complexity, maturity mismatch, leverage, and heterogeneity. These also follow from the theory presented in section 3. The proposals to bring banks incentives more in line with social welfare take the form of taxation, capital requirements, insurance premia, and increased market discipline.

5.2.1 Taxation

Governments can also try to tax financial intermediaries in proportion to their contribution the systemic externality. In theory the size of the externality could be determined for each individual institution using quantitative empirical and theoretical models. All institutions that contribute to systemic risk should be subject to the tax. The list of the institutions that are subject to the tax has to be under constant review. Revenue from taxes would add to government budget. This makes taxes subject to political lobbying by banks, but also to politicians' opportunistic behaviour.

5.2.2 Capital requirements

When capital requirements are used to change banks' incentives, the money accumulated under such regulation accrues to banks. It thus stays within the financial sector. This implies there are fewer distortions from taxation due to inefficient government spending. Also, an independent regulator sets capital requirements. If the regulatory framework is properly designed, this makes capital requirements less sensitive to lobbying by banks. Current policy proposals range from making banks' capital requirements dependent on liquidity risk, leverage, size, complexity of banks balance sheets, the business cycle, expected or forecasted losses on loans, and interconnectedness.

For example, Brunnermeier et al. (2009) propose to reduce liquidity risk by imposing a capital charge based upon the risk implied by the combination of an asset and the way it is funded. If two banks hold the same asset, the one funding the asset with long-term debt should

set aside a lower amount of capital than the one funding the assets with overnight borrowing from the money markets. If funding markets dried up for three months, the short-term funded bank would be in difficulty and would be forced to sell assets. The resulting fire sales would worsen the liquidity and solvency environment for its competitors.

One issue is that capital requirements serve multiple purposes: to act as a buffer as well as to reduce risk-taking incentives in multiple dimensions: interconnectedness, liquidity risk, leverage, size etc. Simultaneously achieving these goals will lead to a highly complex and non-transparent system of capital requirements, which is prone to manipulation, constant re-interpretation and forbearance. A second issue is that capital requirements apply to banks, while non-banks can also contribute to systemic risk.

Counter-cyclical capital requirements and forward-looking loss provisioning can help in addressing procyclicality. Two types of loss provision can be distinguished: "expected loss provisioning" and "dynamic provisioning".[36] With expected loss reserves, banks are allowed to make reserves for expected losses over the lifetime of loans. Thus, expected loss-provisioning holds for a portfolio of loans in the long run. In case of dynamic provisioning, banks have to make general loss provisions in good times when credit growth is above trend and credit risk increases (but is not materializing yet). These general provisions can then be used as a buffer to absorb losses when losses materialize. A disadvantage is that this penalizes efficient banks with above average credit growth.

Counter-cyclical capital requirements are raised during an upswing and slackened in a downturn. The reasoning is that the extra buffer built up in good times can be used in bad times. This way asset price and credit bubbles can be dampened, while equity cushions are created for the downswing (Calomiris, 2009). Important issues are: how to measure the cycle; the exact way in which capital requirements should depend on the cycle; and how to differentiate between banks, countries, and regions.

Countercyclical capital requirements should be based on an objective cycle measure to prevent regulatory forbearance. Regulators may face intense lobbying from the industry if they have too much discretion in setting the level of capital requirements. The simplest form is to multiply capital requirements by some factor that depends on the cycle. This requires that there be a clear relationship between the measure and procyclicality of the financial system. Proposed measures depend on output (Repullo, et al., 2009), credit or asset price growth (Brunnermeier et al.,2009; Goodhart and Presaud, 2008; Davis and Karim, 2009) or some index that measures financial instability.

Since cycles are not identical across countries, another issue is whether the adjustments should be the same for all banks in a single country (or region) or whether the measures should be differentiated per bank or per asset class. Brunnermeier et al. (2009) argue that such measures should be applied on a country-by-country basis, and that coordination in the EU may

[36] Under current accounting standards banks can only make provisions for losses when loan losses are inherent and both "probable" and "capable of reasonable estimation" based on available information.

be advisable. In addition, a measure based on the banks' own credit growth will punishes efficient banks (Panetta, et al, 2009). This problem does not occur when capital requirements depend on country-level credit and asset price growth.

5.2.3 Insurance

An addition route for recapitalisation is to require banks to buy capital insurance in good times that pays out in case of a systemic crisis. An advantage of insurance is that a bank does not have to hold additional capital at all times to protect against major shocks. However, the amount of assets an insurer of systemic risk has to hold will be very large. These assets should therefore be very liquid, as they would have to be sold during a systemic crisis. Insurance can be either via the private sector or governments. Private insurers capacity to pay out will be more limited than that of governments. In addition, private insurers may not be interested because such insurance provides little scope for diversification.

Pricing may also be problematic because the events are rare and therefore difficult to forecast. In addition, the insurers need incentives to price risk correctly. If the government remains in the background as a lender of last resort for the insurer, these incentives will suffer. An advantage if the government underwrites the insurance is that it can tap into capital markets cheaply in times of crisis to raise the necessary funds at the relatively low interest rates government bonds.

