

Summer, Martin

Working Paper

Banking Regulation and Systemic Risk

Working Paper, No. 57

Provided in Cooperation with:

Oesterreichische Nationalbank (OeNB), Vienna

Suggested Citation: Summer, Martin (2002) : Banking Regulation and Systemic Risk, Working Paper, No. 57, Oesterreichische Nationalbank (OeNB), Vienna

This Version is available at:

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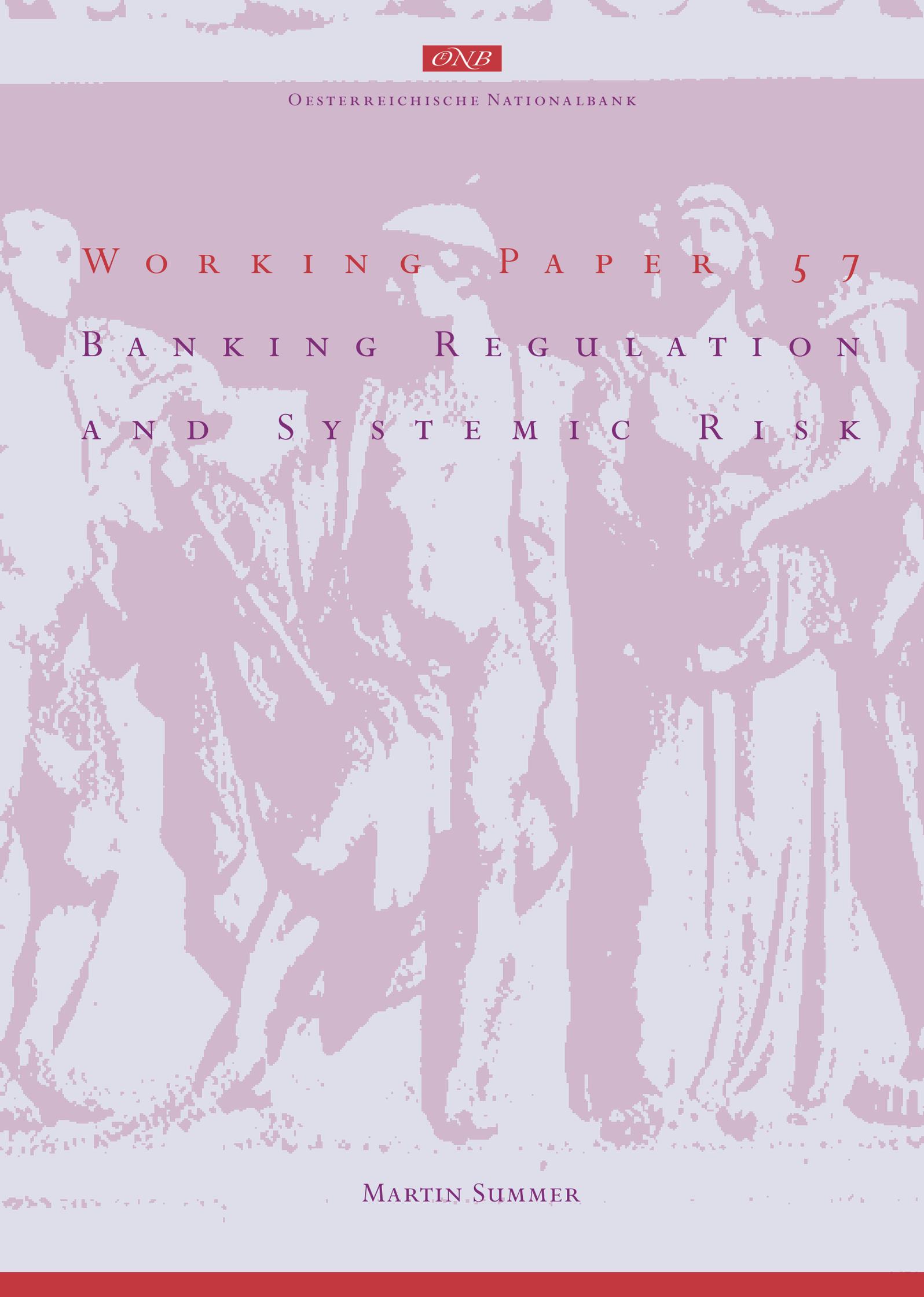
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A detailed black and white engraving of three figures in historical attire. The figure on the left is a man in a long coat and hat, holding a staff. The figure in the center is a woman in a long dress and hat, also holding a staff. The figure on the right is a woman in a long dress and hat, holding a staff. The background is a textured, light-colored surface.

WORKING PAPER 57

BANKING REGULATION

AND SYSTEMIC RISK

MARTIN SUMMER

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Imprint: Responsibility according to Austrian media law: Wolfdietrich Grau,
Secretariat of the Board of Executive Directors, Oesterreichische Nationalbank
Published and printed by Oesterreichische Nationalbank, Wien.

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Editorial

The term *Systemic Risk* belongs to the standard rhetoric of economic policy discussions related to the banking industry. Besides of the goal of protecting small depositors control of systemic risk is given as one of the main arguments for banking regulation. Various recent financial crises have increasingly focussed the regulatory debate on issues of systemic risk and financial stability. In this paper, however, Martin Summer argues that there is no generally accepted definition of systemic risk and the effectiveness and the economic consequences of various instruments of banking regulation that are intended to attenuate it are still only partially understood both theoretically and empirically. Furthermore he discusses some of the issues raised in this debate by reviewing recent contributions to the academic literature.

January 7, 2002

Banking Regulation and Systemic Risk*

Martin Summer
Oesterreichische Nationalbank
Economic Studies Division
POB 61
A-1011 Wien

Abstract

The term *Systemic Risk* belongs to the standard rhetoric of economic policy discussions related to the banking industry. Besides of the goal of protecting small depositors control of systemic risk is given as one of the main arguments for banking regulation. Various recent financial crises have increasingly focussed the regulatory debate on issues of systemic risk and financial stability. There is, however, no generally accepted definition of systemic risk and the effectiveness and the economic consequences of various instruments of banking regulation that are intended to attenuate it are still only partially understood both theoretically and empirically. In this paper we make an attempt to discuss some of the issues raised in this debate by reviewing recent contributions to the academic literature. Our focus is on papers that explicitly model the interaction of many heterogeneous banks. We first briefly review some general ideas that lie at the heart of the discussion about systemic risk in the banking sector. We then give a brief account of the regulatory instruments that are believed to mitigate problems of systemic risks. In a next step we discuss recent contributions to the literature. We focus on three main problems: Hidden aggregate exposures of the banking system, incentive problems and coordination failure. In a final section we discuss some theoretical and empirical issues which we consider as particularly important: The modeling of mutual credit exposures in financial networks, the macroeconomic consequences of banking regulation, the problem of consistency between different regulatory instruments and, finally, the problems of measuring systemic risk.