Kashyap et al. (2008) propose that a private insurer should provide insurance against a systemic crisis. The policy would pay out upon the occurrence of a 'banking systemic event', for which the trigger would be some measure of aggregate write-offs of major financial institutions over a year-long period. Long-term policies would be hard to price and therefore a number of overlapping short-term policies maturing at different dates are proposed.

Under the proposal by Caballero and Kurlat (2009) the central bank would issue tradable insurance credits, which would allow holders to attach a central bank guarantee to assets on their balance sheet during a systemic crisis. For a fee, the holders of these credits will have access to insurance for their assets during a financial crisis. The tradable insurance credits are like credit default swaps during a crisis, but not during normal times. They protect the holders in case of a systemic crisis, but not against idiosyncratic risks in normal times. This lowers the cost for insurance. A threshold level or trigger for systemic panic would be determined by the central bank.

Perotti and Suarez (2009) call for introduction of liquidity insurance charges to force banks to internalise the negative systemic effects of fragile funding strategies. Regulation should levy charges based on banks' funding structure as a simple proxy for the banks contribution to systemic risk. More specifically, banks should pay a Pigouvian tax that is determined by weighing its liabilities according to their maturity. The regulator could adjust these weights in response to aggregate risk accumulation, such as the aggregate leverage or the amount of credit in the financial system.

5.2.4 Market discipline

In the context of this study, market discipline refers to the role of market participants in actively monitoring and controlling risk taking by financial intermediaries. For market discipline to be effective, market participants must have an incentive to monitor. That is, the financiers of banks, i.e., the holders of unsecured debt and equity, should have something at stake when they invest their money in a bank. When banks run into trouble, market discipline thus requires that creditors and shareholders absorb some of the losses before the taxpayer does.

Contingent capital forms an important ingredient of improved market discipline. These debt conversion proposals require banks to hold some type of financial instrument ex ante that converts into equity when some indicator of the bank's health reaches a pre-specified level. This prevents them from becoming undercapitalised without having to raise capital ratios ex ante. It improves market discipline by transferring losses to creditors when the equity ratio of a bank falls low.

An advantage of debt instruments is that they are simple and liquid (these securities could be traded and priced through markets) which may keep transaction costs low. The market price of subordinated debt may be useful as a potential signal of a bank solvency. To ensure that financial institution use this type of debt, regulators could either force them to issue such claims or give them incentives to do so. One way to give such incentives is to allow reverse convertible bonds more favourable conditions in capital requirements.

Flannery (2005, 2009) proposes to introduce so-called Reverse Convertible Debentures. These are debt certificates that pay a fixed payment to its holders but convert into common equity when a bank's market capital ratio falls below some pre-specified level. To prevent manipulation and forbearance, using a capital ratio based on accounting principles should be avoided. Instead, the ratio should be measured using current share prices. They convert at the share's current market price rather than at a predetermined price. This forces shareholders to internalise a larger fraction of the cost of their risk taking. This proposal has a potential shortcoming. It is relatively lenient towards management because it eliminates one of the disciplinary effects of debt (debtholders intervening in management). It can therefore give the manager the perverse incentive of talking down the stock so as to obtain more slack.

However, during the 2007-2008 crisis existing going-concern capital instruments such as subordinated debt and hybrid capital largely failed to bear losses. This may have had two reasons. First, banks may have been counting on implicit government guarantees. The effectiveness of market discipline is strongly reduced by governments' implicit guarantees to banks' creditors. Thus, a properly designed ex post bankruptcy regime is crucial to increasing market discipline as a way to curb banks incentives to take on excessive risk. We will discuss this separately below.

Second, because of their limited liability, banks might have been gamble for resurrection and convert too late. The choice to convert should therefore not be left to banks themselves. An important issue is therefore how conversion should be triggered. The possibilities are institution

specific measures or system wide triggers. In addition, triggers can be based either on a rule or discretion by a regulatory body. Where rule-based triggers prevent regulatory forbearance and create transparency, discretion-based triggers prevent irrational market behaviour to falsely trigger con version.

Regarding the institution specific conditions it is generally agreed that it should be some measure of capital adequacy, but the issue is whether this should be based on market measures or book value measures. The former gives the more timely information, but is subject to market inefficiencies (like fires sales), while the latter may suffer from 'creative accounting' and allow more scope for regulatory forbearance. Rajan (2009) argues that to trigger debt conversion the system must be in crisis, and banks' capital has to fall below a certain level. The first is to ensure that inefficiently run banks cannot avoid the disciplinary power of debt. The second is to give banks an incentive to stay well capitalized as that prevents conversion and dilution of capital.

5.3 Structural regulation

Structural regulation tries to limit systemic risk through quantity regulation, such as putting quantitative restrictions on bank characteristics that are thought to be related to systemic risk or limiting the activities that banks are allowed to perform, and structural measures, such as regulation rating agencies, increasing the transparency of markets, or reducing competition.