Keywords: Banking Regulation, Systemic Risk, Banking Crises
JEL-Classification Numbers: G21, K23, L51, E58

*The views expressed in this paper are strictly those of the author and do not necessarily represent the views of the OeNB. Helpful comments by Bob Chirinko, Jürgen Eichberger, Simon Gächter, Eduard Hochreiter, Markus Knell, Peter Mooslechner, Tom Mayer, Gabriela de Raaij, Burkhard Raunig, Klaus Ritzberger, Hyun Song Shin, Helmut Stix and Workshop and Conference Participants at Sveriges Riksbank, University of St. Gallen, WEA and the Bundesbank are gratefully acknowledged. The usual disclaimer applies.

1 Introduction

In view of several financial crises during the past two decades issues of financial stability have gained a prominent role in economic policy debates. This increasing concern with the stability of the financial system has also refocused the regulatory debate related to the banking industry from issues of protection for small depositors to problems of “*Systemic Risk*”. While these problems are discussed in connection with the financial system in general - including markets, institutions and the payment system - banks are usually supposed to play a key role. It is a widely held belief among economists, regulators and the general public that the banking system is particularly prone to the dangers of systemic crises, to financial fragility, panics and contagion. The fear that a few institutions in distress can tear down the entire financial system and in consequence trigger a general economic recession is wide spread. This fear is partially rooted in past and recent experiences of financial crises. Much research, empirical as well as theoretical, about the costs arising from the spillover of bank failures to the real economy supports the belief that these fears are not without foundation.¹

Perhaps somewhat surprisingly the arguments supporting the hypothesis that such crises can be prevented by suitable regulation of the banking sector are not as firm as one might expect given the huge amount of public and political attention this problem has achieved. This refers to the theoretical literature as well as to the empirical evidence that has been provided.² Many of the arguments in the debate about systemic risk and regulatory instruments that are meant to mitigate or even prevent it have not yet been scrutinized to the extent one might wish. Indeed, despite of the fact that systemic risk is one of the most popular catchwords in the debate about banking regulation, it is fair to say that there does not exist a precise definition of this notion except of the vague understanding that there are special problems in the banking industry arising from the linkages of different banks.³

¹Important papers on this issue begin with the work of Fisher (1933), Friedman and Schwartz (1963) and continue with the work of many scholars such as Bernanke (1983), Bernanke and Gertler (1983), Bernanke and Lown (1991), Kashyap and Stein (1993), Holmström and Tirole (1997), Kang and Stulz (2000) and Peek and Rosengreen (1997, 2000).

²Empirical evidence about the effect of regulation on banking stability and performance are relatively rare. See, however, the work of Caprio (1998) as well as Barth, Caprio, and Levine (1999) and the references to past and recent empirical literature cited there.

³A recent book (Kaufmann (1995)) containing a collection of essays under the title “*Banking, Financial Markets and Systemic Risk*” shows the remarkable feature that all the contributions by experts in this field stress the fact that it is unclear what systemic risk actually means and give individual definitions that differ substantially. For instance Bartholomev and Whalen (1995) define systemic risk as “*the likelihood of a sudden, usually unexpected, collapse of confidence in a significant portion of the banking or financial system with potentially large real economic effects.*” (p.7) Anna Schwartz in the same volume, regards the term as useless: “*the terms systemic risk could be dispensed with, with no loss to the analysis of putative disruptions of the payments and settlements system, the essence of a financial crises*” (p. 20), Frederic Mishkin (1995) suggests the definition: “*Systemic risk is the likelihood of a sudden, usually unexpected, event that disrupts information in financial markets, making them unable to effectively channel funds to those parties with the most productive investment opportunities*” (p.32). George Kaufmann a few pages later writes: “*To me systemic or contagion risk is the probability that cumulative losses will occur from an event that sets in motion a series of successive losses along a chain of institutions of markets comprising*

At first glance the literature shows that systemic risk is used as a description of many different phenomena as has been pointed out by Dow (2000) and by De Bandt and Hartmann (2000). It is used to describe crises related to the payment system, to bank runs and banking panics, to spillover effects between financial markets up to a very broadly understood notion of financially-driven macroeconomic crises. In this paper we want to confine ourselves to the banking system and rely on a vague and broad notion of systemic risk. We think of systemic risk as the problem of simultaneous failure of many banks. We are particularly interested in the role that is played in this context by mutual credit exposures among banks.

Despite of the frequent reference to issues of systemic risk much of the literature on banking regulation (see Freixas and Rochet 1997) as well as large parts of regulatory practice are primarily concerned with single institutions. Until recently issues that arise from the fact that in a modern banking system many heterogeneous institutions interact were relatively rarely discussed in the academic literature though these issues lie at the heart of the policy debate about systemic risk in the banking sector. There is an increasing awareness, however, that these issues of "*macro-prudential dimensions of financial stability*" (Crockett, 2000) need a deeper understanding.

It is the purpose of this paper to discuss some of the issues related to banking regulation and systemic risk by reviewing recent contributions to the academic literature. The paper is mainly concentrated on conceptual and theoretical ideas, though we make an attempt to give references to empirical work as we go along.

There have been some related papers, most notably De Bandt and Hartmann (2000), Dow (2000), Staub (1998), Hellwig (1997). De Bandt and Hartmann (2000) discuss systemic risk with respect to the entire financial system. It gives a fairly comprehensive survey of the theoretical and empirical literature. It also proposes a broad concept of systemic risk. Dow (2000) gives a selective survey of the literature and discusses some aspects of what systemic risk actually is. Hellwig (1997) mainly connects the issues related to systemic risk to some of the open problems in the theory of financial intermediation. Staub (1998) focuses on the interbank market as an important institution relevant to systemic risk. In contrast our paper is focussed on the question of what the recent literature has to say about the effectiveness of some of the existing instruments of banking regulation in mitigating systemic risk. It is our hope that it is helpful in highlighting some of the issues that need to be addressed in this debate.

2 Systemic Risk in the Banking Sector

The notion of systemic risk is perhaps one of the most popular terms used in connection with the discussion of crises in the banking system, both by regulators and in the academic literature. Despite of the lack of a precise definition it seems that most authors have in mind the problem of simultaneous failure of many institutions. This is a problem

a system" (p. 47). Going through the volume a couple of other definitions could be cited.

because there is evidence that the spillover effects from widespread bank failures to the real economy are very costly. In the following we attempt to give a broad outline of what seem to be the main ideas in the literature that lie at the heart of many discussions of systemic risk in the banking sector.

A recurring theme are problems of *contagion* often referred to as *domino effects*. The tight network of credit interconnections in the banking system creates a special source of risks, that can induce chain reactions emanating from the distress of a few institutions or from macroeconomic shocks that get propagated via the banking system. It might seem surprising that this is seen as a phenomenon special to the banking system. In fact complicated financial interconnections between firms is a typical feature of many industries in modern economies. So why is the discussion of systemic risk seen as particularly relevant to the banking sector? Probably the main reason is simply to be found in historical experiences of financial crises and the huge spillover costs from systemic banking crises to the real economy.⁴ In fact the reference to historical banking crises is frequently given as the main argument for the particular relevance of systemic risk for the banking sector. It is very rare that the literature on systemic risk contains a critical discussion about the relevance of the historical experience for the current situation. Furthermore many historical cases don't allow a clear-cut interpretation⁵. The financial sector and the banking industry have also been probably one of the most dynamic sectors since the early seventies and have gone through a spectacular wave of structural change. Thus the role of the banking system for the real economy has probably changed since these times and certainly since the times of the great depression. These problems notwithstanding, the potential for domino effects and contagion in the banking sector is taken for granted by regulators and in numerous contributions to the literature.

The fragility of a complicated network of cyclical credit exposures under circumstances of uncertainty combined with the combination of short-term debt and long-term illiquid assets of individual institutions, also makes the banking system particularly prone to information effects and panics. The mere fear that some contracts might not be honored somewhere in a complicated network of mutual obligations can become self-fulfilling and can finally lead to a chain reaction of default. This source of systemic risk is also often referred to as an *information effect*.

⁴Perhaps another reason lies in the nature of financial contracts. These contracts are promises to future payments of income (see Geanakoplos 1998). Typically one party to the contract has to pay today to receive repayment in the (maybe quite distant) future. Since this involves a lot of uncertainty it is not clear at the outset whether the parties to the contract will be actually able to honor their promises. The problem gets even more complicated by the cyclical nature of exposures in a network. The ability of a single party to honor its promises depends on whether other parties in the network will be able to honor their promises. Metaphorically speaking, promises can be made and be broken almost instantaneously and shocks and default can possibly propagate very quickly in a network of financial contracts. Of course this fact led to a rich set of legal rules to ensure that promises inherent in financial contracts will be kept. These institutions however work only imperfectly and some do poorly in a situation of system wide crises. For instance in a system-wide crisis a creditor may find the value of his collateral typically depressed exactly when his counterparty defaults.

⁵For instance Hellwig (1997) points out that it is not clear whether the crises of Danatbank in June 1931 caused the banking crises in Germany or whether it triggered an unavoidable run on the Reichsmark, which resulted in a bank run. (See Hellwig (1997) p. 124)

In summary, the heart of the systemic risk discussion is basically a hypothesis about the inherent fragility and instability of the financial system.⁶ To clarify and analyze the financial fragility view it has to be combined with a theory of economic behavior and risk taking. Thus it needs to be complemented with a theory of the behavior and incentives of banks. One concern in this context is that banks, due to information, coordination or incentive problems, tend to take risks that could in principle be better diversified. By taking for instance simultaneous exposures to common risk factors banks increase the likelihood of joint failures of many institutions. Some authors emphasize incentive effects of capital structure which encourage risk shifts from shareholders to borrowers, others point out herding phenomena and coordination failures. Other authors are concerned with the risk allocation effects related to the banking business. The core of the banking business has traditionally been to take short term debt (deposits) and invest these funds into long-term illiquid assets. The uncontingent and demandable nature of the deposit contract has the consequence that banks take a considerable part of an economy's interest rate risk. Since this is an aggregate risk it can not be diversified away. But given we take it for granted that there are high costs of the spillover from bank failures to the real economy the question is then "*why the banking system is bearing these risks rather than somebody else*" (Hellwig, (1998), p. 330).

Taking all these ideas together, the problem of systemic risk in the banking sector boils down to the study of a *risk allocation problem*, where particular emphasis is given to the influence of the interdependence between many institutions and the problem of chain reactions of default triggered by mutually connected credit exposures.

From this perspective it becomes clear why systemic risk can be relevant for regulation.⁷ The classical economic theory of regulation is built on a theory of market failure. In view of this theory regulation is justified (and indeed necessary to prevent or mitigate inefficiency) in cases of market power, in the presence of externalities and in situations of asymmetric information between market participants. (see for instance Laffont, (1988)). As Freixas and Rochet (1997) observe, banking regulation can partially be viewed under this perspective, but they think that the issues in banking are "so intertwined that a specific analysis is called for" (p. 258). Whatever the specific analysis might come down to in the end any theory of banking regulation and systemic risk has to answer the question whether there are externalities or problems of asymmetric information and incentives that lead to situations in which the banking system takes on risks that could in principle be better diversified or whether the banking system takes an exposure towards aggregate risks that is too high compared with a socially optimal allocation. It has to analyze the consequences of the close interdependence of many institutions in a system for the analysis of this risk taking behavior and provide a framework that allows to assess the

⁶This is termed "the financial fragility hypothesis" by De Bandt and Hartmann (2000).

⁷Having said this it should be stressed that it does not mean that we should take this relevance for granted. Looking at the issues rigorously we have to admit that they are still poorly understood. It is thus hard to assess the effect of regulatory measures on systemic risk. Furthermore one should always keep in mind that there is a political economy aspect to banking regulation, where regulators and the banking system share a mutual interest in shielding financial institutions from competition (see Hellwig, 2000). To disentangle these aspects from functionally necessary regulatory rules, a firm understanding of the issues is urgently called for.

performance of different regulatory instruments in this context.