5.3.1 Quantity regulation

Quantity regulation addresses the external effects of maturity mismatch, leverage, interconnectedness, size and business models by imposing direct limits on banks. For example, a leverage restriction restricts banks leverage ratio to be smaller than a particular number.[37] Previous to the crisis, some countries already enforced a maximum leverage ratio. For example Canada had a maximum leverage ratio of 20:1, whereas the US applied a leverage restriction to the assets of bank holding companies, but exempted investment banks from its coverage.
There are several arguments in favour of quantity regulation. First, risk-based capital requirements have difficulties taking into account the extreme tail-events of a systemic crisis. Quantitative restrictions may help to put an upper limit on potential spillovers in case of a crisis. In addition, in good times quantitative constraints may prevent a build-up of risks that make the financial system vulnerable to bubbles and to shocks. Second, calculating capital requirements based on internal models entails significant judgement, and there will always be dangers that debates between bank management and regulators might result in too lenient a treatment. Quantitative restrictions work as a safeguard against regulatory concessions. Finally, an important advantage of this approach is its simplicity. There is no need for intricate calculations

[37] In general, a bank's leverage ratio is defined as its tier I capital as a percentage of total adjusted capital, which includes items like goodwill.

of weighted risks that figure price regulation such as taxation, capital requirements and insurance premia. The simplicity of the application and monitoring of such restrictions enables quick adoption without imposing high costs or expertise requirements on banks or their supervisors.

A common criticism a quantitative constraints is that they do not correct for the risk of different assets. A simple restriction ignores finely granulated risk measures such as developed under Basel II. Thus, quantitative restrictions are bound to be inefficient. In addition, because quantitative restrictions do not distinguish between the risks of different types of bank assets, they may induce risk-shifting both within financial institutions, but also to less intensely regulated parts of the financial system.

A second disadvantage of a leverage restriction is its reliance on an accounting framework. Differences in accounting consolidation and asset recognition rules can make it difficult to compare the leverage ratio across jurisdictions. In the absence of a uniform application of the ratio, there can be considerable scope for competitive advantages to banks that are mandated lighter leverage ratios by their domestic regulators. These differences facilitate cross-border regulatory arbitrage.

5.3.2 Portfolio restrictions

The maturity mismatch between short-term liabilities and the illiquid and risky long-term loans makes banks vulnerable to bank-runs. Portfolio restrictions aim to increase the stability of the banking system, by partitioning the financial system into safe banks, whose activities are restricted, and risky banks, who are allowed to perform other activities[38]. In this way, governments could credibly commit not to bail out risky banks, increasing market discipline, while at the same time ring fencing crucial parts of the financial system.

Under narrow banking proposals, banks can only use the deposits they collect to purchase riskless financial securities. This would solve the problem of contagious bank runs, as banks would always be able to honour their liabilities. A less intrusive restriction is to separate investment banking from other types of banking. Such portfolio restrictions have been in place in the US. The Glass-Steagall Act of 1933, which was repealed in 1999, separated banks into investment banks and commercial banks.[39] Commercial banks were allowed to underwrite

[38] Nobel Prize winners Irving Fisher (1935), Milton Friedman (1959) and James Tobin (1985) have all advocated the establishment of narrow banks (also know as 100% reserve banking) to enhance the safety of the payments system and eliminate the costs associated with the present system of federal deposit insurance. Going even further back, in the Wealth of Nations, Adam Smith (1789, bk. 2, chap. 2) urged bankers to match the maturity structures of their assets and liabilities.

[39] Separating commercial from investment banking does not solve the problem of bank runs, for commercial banks will still lend short and borrow long. The act was instigated because of fears that (1) combining investment and commercial banking functions would create significant conflicts of interest and (2) direct involvement of commercial banks in the securities business would increase the riskiness of banks and the financial system. Another rationale may be that separate commercial banks are more transparent, and therefore easier to regulate ("what can you do wrong with simple loans and deposits")? Kroszner en Rajan (1994) find no empirical that commercial bank securities affiliates systematically fooled the public before 1933.

government securities, but were not allowed to underwrite corporate securities, or to engage in brokerage activities.

Proposals on narrow banking differ in the degree of restriction placed on the types of asset that narrow banks should be permitted to hold. Proposals vary from introducing a 100 percent reserve requirement that bound banks to fully back transaction accounts with marketable short-term Treasury debt (Kareken 1986, Spong 1991, Mishkin 1999, Thomas 2000), to requiring banks to invest fully insured deposits only in high-grade securities including government paper or government-guaranteed securities of various maturity (Litan 1987, Herring and Litan 1995). Another proposal allows banks to use insured checkable deposits for short-term lending to consumers and businesses (Pierce 1991). So far, however, no practical experience with these forms of pure narrow banking exists. Discussions on the costs and benefits of narrow banking therefore remain theoretical.

Narrow banking has several potential advantages (Bossone, 2001). First and most important, by locking bank assets in high-quality instruments, narrow-banking regulation would minimize banks' liquidity and credit risks. Second, confidence in the value of their claims used to make payments could not be weakened by changes in the value of loans. Third, if payment system access were restricted to narrow banks, payments would be fully secure: any shock to the financial system would be isolated from the payment system (Burnham, 1990; Thomas, 2000). Fourth, narrow banking improves the central bank's ability to control the money supply process. Nonbank financial intermediaries would be allowed to engage in all types of financial activities using non-guaranteed funds. They should be allowed to fail and are subject to market discipline.