Having said this it should also be stressed that it does not mean that we should take the need for regulation for granted at the outset. Looking at the issues more closely we have to admit that they are still poorly understood. It is thus hard to assess the effect of regulatory measures on systemic risk. Furthermore one should always keep in mind that there is a political economy aspect to banking regulation, where regulators and the banking system share a mutual interest in shielding financial institutions from competition (see Hellwig, 2000). To disentangle these aspects from functionally necessary regulatory rules, a firm understanding of the issues is urgently called for.

3 Instruments of Banking Regulation

According to Mishkin (2000) the instruments of banking regulation can be described by the following basic categories: The government safety net, restrictions on bank asset holdings, capital requirements, chartering and bank examination, disclosure requirements, consumer protection and restrictions of competition. Similar categorizations can be found in other sources as for instance in Freixas and Rochet (1997) or in Greenbaum and Thakor (1995).

The prevention of systemic risk is frequently given as an argument for most of these measures. In the following we want to give a brief account of regulatory instruments that are most frequently mentioned in connection with problems of systemic risk.

3.1 Deposit Insurance

A major part of research on banking regulation has been concerned with the fragility of fractional reserve banking. The combination of a capital structure that consists largely of short-term debt (deposits) which is used to finance long-term illiquid loans has made banks traditionally prone to bank runs and banking panics and it has puzzled economic theorists how this unstable combination of short term debt and long term illiquid assets can be explained. A large part of the economic theory of intermediation actually deals with this explanation (see Freixas and Rochet (1997) for an overview and Diamond and Rajan (1999) for a recent theory).

The probably most famous papers in this literature have been Bryant (1980) and Diamond and Dybvig (1983), influencing large parts of the banking literature up to the present. This theory explains the short term and uncontingent nature of bank deposits as a possibility for depositors to insure against the uncertainty about the timing of consumption needs. A bank - only knowing the distribution of liquidity needs in the economy - can provide this insurance by making use of the law of large numbers. By just keeping enough funds to meet the needs of depositors in expectation it can offer deposit contracts and invest part of the funds in high return, long term but illiquid investments. A famous result in this theory of banking as liquidity insurance is that the insurance game between a

bank and its depositors has two Nash equilibria in pure strategies. One equilibrium is always a bank run equilibrium resulting in inefficient liquidation of long term assets. This equilibrium is costly and wasteful because it can lead to a run on a solvent bank by a mere phenomenon of self fulfilling prophecies. Deposit insurance and the establishment of a lender of last resort are two classical institutions of banking regulation that have been established to eliminate this inherent instability of fractional reserve banking. However, these instruments have created new incentive problems instead. (See for instance Milgrom and Roberts (1992), Greenbaum and Thakor (1994), Freixas and Rochet (1997), Mishkin (2000)). Much has been written about these issues and the problems of deposit insurance are well understood. (For a detailed discussion of deposit insurance see Bhattacharya, Boot and Thakor (1998). For a comprehensive discussion of banking regulation in a bank run model, see Eichberger and Harper (1997), Eichberger and Milne (1991)). We will therefore not deal with this topic in further detail here but refer to the literature instead.

There is, however, another reason why we refrain from a closer discussion of the traditional bank run literature. Though bank runs and banking panics are usually discussed under the header of systemic risk, the theoretical framework of liquidity insurance, which is largely used to discuss and analyze this problem, does not provide much guidance on the question what is "systemic" about the inefficient Nash equilibrium. In fact - at least in the light of this theory - the bank run equilibrium has nothing to do with the interdependence of banks in a banking system. In theory it is an equilibrium coordination problem that occurs even when all depositors keep their funds in a single institution. Furthermore in the framework provided by this theory deposit insurance solves the bank run problem.

The literature on information based bank runs has developed models, where adverse information about bank returns acts as a trigger mechanism. These models come closer to the systemic aspects of bank runs, since a run is not explained as a mere sunspot phenomenon. These models include Jacklin and Bhattacharya (1988), Chari and Jagannathan (1988) Postlewait and Vives (1987) and Gorton (1988). There is also a recent literature that embeds the Diamond-Dybvig model into a game theoretic framework of higher order beliefs, initially introduced by Carlsson and van Damme (1993). In this framework agents make noisy observations about fundamentals. These observations function as a coordination device for agents beliefs about the true state of the economy. The construction allows to determine a unique equilibrium for each realization of fundamentals in a liquidity insurance model a la Diamond and Dybvig. An excellent paper analyzing this approach is Goldstein and Pauzner (2000). Dasgupta (2000) extends this framework to explain contagious bank failures due to bank runs. Neither Goldstein and Pauzner (2000), nor Dasgupta (2000) apply their framework to discuss the instruments of banking regulation.

The empirical literature has provided some insight into the systemic aspects of bank runs. It has been concerned with evidence for the problem that the run on a single bank might spread by contagion to a run on other possibly solvent institutions. The evidence provided shows conflicting views on the issue of contagious bank runs. While Kaufman (1994) denies that there is any conclusive evidence on this phenomenon⁸ Schoenmaker

⁸Kaufman (1994) writes in his conclusions: "... there is no evidence to support the widely held belief that even in the absence of deposit insurance, bank contagion is a holocaust that can bring down solvent

(1996) argues to the contrary that evidence for contagion risk in banking *can* be given. He criticizes that studies of contagion risks, such as Kaufman (1994) suffer from the drawback that they examine data samples from periods where the central bank played an active role as a lender of last resort to the banking system. Looking at a U.S. data set from a period before the establishment of the federal reserve system, Schoenmaker finds evidence for contagion risk. Other evidence from a detailed study of the Chicago banking panic of June 1932 provided by Calomiris and Mason (1997) find that the panic did not lead to significant costs in terms of failures of solvent banks.