However, narrow banking also has potential drawbacks. The history of a depositor provides valuable non-tradable information on the riskiness of that depositor as a borrower. These economies of scope would be lost when separating the two functions (Fama, 1985).[40] Empirically, it is unclear whether such costs outweigh potential benefits of narrow banking.

In addition, it is questionable how effective such a separation would be in terms of reducing systemic risk. Under narrow banking, maturity transformation by narrow banks will be limited. But there exists a fundamental demand in the economy for maturity transformation. This has to be done somewhere in the financial system. To the extent that they finance by means of short-term liabilities, the problem of bank runs will shift to these intermediaries. As , as the failure of Bear Stearns, AIG and Lehman Brothers in the 2007-2008 crisis has shown, non-depository banks may also contribute to systemic risk.

In addition, the financial intermediaries that extend risky loans to firms will have to finance these assets in some way. Other financial institutions will offer new financial instruments to consumers with higher interest rates, in return for more risk. Whether governments can commit not to guarantee these risk-seeking consumers is, however, questionable. If enough voters'

[40] Nakamura (1994) finds informational economies of scope between deposit taking and loan insurance for small banks, but not for large banks. Degryse and van Cayseele (2000), using detailed contract information from nearly 18,000 bank loans to small Belgian firms, find that the scope of a relationship (which they define as the purchase of other information-sensitive products from a bank) decreases the loan's interest rate substantially.

savings are at stake in times of crisis, this will create a strong incentive to extend some form of government guarantee. Also, the current crisis has shown that keeping credit to firms flowing is an important reason for bailing-out the financial sector as a whole. If a large part of credit comes from banks other than narrow banks, governments will be reluctant to let such financial intermediaries fail.

5.3.3 Transparency and standardization

In the pre-crisis decade the number of Over-The-Counter (OTC) transactions has increased significantly. In a network of OTC contracts, total counterparty risk becomes hard to measure for the contracting parties themselves and even more so for other parties. This is especially the case because of so-called "daisy chains": the exposure of A to B also depends on the exposure of B to C, which is unobservable for A.

The current financial crisis has highlighted two aspects of the OTC market that deserve reform. The first aspect is that financial innovation typically occurs in such markets. The second aspect concerns the opacity of exposures in OTC contracts. Since such contracts are not exchange-traded or centrally cleared, neither regulators nor market participants have accurate knowledge of the full range of exposures and interconnections (NYU working group, 2009). As a result of this lack of transparency, regulators will find it more difficult to adequately monitor and control individual risk and aggregate risk. Centralized clearing improves transparency and insight into counterparty risk for both regulators and market participants.

One option to address this issue is to require transactions to be cleared via a central clearing party (CCP). This way, settlement risk is transferred to the CCP. Note that this does not imply that OTC transactions have to be traded via the CCP derivates that are not traded through a clearinghouse may still be settled via a clearinghouse. Compared to bilateral relations, central clearing has the additional advantage that it allows for multilateral netting of positions. This reduces counterparty risk. The CCP, however, may now become systemically important. Although CCPs currently have a good track record at self-regulation (for instance via margin requirements), increased systemic relevance of these platforms may warrant closer regulatory scrutiny.

Non-standard, customized OTC contracts are tuned to the needs of a specific customer and hence valuable. For non-standard, customized contracts mandatory clearing via the CCP is not very practical. Nevertheless, such contracts may add to systemic risk and in that case should be subject to regulatory scrutiny. One option may be to increase regulatory cost of transactions that are not carried out via a CCP, so financial institutions have an incentive to trade via the CCP. To further improve transparency, regulators can -in addition to central clearing- require banks to disclose their exposure to counterparty risks.

Another potential route is to promote the standardization of financial products. There are social benefits to trading standardized and thus more liquid products. Margins can be set with more precision because price information is available, which allows the central clearing

counterparty to better manage his risk (Tirole, 2009). As a result, the solvency of central clearing counterparties becomes more transparent. Such products may therefore be promoted, for instance via lower capital charges for standardized products compared to customized products. Of course, as a result non-standard OTC products will become more costly.

5.3.4 Fair value accounting

Fair value accounting (FVA) has important benefits. By marking assets to market, it forces banks to recognize their losses and deleverage. This has an important ex ante disciplinary effect. In addition, in the midst of a crisis the discretion of banks in making information available to the market may create additional systemic risk by increasing uncertainty about the quality of banks. Nevertheless, FVA also has drawbacks. If market prices do not reflect the value of an asset to the bank, FVA will under- or overestimate the actual net worth of a bank. Given that some banks had over 50% of their assets on their trading books (which according to FVA have to be marked-to-market), insolvency is hard to avoid when asset prices fall strongly (Panetta, et al, 2009).

Should FVA therefore not be used when determining a bank's regulatory capital? An important point is that the level of capital should not reflect a bank's net worth under a going concern assumption, but its ability to withstand shocks and its ex ante risk taking incentives. If the market for certain assets is very illiquid, and a bank holds these assets on its balance sheet, this bank's ability to withstand shocks will be eroded. Of course, the flip side of this is that an appreciation of assets that are illiquid even in normal times should not add to a banks regulatory capital.