3.2 Capital Adequacy

Capital adequacy has become one of the focal instruments of modern banking regulation by the work of the Basle Committee of Banking Supervision. Capital adequacy requires banks to hold capital as a function of their risk-weighted assets to serve as a "buffer" for losses they might incur. Capital requirements are also supposed to have an indirect incentive effect related to capital structure. By reducing the relative amount of debt more capital reduces risk-taking incentives. This has to do with an important incentive feature of debt finance combined with the legal construction of limited liability. Limited liability implies that after all assets have been liquidated and all outstanding debt has been redeemed as far as possible, the remaining debt is forgiven.⁹ Thus, the cash flows of owners under limited liability can not become negative. The incentive effect of this legal construction has been extensively discussed in the corporate finance literature under the notion of *risk shifting*. Since owners in a leveraged firm have all the gains from success but can pass on losses to the lenders by limited liability, they have an incentive to take more risk than a Pareto optimal risk allocation between the different claimholders would require. In fact it is easy to imagine examples where owners could have an incentive to pursue even projects with a negative net present value (see for instance Milgrom and Roberts (1992)). Since banks have a capital structure with debt of sometimes up to 90 percent risk shifting is supposed to be particularly problematic in banking. There is some indirect evidence identifying the risk shifting phenomenon in banking provided by Keely (1990). (Further evidence is cited in Greenbaum and Thakor (1995).)

Capital adequacy is thus a regulatory instrument that not only provides a "buffer" in bad times but also prevents excessive risk taking ex ante. (Rochet, (1992); Dewatripont and Tirole (1993)). It is hoped that the attempt to regulate the safety and soundness of a single institution in this way will make the banking system as a whole less prone to risk and crises.

There is a literature dealing critically with capital adequacy, which we do not discuss here. The reason for this omission is that these papers take a partial equilibrium framework and analyze the decision problem of a single bank, given a capital requirement. All of these contributions do not analyze the issue how capital adequacy works in a system with many heterogeneous banks. This does not mean that they are irrelevant for issues

banks, the financial system, and even the entire macroeconomy in a domino fashion." p. 143.

⁹See Eichberger and Harper, (1997), p. 163.

of systemic risk. To the contrary, if capital adequacy does not contribute to the safety and soundness of a single institution it can not contribute to the prevention of systemic risk. However, since we are mainly concerned with papers that explicitly model a banking *system*, we refer the interested reader to the literature (see Kim and Santomero (1988), Rochet (1992), Dewatripont and Tirole (1993), Gehrig (1995, 1996), and Blum (1999), Calem and Rob (1999)).

3.3 Resolutions of Bank Failure

The rescue policies for distressed banks are an important tool of crises management. Despite its detrimental effects on ex ante incentives of bank owners, ex post interventions are relatively frequent. Just to give some examples, since the Eighties there have for instance been bank rescues in Argentina, Indonesia, Chile, Thailand, South Korea, Malaysia, Venezuela, Mexico, Japan, the Czech Republic, Finland, Hungary, Brazil, Russia, Sweden and the United States.

Goodhart and Schoenmaker (1993), based on a data set of 104 bank failures in 24 countries suggest a categorization of resolution methods. These instruments can range from liquidation to bank sales (mergers), government takeovers until open assistance. The latter is probably the most spectacular case of regulatory intervention often called a "bail out". Ex post rescue operations are usually extremely costly. Citing a recent study by Caprio and Klingbeil (1999), Mishkin (2000) reports a table listing the costs in percent of GDP of rescuing banks in the countries enumerated above. These costs range from 3 percent in the United States up to 55 percent in Argentina. Rescue operations are usually justified by preventing crises of the entire financial system ex post, because the bailed-out banks have "systemic" importance. Again here we have a case of regulatory intervention connected to problems of systemic risks. In the same way as with capital adequacy the rationale for bail-out policies remains controversial. The central issues that arise here are incentive problems. More specifically, bank rescues are an ex post instrument that feed back on incentives for taking risks ex ante. It has therefore to be checked how these incentives fit together with instruments such as capital adequacy that are targeted to ex ante risk taking behavior.

There is an important microeconomic literature on bank failure resolution based on the theory of incomplete contracts (Aghion and Bolton (1992), Dewatripont and Tirole (1993), Repullo 1993)), which we will not discuss here. Again the reason is that we want to focus on papers which explicitly discuss models of interaction between heterogeneous banks. A good summary of the main results of the incomplete contract approach to bank regulation can be found in Freixas and Rochet (1997).

3.4 Bank Supervision and Assessment of Risk Management

An important instrument of banking regulation which is in place in most countries is the direct supervision of banks. Regular on-site examinations are used to monitor the banking

system and to enforce regulations such as capital adequacy. In recent times supervisors have also increased their attention to directly assess the risk management procedures and the general management process of the bank. The key question from the viewpoint of preventing systemic risk through supervision is, which information should supervisors look at? Does it suffice to assess institution by institution on a regular basis to capture dangers of systemic risk in the banking system?

In the following discussion we want to keep in mind all of these regulatory instruments and ask ourselves whether the recent literature on systemic risk can contribute to the deeper understanding and the critique of these instruments. In the following we want to review some recent papers without claiming to give a complete survey.¹⁰ We hope however that the discussion nevertheless gives a reasonable picture about some of the important issues.

4 Models of Systemic Risk

4.1 Aggregate Risk and Hidden System Exposure

Hellwig (1995, 1997, 1998) has pointed out that crises of entire banking systems usually occur in conjunction with macroeconomic shocks, like interest rate and exchange rate shocks or recessions. These shocks are aggregate risks and thus are by their very nature not diversifiable. The only way the banking system can deal with these kind of risks is to either limit its aggregate exposure or individual banks can pass the risks on to other parties who are better able to bear them. In principle, there are several ways how aggregate risks faced by banks can be passed on to other parties. As observed by Hellwig (1995) and Staub (1998), they can be shifted to borrowers, to lenders or to third parties. If the main problem of systemic risk is simultaneous default of many institutions, these strategies will, however, work only partially. As pointed out by Hellwig (1995, 1997, 1998) the only successful way for banks to reduce the possibility of insolvency is to pass on these risks to depositors, because the bank's deposit obligations are then tied to its return.¹¹ The other strategies will only be partially successful because the bank will just substitute for instance its interest rate risk by a credit risk. As pointed out by Hellwig (1994, 1997) de facto aggregate risks in banking are not shifted to depositors. The deposit contract is demandable and does not include clauses for macroeconomic risks, such as interest of exchange rate risk: It is non-contingent and makes banks vulnerable to aggregate shocks. Hellwig (1994, 1997) points out that this fact is difficult to understand theoretically. In a liquidity insurance model with technologically induced interest rate

¹⁰However, once the papers on bank runs in the tradition of the Bryant- Diamond and Dybvig model are taken out of the picture the literature on systemic risk and banking regulation seems yet to be still rather small and fragmented though the literature has been developing extremely rapidly in the last two years. (See De Bandt and Hartmann (2000)).