The central question seems therefore not to what extent FVA should be replaced with, for example HCA. If there is a difference at all from the viewpoint of a bank's financiers, this is a question of how much markets should know about a bank's health. Rather, the question is how changes in the market value of a bank's assets translate into changes in a bank's capital requirements. A possible solution would be to give regulators the option of weakening capital requirement when a crisis erupts by adjusting the capital requirements for assets held in the trading portfolio.

A move away from FVA has several potential adverse effects. First, because markets will have less information on a bank's health, it will increase the scope for regulators to postpone painful measures. Second, it will give banks more scope to artificially inflate earning by engaging in 'gains trading', i.e., selling assets that are undervalued by accounting measures and keeping those that are overvalued.

5.3.5 Credit rating agencies

Well functioning credit rating agencies facilitate market discipline. In addition, their ratings of assets banks have on their balance sheets play an important role in determining regulatory capital requirements. From an economic viewpoint, credit rating agencies are information

intermediaries, creating information about the quality of products produced by issuers and providing this information to investors who buy these products.

Credit rating agencies have been regulated in the US since 1973 when the Securities and Exchange Commission (SEC) adopted rule 15c3-1, and created the so-called Nationally Recognized Statistical Rating Organization (NRSRO). Pension funds and banks often require that ratings data originate from an NRSRO. Following this rule, credit ratings have been incorporated into hundreds of rules, releases and regulations, in areas including securities, pensions, banking, real estate and insurance (Partnoy, 1999).

Credit ratings agencies have evolved a remuneration model where the issuer of a particular security pays for the ratings it receives. This model may lead to a conflict of interests, which may negatively affect the quality of ratings in several ways. First, ratings may be biased upward because rating agencies inflate ratings. This may be easy if models are very complex and sensitive to small variations in input parameters, or if they allow a substantial amount of discretion. Second, the rating agencies may purposely choose coarse rating scales or not to publish rejected applications in order to facilitate ratings shopping. If an issuer doesn't like the rating received by one rating agency, and the rating is not disclosed, it can turn to another rating agency. Credit rating agencies typically do not disclose ratings that displease issuers.

One solution is to establish a government agency that supervises the internal checks and balances, independence and transparency of rating agencies. There should also be more emphasis on uniform rating, for example by penalizing agencies that perform worse than their peers or by dictating ratings methodologies. Another solution is that the supervisory authority that sets regulatory capital chooses a rating agency, either at random or according to expertise, to rate each asset. Removing issuers' choice of rating agency diminishes the scope for ratings shopping and removes the incentive for agencies to attract business by offering favourable ratings.

5.4 Ex post crisis intervention

5.4.1 Lender of last resort

The term lender of last resort (LLR) refers to a central bank's liquidity facilities that are open to commercial banks. To resolve potential liquidity problems, Bagehot (1873) originally proposed that the central bank act as a lender of last resort by stating in advance its readiness to lend any amount (at a penalty rate) to a bank that is illiquid but has good collateral and is solvent.

A solvent bank could in principle borrow from the market if it were able to credibly signal its solvency. Thus, in a normally functioning market, if a bank were unable to borrow through the market, this would signal that it is insolvent. A rationale for a LLR exists if money markets fail to allocate liquidity to solvent banks that need it, i.e., if market mechanisms cannot insure against liquidity shocks.

We can distinguish three reasons why solvent banks may not be able to lend in the interbank market. First, there may be uncertainty in the market about the solvency of banks. There is a role for a LLR if regulators have more information than the market and lend to banks that the interbank market wrongly judges insolvent. Second, if one bank's liquidity surplus is insufficient to lend to several banks it will not be able to diversify the risk of making a bad judgement. A LLR can lend to all illiquid borrowers and hence reap the benefits of diversification. Third, the interbank market may dry up due to a coordination failure between banks, or because the market for liquidity insurance is incomplete. (Freixas et al., 2002, Allen and Gale, 2000)

Several questions pertaining to the optimal design of LLR facilities emerge. First, it is likely that emergency assistance is made against collateral that is not acceptable in normal monetary operations or on the interbank market (Calomiris, 2008). Therefore, emergency assistance may expose the central bank to credit risk due to the uncertainty of the value of the collateral taken. In practice, when an institution faces a sudden liquidity crisis, it is sometimes difficult for the central bank to obtain timely and detailed information to assess whether the institution is fundamentally solvent or not. A central bank may therefore also mistakenly lend to an insolvent bank. Moreover, what starts as an illiquidity problem can evolve into an insolvency problem. A bank which is solvent ex ante may not be so ex post; e.g. a future deterioration in the general economic situation may mean that a bank which was solvent at the time of the liquidity injection becomes insolvent later. Central banks which lend in such circumstances should have a clear exit strategy.

Second, should lending be at a penalty rate? In practise, emergency lending to individual solvent institutions has sometimes been made without applying a premium over the current notional market rate (Goodhart and Schoenmaker, 1995). This divergence from Bagehot's rules has several justifications: lending at a high rate may (i) aggravate the bank's crisis; (ii) send a signal to the market that precipitates an untimely run, unless it is provided covertly; and (iii) give the managers incentives to pursue a higher risk/reward strategy to get themselves out of trouble ('gamble for resurrection'). In practise, LLR lending is often used to bail-out banks. Such bail-out may be necessary to prevent a systemic crisis, but the possibility of a bail-out also introduces moral hazard. In addition, too much discretion for regulators in setting the terms of a liquidity injection may increase the scope for regulatory forbearance.

5.4.2 Deposit Insurance

The primary goal of deposit insurance is to prevent bank runs. A bank run occurs because depositors scramble for cash and all try to be first in line to ensure they get their money back. Due to deposit insurance the need to be first in line supposedly no longer exists. Deposit insurance used to be rare, but has become a widespread since the early seventies. Currently all OECD countries have deposit insurance, although this did not prevent the 2007-2008 financial crisis, so it seems. In many cases, systemic banks did not even have depositors.

Several issues play a role in designing optimal deposit insurance schemes. First, there is an important debate whether deposit insurance actually improves stability. Exposure to losses carries an incentive to monitor and to police the risk-taking behaviour of banks and their government financial regulators. Mispriced guarantees introduce scope for cross-subsidisation and moral hazard. In an empirical study, Demirgüç-Kunt and Detragiache (2002) conclude that explicit deposit insurance tends to be detrimental to bank stability. The negative impact of deposit insurance on bank stability tends to be stronger when the scheme is run by the government rather than by the private sector, and the more extensive the coverage offered to depositors is. Demirgüç-Kunt and Detragiache argue that deposit insurance schemes involving the private sector in their day-to-day management control moral hazard and financial fragility more effectively. Private deposit insurance schemes, however, also have important drawbacks. In the end, only the government can bear the risk of a full-blown systemic crisis since it involves a simultaneous collapse of all banks. Thus, government guarantees need to back private insurance schemes, undermining these schemes incentives to price correctly.

Second, a deposit insurance scheme may suffer from adverse selection. Requiring compulsory membership in the deposit insurance system for financial institutions increases the size of the insurance pool and prevents self-selection by low-risk institutions. The deposit insurance premium charged to banks should also reflect the risk that these banks will face a bank run. Such pricing may be difficult in the presence of asymmetric information.

Market information could play a role in reducing the information asymmetry between regulators and regulated. Market participants, however, only have an incentive to gather information when they have something at stake. Deposit insurance schemes should therefore limits insurance of large depositors, subordinated debt-holders and other banks understand that their funds are at risk. It seems particularly appropriate to avoid insuring interbank deposits—since such coverage would discourage banks from monitoring one another. Coinsurance and related private loss-sharing arrangements, such as subordinated debt and extended stockholder liability, sharpen these incentives. However, a particular deposit insurance mechanism should be credible. Frydl and Quintyn (2000) argue that limited deposit insurance schemes are inadequate to restore confidence. What is needed in such cases is the announcement of full protection for depositors and creditors. Such a guarantee aims to stabilise the banks' funding and prevent or stop bank runs.

Clearly, changing the deposit insurance scheme in the event of a crisis undermines the objective of reducing the incentive for moral hazard type behaviour in the future. Peria and Schmukler (2001) argue that deposit insurance schemes are never fully credible when either governments have reneged their promises in the past, if the deposit insurance scheme is under-capitalized, or if depositors are concerned about the cost of repayment (typically because of delays) through the deposit insurance fund.

5.4.3 Prompt Corrective Action

The US Federal Deposit Insurance Company Improvement Act introduced Prompt Corrective Action (PCA) in 1991. Under PCA, regulators' mix of mandatory and discretionary actions depends on whether bank's capital ratios cross certain thresholds. It aims to restrict banks' risk taking by progressively penalizing banks as their capital ratios deteriorate and to mitigate regulatory forbearance, i.e., to prevent regulators from postponing painful interventions in the hope that problems will solve themselves. The motivation behind the law is to provide banks with incentives to address problems while they are still small enough to be manageable.

The framework establishes a mix of mandatory and discretionary actions whenever a bank fails to maintain adequate capital. Examples include limits to dividend payments, restrictions to asset growth, restrictions to interaffiliate transactions, required authorisation to raise additional capital, and limits to credit for highly leveraged transactions. It sets out five categories of capital and mandates corrective action for banks in certain of the categories. Critically undercapitalised institutions, with a ratio of total capital assets below 2%, are required to be taken into receivership by the Federal Deposit Insurance Company. The Federal Deposit Insurance Company then resolves the bank so as to minimize its long-term losses or to minimize systemic risk.

Although it might seem a good idea to restrict banks' activities in this way, an obvious question is why ordinary capital adequacy regulation which does not restrict activities is insufficient. Freixas and Parigi (2000) argue that PCA improves upon capital regulation because agency problems due to moral hazard may differ among different classes of assets in a way uncorrelated with these assets' risk. If this is the case, then capital regulation may cope with risk and adverse selection, but is unable to reduce moral hazard at the same time.