¹¹Hellwig (1995), p. 729 points out: "to be sure, the depositors will require a risk premium for the risk he assumes. However, given the real assets that are financed and given the risks inherent in these assets, these risks have to be borne anyway, and whoever bears them will require a risk premium. There is no prior presumption that the risk premium required by depositors will be larger than the risk premium demanded by anybody else, in particular a shareholder. "

risk, he demonstrates (Hellwig (1994)) that an optimal risk sharing arrangement requires that the deposit contract specifies that impatient consumers bear part of the economies interest rate risk. What is observed instead is that banks try to pass interest rate risk on to third parties via derivative contracts. A typical example is the frequently used instrument of an interest rate swap. However, as pointed out by Hellwig (1997) and Staub (1998), an interest rate swap creates a mutual credit exposure between the parties and carries a default risk. This counterparty risk is correlated with the interest rate risk which was intended to be passed on. The interest rate swap only partially allows to pass on interest rate risk since due to the correlation problem the risk comes back to the bank in form of a credit risk. Since the bank usually doesn't know its counterparty's position and the position of the counterparties of the counterparty etc., the bank may be part of a cascade in which credit risks are highly correlated, without being aware of it.

A similar problem occurs if a domestic bank borrows in foreign currency and lends in this currency to domestic firms to eliminate currency risk. However, once a devaluation of the home currency has taken place the firms to which the bank has lent may have insufficient foreign currency income to service their debt. This happened for instance during the Asian banking crises in 1997, after the domestic currencies saw a devaluation against the dollar.

The basic point in Hellwigs argument is that aggregate risks borne by the banking sector stay within the system as systemic risk of chain reactions of default triggered by mutual credit exposures.

Taking the vulnerability of the banking system to macroeconomic shocks to the center of the debate about systemic risk has implications for banking supervision. Given that aggregate risks are not passed on to depositors by the banking system all that can be done in principle is to limit the exposure of the entire system to aggregate risks. In the light of these arguments a supervisory practice that proceeds bank by bank is flawed because it fails in this way to detect the risk position of the banking system as a whole. To uncover these hidden aggregate exposures some pooling of relevant information would have to be provided, which is at the moment not available. As pointed out by Staub (1998) the contractual obligations between banks, which are highly relevant to hidden aggregate exposure, are OTC derivative and money market transactions, which are off the banks's balance sheet. A regulator with a systems perspective would not entirely concentrate on the supervision of single institutions but he would want to know the exposure of the banking system as a whole. Theoretically it is clear that information that conveys the exposure of the system can not be obtained from the supervision of single institutions without knowing their mutual exposures. An extreme example, illustrating this point with a case of maturity transformation is given by Hellwig (1995, 1997): "*...consider an institution that finances itself by issuing fixed-interest securities with a maturity of n months and that invests in fixed-interest rate securities with a maturity of $n + 1$ months. On the face of it, maturity transformation is small, and interest risk exposure is minimal. Suppose however that we have 479 such institutions. These institutions may be transforming a one-month deposit into a forty year fixed-interest rate mortgage, with significant interest rate risk exposure of the system as a whole. The interest rate risk exposure of the system as a whole is not visible to the individual institution unless it knows*

that it is but an element of a cascade and that credit risks in the cascade are correlated.”

The problem of hidden aggregate risk exposure, discussed in Hellwig and Staub, is certainly a highly relevant one for the problem of systemic risk. Some of the recent banking crises, for instance in Scandinavia and in Switzerland or the banking crises in Asia all showed elements of this phenomenon (see Dow 2000). Though there does not exist a formal model yet, allowing a more precise discussion of the problem, the argument has direct implications for the current practice of banking supervision. Supervision that is able to detect hidden aggregate exposure must face a major reorientation from a practice that proceeds institution by institution to a system perspective. What this practically means in terms of reporting and measurement remains up to now an important open issue. How it can be decided what amount of aggregate exposure a society is willing to take - given aggregate exposure could be measured in a meaningful way - is an even more difficult problem.

There are also some issues related to the aggregate exposure problem, which are difficult to address. Conceptually it is clear what an aggregate risk is. Practically this is a question which is much harder to decide in a clearcut way. The question what are relevant aggregate risks for banks can only be decided empirically.¹² Another problem is more fundamental. It is not clear how to decide about a pareto optimal aggregate exposure of the banking system. The literature on intermediation (see Freixas and Rochet, chpt. 1) shows that frictions have to be added to the standard general equilibrium model to explain the economic role of intermediation. Thus in any model of intermediation we are from the outset in a second best world, where welfare analysis is difficult. Furthermore relatively little progress has been made so far in embedding banking models into a general equilibrium framework that can be used for conducting such a welfare analysis.

4.2 Incentive Problems and Systemic Risk

The idea that capital structure can have substantial effects on risk taking behavior has been analyzed frequently in the modern theory on corporate finance (see Milgrom and Roberts 1992). We have already discussed the incentive effects of capital structure. By limited liability, equity has an option character. It becomes more valuable, when the underlying asset - the value of the firm - becomes more volatile (Merton (1974)). The incentive effects of such risk shifts are particularly strong in banking because banks have a capital structure consisting largely of debt. Most papers analyzing risk shifting incentives are not dealing with banking systems but rather with the partial analysis of single institutions. (See Dewatripont and Tirole (1993), Blum (1999)).

Acharya (2001) addresses the systemic problems that arise from risk shifting incentives in a banking system. Leaving interbank relations aside Acharya analyses incentive problems leading banks to invest into correlated assets, thereby taking excessive risks. "Excessive" risks means more than a Pareto optimal allocation would require, taking into account the interest of depositors as well as the social costs of financial distress. He applies this model

¹²I have to thank Burkard Raunig for pointing this problem out to me.

to assess current regulation measures, most importantly the design of rescue policies and capital adequacy. Contrary to the previous papers which have been focussed on problems of risks that are undiversifiable, Acharya attempts to point incentives of banks to take correlated risks on the asset side that could be better diversified if all social costs were properly accounted for. So the correlation problem discussed here is quite different in nature from the correlation problem discussed in Hellwig and Staub.

Acharya's model is based on a combination of risk shifting incentives and externalities of bank failures. A major insight comes from the observation that, once externalities from bank failures are taken into account, risk shifting may not only occur at the level of a single institution but also at a collective level. He argues that, in the face of collective risk shifting incentives, traditional instruments of banking regulation are too myopic because they fail to correctly internalize all the relevant external effects.

The model analyzes a banking system consisting of two banks which are in business for two periods. Banks can issue standard deposit contracts, which they can invest into a safe and a risky asset.¹³ The banks can also decide in which industry they want to undertake their risky investment. Their choice of industry endogenously determines the joint failure probability of their investment. The model postulates two effects resulting from the failure of a bank. A bank failure after the first period reduces the aggregate supply of deposits available at the beginning of the next period because a surviving bank can only acquire a fraction of depositors from the failing bank. This reduces the profitability of surviving banks through an increase in the market clearing interest rate. There is also a positive externality because of scale effects on surviving banks that result from the acquisition of depositors and lending facilities from the failed bank.

When the negative externality dominates, banks have an incentive to choose their risky investment in the same industry such as to survive or to fail together. Acharya calls this constellation of incentives *collective risk shifting*. The consequence is that banks who hold highly correlated assets have a high probability of joint default. Negative externalities and thus the incentives to take correlated investments are particularly high, when bank default has a substantial effect on aggregate investment, i.e. when the failing bank is big, or when it is unique so that hardly any of the former depositors are able to migrate to the surviving bank or when the surviving banks can not profit from overtaking the facilities of the failed bank.

The collective risk shifting equilibrium is compared with a planner solution. A planner who equally weights the benefits of bank owners and depositors and takes into account other social costs of financial distress would care to avoid individual as well as collective risk shifting. He would therefore pick a lower risk level for individual bank investments and at the same time care for a diversification of risky investments across industries to avoid correlated exposures.

The most important consequence of this analysis for regulation is that a regulator rather than looking at the "safety and soundness" of each institution individually he has to take a system perspective. It has to be understood that banks will *collectively* react

¹³The intermediation role of banks is postulated in this model and not endogenously derived.

to any measure of regulations and that this collective action will determine whether or not systemic risk is mitigated. Acharya's applies these insights to the discussion of two regulatory instruments: Closure policies and capital adequacy.

Closure policies are modelled as bail outs of failed banks with a dilution of the owner's equity claim in the bank. This dilution is described by a forbearance parameter. The level of forbearance can be used to influence the negative incentives on individual ex ante risk taking behavior. Forbearance should, however, also be used to punish banks upon joint failure. To make such a collective closure policy credible, Acharya suggests a bank sales mechanism that rewards banks that survive while other banks fail.

Capital adequacy can also be used to influence risk taking behavior. However, as in the case of rescue policies, the presence of collective risk shifting incentives calls for a capital adequacy regulation that is not only taking into account the individual risks taken by the bank but also the correlation of banks' assets with the assets of other banks in the system. Acharya shows that individual capital adequacy regulation, as it is practiced under the BIS requirements, may reduce individual failure risks but leaves collective risk shifting incentives unaffected.

In summary Acharya's theory explains systemic risk as an incentive problem of collective risk taking in a banking system. Externalities and the exogenous restriction that risky investment can be made in only one industry, lead to situations where banks take positions on the asset side, that lead to a concentration of risks that could in principle be better diversified. Therefore, this analysis abstracts away from domino and information effects and also does not discuss the system exposure towards aggregate risks analyzed in Hellwig (1997) and Staub (1998).

An earlier paper, which discusses systemic risk from the perspective of incentive and contract theory, is Rochet and Tirole (1996). These authors concentrate on the role of interbank markets in allocating liquidity. In practice, short term liquidity management in these markets leads to substantial uncollateralized exposures. This creates a risk that the default of one institution in the system may trigger a series of other defaults.

The basic hypothesis is that interbank markets confront regulators with a trade off. On the one hand he could eliminate systemic risk in the interbank market altogether by centralizing liquidity management at the central bank, who acts as a counterparty to all transactions and guarantees the finality of payments. On the other hand by doing so a regulator gives away an incentive effect that is inherent in decentralized interbank markets. It is the monitoring incentives of banks who hold mutual credit exposures. Thus the main aspect discussed in Rochet and Tirole (1996) is a theoretical argument focussing on the incentive effects of peer monitoring in a decentralized interbank system. The main aspect relevant to regulation within this theoretical framework is a discussion of optimal rescue policies for distressed institutions by a central bank that take advantage of the incentive effects of peer monitoring in an interbank system.

Tirole and Rochet (1996) are basically concerned with the misalignment of incentives of bank managers and depositors. The bank management in charge of financing investment projects has private benefits from shirking on their duty to select the best investment

projects and therefore are biased towards choosing projects with a relatively high probability of failure. The investment problem of the bank managers is complicated by the fact that between the investment date and the maturity date of the project a random liquidity shock has to be accommodated to carry on with the project initially chosen. The authors discuss an optimal contractual solution to solve this incentive problem. The basic feature of an optimal incentive contract is that the incentive costs to motivate the managers drives a wedge between the value of external claims on the bank's projects and the its full value. The value of external claims on the bank is strictly smaller than the full value of the project. Thus, there is a need to hoard liquid reserves to withstand the shock in the interim period in any incentive compatible, Pareto optimal allocation. The wedge between the value of external claims and the outside value makes it impossible for banks to attenuate the liquidity shock by leveraging up. In this framework possibilities to reduce the private benefits of bank managers from moral hazard reduces incentive costs and therefore the need to hoard liquid reserves.

That this function of reducing incentive costs can be fulfilled by an interbank market with mutual credit exposures is then illustrated in the context of an example of a borrowing bank supervising a lending bank. The authors show that allowing banks to monitor each other and at the same time exposing them to each other's liquidity shocks enhances their monitoring incentives. This is basically the intuition about the benefits of a decentralized interbank market.

In the framework of this example implications for optimal rescue policies are investigated. In summary, they get three main conclusions: First they argue that the mere fact that other banks are exposed to a failing bank does not justify the intervention to bail out the bank in distress. To keep up monitoring incentives it might be better to let the borrowing bank fail while directly helping the uninsured depositors. Second the simple structure of the model allows a distinction between solvency and liquidity, which is hardly possible in practice. Therefore it can happen that an optimal mechanism would require to close a bank that is solvent but illiquid. In this case the closure decision can not be made credible and then it might be optimal to have no interbank relations but rather some form of a centralized liquidity management for the banking industry. Third the authors argue that in the case of monitoring spillovers due to economies of scope between commercial and interbank activities optimal closure decisions may be interrelated.