Benston and Kaufman (1988) identify a number of advantages of PCA. First, it reduces the regulatory burden on well-capitalized institutions. Second, it mitigates the risk taking incentives embedded in deposit insurance schemes by increasing market discipline. Third, linking the regulatory response to an institution's financial condition directly would reduce the scope for regulatory forbearance. Finally, forcing regulators to close an institution at the point of insolvency would reduce the cost to uninsured depositors and to the taxpayer. As prerequisites for successfully implementing a PCA policy Mayes et al. (2008) identify supervisory independence and accountability, accurate and timely information, and adequate resolution procedures.

The sparse empirical work that tries to assess the impact of PCA on banks' risk concludes that the introduction of PCA has raised capital ratios and reduced risk (Aggarwal and Jacques, 2001; Elizalde and Repullo, 2006).

One issue with PCA is its scope. PCA in the US only focuses on commercial banks, while an important part of the problem of the current crisis lies within the investment banks and other non-bank institutions. It is therefore necessary to broaden the scope of prompt corrective action.

Another issue is to find the appropriate levels of capital at which measures are intensified. The Federal Deposit Insurance Company Improvement Act specifies 10%, 8%, 6% and 2% as critical capital ratios. It is unclear why these levels are chosen and whether they are appropriate in practice. Presumably, different banks may contribute to systemic risk in different ways. For example, risk taking by big or heavily interconnected banks may contribute more to systemic risk. As a consequence, trigger levels should be more stringent for such institutions.

Also, trigger levels should not be easy to manipulate. Risk adjusted capital ratios may therefore not be the most appropriate trigger mechanisms. Hart and Zingales (2009) suggest that large financial institutions maintain a capital cushion sufficiently great that their own credit default swap price stays below a threshold level. If this level is violated the regulator forces the large financial institutions to issue equity until the credit default swap price moves back below the threshold.

Finally, the PCA approach may run into trouble when asset values change rapidly. In that case, there is no gradual increase of regulatory intervention. The speed of the deterioration can interfere with the carefully planned procedure that regulators have devised to prevent insolvency or provide for an orderly dissolution. Regulators may not be able to prevent creditors to write contracts that allow them to withdraw early when a bank is sufficiently distressed.

5.4.4 Living will

To credibly allow banks to fail, governments have to ensure that the liquidation of the bank will not have too many negative spillover effects. One way to ensure this is to require banks to make plans to resolve themselves in a short period of time, the so-called “living will”. Such plans would also give banks an incentive to keep their structure simple (Rajan, 2009). To set up a living will, a bank has to make an inventory of its capital structure, guarantees provided and the valuation of their portfolio. This living will should be made from the perspective of a sudden liquidation.

However, there are some problems with designing a living will. First, the lack of uniformity. There is no consensus on the rules for setting up a living will. The issues included in the living will should be based on objective methods of measurement. At the same time, to keep the living will up-to-date will be costly, especially for reporting the value of illiquid assets. Also there is a problem that the living will itself will be to complex if more and more issues are included. Another problem according to the NYU working group (2009) is the identification and timing of a trigger variable. The purpose of a living will is to provide a swift rescue and to try to fulfil the obligatory payments as much as possible. However, if the identification variable reacts too late, the bank will be unable to fulfil any obligation.

5.4.5 Bank-specific bankruptcy law

In some countries, such as US, Canada, or Japan, banks are subject to special insolvency regimes that differ considerably from those applicable to other companies.[41] These jurisdictions confer considerable powers on administrative and regulatory agencies to deal with bank failures. Yet in other jurisdictions, such as most European countries, bank insolvency is treated no different from ordinary bankruptcy.[42]

From an economic point of view, bankruptcy laws for normal firms exist because the contracts that debtors can write are incomplete.[43] Thus in the case of expected bankruptcy, each individual debtor cannot do better than try to be the first to recover his debts, for example by seizing a firm's assets. This may lead to an inefficient dismantlement of a firm (Hart, 2000).

In the case of banks, the potential externalities from a bank's bankruptcy that are described in section 3 and section 4 are an important reason why a special bankruptcy regime should apply to banks. Such a regime should not only account for the inefficiencies individual claimants inflict on each other, but also for the inefficiencies they inflict on non claimants such as other banks and, ultimately, the taxpayer.

One example of such a bank-tailored bankruptcy law is the FDIC Improvement Act in the US, which increased the powers of the FDIC and the Fed by expanding their authority as a federal and primary regulator. They have the possibility to close a bank and appoint the FDIC as its statutory receiver. Before closing a bank most times it runs as a bridge bank which means that the bank still operates while the final disposition is being worked out. This bridge bank is owned and operated by the FDIC.

Some pitfalls in developing special bankruptcy laws for bank exist. The first issue is related to jurisdiction. As banks operate across different legal jurisdictions, the insolvency process itself creates a coordination problem across the courts in different countries. Jurisdictions may differ in several aspects.

First, legal approaches to bankruptcy resolution may be either pro-creditor or pro-debtor.[44] The distinction matters when bi-directional transactions between counter parties have to be settled. In payment systems, for example, banks send each other funds to settle thousands of transactions throughout the day. Whereas the gross positions are large, the net positions are

[41] According to Sheila Bair, in the US "the current bankruptcy framework available to resolve large, complex non-bank financial entities and financial holding companies was not designed to protect the stability of the financial system. (…) the FDIC has the authority to take control of only the failing bank subsidiary, thereby protecting the insured depositors." Statement of Sheila C. Bair Chairman, Federal Deposit Insurance Corporation on Regulating and Resolving Institutions Considered "Too Big To Fail" before the committee on banking, housing and urban affairs of the US senate.

[42] The UK has recently introduced a separate bankruptcy regime for banks.

[43] According to Hart, 2000, economists do not yet have a satisfactory theory as to why contracts are incomplete.

[44] Pro-creditor bankruptcy laws recognize the right of creditors to protect themselves against default through ex ante contractual agreements that permit the solvent counterparty to close out contracts and set off obligations. The pro debtor approach, seeks to maximize the value of the bankrupt bank by affirming claims due to the bankrupt firm and disavowing claims made on the firm. This approach often ignores ex ante contractual arrangements that would favour one creditor over another (Bliss, 2003).

relatively modest. Clearing payments in the case of the resolution of an insolvent bank can be done by using a close-out netting agreement. In general, close-out netting involves the termination of all contracts between the insolvent and a solvent counterparty (Bliss, 2003).

Another issue is the treatment of branches. Jurisdictions may also differ in how they treat branches. Branches of foreign banks will then be treated as separate legal entities. In a separate entity approach, the various branches of the bank located in different jurisdictions will be dealt with in separate legal proceedings. In contrast, when the single entity approach is adopted there will be only one of set insolvency proceedings in which the bank is treated as a whole. Such differences may lead to potentially adversarial competition among jurisdictions each seeking to maximize the value of assets available to their own creditors (Bliss, 2003). Coordination between jurisdictions may alleviate this problem.

To credibly allow banks to fail governments have to ensure that the liquidation of the bank will not have too much negative spill over effects. One way to ensure this is to require banks to make plans to resolve themselves in a short period of time, the so-called “living will”. Such plans would also give banks an incentive to keep their structure simple (Rajan, 2009).

6 Conclusions

The 2007-2008 financial crisis has put systemic risk at the centre of the academic and policy debates. It is therefore important to make the notion of systemic risk in financial markets more precise. Systemic risk refers to the probability that a systemic crisis arises. This probability depends largely on the externalities from banks' risk taking. These externalities exist because several mechanisms propagate and amplify the effects of a shock to the financial system to the extent that it can no longer efficiently perform its intermediary function.

We identify two amplification mechanisms that create externalities from individual banks' risk taking decisions: contagion within the financial sector and the pro-cyclical connection between the financial sector and the real economy. The basic mechanisms for contagion are interconnectedness, the potential for informational spillovers, and liquidity-freezes. The basic mechanisms for pro-cyclical connections are imperfect regulation, credit rationing, and herding.

Regulation can try to diminish systemic risk by forcing banks to internalise the external effects of their risk taking, or seek to dampen propagation mechanisms. Alternatively, regulation may try to reduce the probability that an individual bank fails. Government regulation of financial intermediation takes the form of banking supervision, deposit insurance, capital requirements, lender of last resort facilities and bank crisis resolution regime. Although some of these measures reduce externalities (for example lender of last resort) or dampen propagation mechanisms (for example deposit insurance), regulation has traditionally focussed on reducing the probability that an individual bank fails by imposing adequate capital requirements. It is, however, now widely recognized that regulation should instead focus more on systemic issues. Unfortunately, four generic problems interfere with effective regulation of systemic risk.

In view of these generic problems, policies that try to reduce systemic risk should meet several requirements. First, they should give financial intermediaries the incentive to reduce systemic risk. Second, they should give regulators sufficient incentives to intervene and reduce governments' time-inconsistency problem. Third, they should not depend on complex information, but instead be easy to enforce and difficult to manipulate. Finally, they should increase market discipline.

Strengthening market discipline and making optimal use of information generated by markets are the best way to overcome the measurement problem, prevent regulatory gaming, reduce the scope for regulatory forbearance, and address governments' time-inconsistency problem. Policy measures that contribute to this goal include prompt corrective action, a bank-specific bankruptcy regime, a living will, and isolating crucial parts of the financial system. This, however, requires that at least some financiers have something at stake when they lend their money to a bank. With some probability they should loose their money.

It should therefore be credible for the government to allow a bank to go bankrupt. Several policy measures contribute to this goal including prompt corrective action, bank-specific

bankruptcy regime, living will, and isolating crucial parts of the financial system. For example, the payments system should be designed in such a way that it is able to function, despite the bankruptcy of one of its users. Decoupling this crucial public utility function from banks would reduce spillovers from a bank failure to the real economy and help the government in committing not to bail out financial intermediaries when they go bankrupt.

Finally, we should realise, however, that systemic risk is inherent in the functions of banks: reducing moral hazard by monitoring borrowers, smoothing the idiosyncratic liquidity needs of consumers and firms and facilitating payments. The interconnectedness of banks is driven by banks' desire to insure against unexpected liquidity shocks and the opportunities for diversification offered by idiosyncratic risks. Banks' fragile funding structure results from the illiquidity of their assets and funding through demandable deposits and short-term loans. Procyclicality results from the agency costs that tie the amount of collateral firms' can generate to the amount they can borrow. It is both impossible and undesirable to fully eliminate systemic risk.

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