The most provocative conclusion is perhaps, that regulators should sometimes close solvent banks if they have substantial monitoring responsibility but didn't deliver. Thus in a similar manner as Acharya, but for different reasons, these authors support a *contingent* rescue policy. Provided lenders can be made accountable for poor monitoring, the analysis also has some implications for capital adequacy that should be imposed on interbank lending. If monitoring can be assessed, the authors suggest to count some of the interbank liabilities as regulatory capital. The analysis shows that once the system interaction is taken seriously into account it becomes clear that all the banks in the system will *collectively* react to a given regulation. This aspect can not be taken into account by an analyses that is based on the partial viewpoint of a single bank.

4.3 Coordination Problems

A central topic in the literature on systemic risk is the idea that coordination failure in a liquidity crises could lead to default of solvent institutions possibly propagating through the network of credit exposures. The establishment of institutions such as a "lender of last resort" that are able to prevent such wasteful systemic crises have been discussed already in the 19th century. (see Humphery, (1975)). Of course, the theory of emergency lending to institutions that are solvent but illiquid raises a number of difficult questions. These problems are pointed out by Staub (1998). Some form of market imperfection is needed for such a distinction to make sense. In a world of perfect credit markets an illiquid bank that is solvent can at any time raise the necessary funds on the market. In the microeconomic banking literature that has taken up the challenge to explain these frictions (see Freixas and Rochet (1997)) the distinction between solvency and liquidity is in many cases unimportant. In this literature assets are usually modelled as liquid reserves and illiquid assets. If liquid reserves fall below the liabilities of the institution and since illiquid assets can't be liquidated by assumption illiquidity implies insolvency. Finally, in practice, the distinction between illiquidity and insolvency can be extremely difficult and ambiguous. The very concept of insolvency requires the possibility of a unique valuation of assets, i.e. a valuation of assets at market prices. This possibility depends on the existence of liquid markets. In the presence of these markets - however - there is no problem of illiquidity. On the other hand, if markets are not liquid there is a considerable leeway in the valuation of assets and the concept of insolvency becomes vague. (For all of these points see Staub (1998), p. 196).¹⁴

The analysis of coordination problems due to liquidity crises in a banking system have been analyzed in a paper by Freixas, Parigi and Rochet (2000). These authors analyze some aspects of interbank markets and systemic risk in a theoretical framework of liquidity insurance. They use this framework to analyze the problem of contagion and issues of optimal bailout policies.

Interbank relations are captured in a version of the Bryant-Diamond-Dybvig model of liquidity insurance. A finite set of banks, each assumed to serve a particular geographic area populated by a unit mass of depositors faces a long term investment opportunity with a high return but a cost of early liquidation. Liquidation costs can be avoided by the bank, if resources are stored in a low return alternative investment opportunity. Depositors can only indirectly invest their funds via the bank at their home location. The only incentive for banks to keep some resources in the liquid low return investment is that they have a certain probability that in an interim period a random fraction of depositors travels to another location taking their funds with them to finance final consumption. For a bank it is in this case enough to keep liquidity in accordance with the expected withdrawals in the interim period and invest the rest in the high return project.

As a system banks can however do even better by granting each other credit lines so that consumers who travel to another location get a claim written on their home bank

¹⁴An attempt to find a rigorous framework in which issues of insolvency and illiquidity are addressed is given by Rochet and Vives (2000) in an application of the literature on higher order beliefs (Carlsson and van Damme (1993) and Morris and Shin (1998) to the Diamond-Dybvig Bank run model.

and credited at the bank of their travel destination. At the end of the last period banks compensate their claims and costlessly transfer the income across space. This system of credit lines allows to invest the funds at a higher return making the system as a whole better off.

Formulating the interaction between the banks and the mobile depositors as a game where banks decide about credit lines whereas depositors decide how much to withdraw and how much to keep in the bank the authors show that in the case where all banks are solvent there are two Nash equilibria in pure strategies. One where the efficient investment pattern with credit lines emerges as a self enforcing arrangement and one where a inefficient bank run equilibrium (grid lock) emerges. This possibility that even in a situation of solvency for the whole banking system (a notion that can be defined unambiguously in the simple context of the model) something like a bank run can occur is interpreted as fragility of the interbank system. Gridlock in this model can always be avoided if a central bank steps in as a coordinator and guarantees deposits. In the absence of moral hazard problems and given that solvency can be unambiguously defined this solves the coordination problem in this model.

Issues become more complicated when at least one bank in the system becomes insolvent and efficiency would require to close it. The question is that given the mutual credit relations in the interbank market, whether this is possible without creating a contagious failure of the whole banking system. This question is discussed next in the light of the model for some special cases. Specifically the authors discuss when the insolvency of one institution can be absorbed by the banking system without causing a gridlock situation, i.e. while still keeping the efficient credit line pattern as a Nash equilibrium of the game between banks and depositors.

The authors show that, typically, there is a trade-off for banking regulation. On the one hand the system can (under certain conditions) absorb an insolvency of one institution without a systemic crisis. This weakens market discipline, however, since the insolvent institution is cross subsidized by the solvent remaining ones. On the other hand closure may induce excessive liquidation, which also imposes a cost on the whole system.

The main implications of this model are relevant for the role of the central bank as lender of last resort and for banking supervision. The coordination role of the central bank in preventing a gridlock equilibrium is a straightforward extension of the logic of bank run models to this model of a banking system. The central bank has to manage the trade off between closing insolvent bank and preventing a liquidity crises in the other banks depending on the defaulting bank. Perhaps the most interesting implication is that the authors suggest that interbank market lending may loosen market discipline because the interbank system can attenuate the insolvency of a particular institution when efficiency would have required its closure. This creates a role for banking supervision and monitoring. The uncertainty faced by agent's in the model is described by an idiosyncratic shock determining "travel destination", which is not interpreted by the authors in metaphoric terms nor is there given evidence about liquidity demands created in this way. Thus the model provided by these authors can be seen as a "thought experiment" that brings to the fore one of the important trade offs a regulator with a lender of last resort function, like

a central bank, has to face when deciding about closure policies of insolvent institutions.

5 Theoretical and Empirical Issues

We have seen that the recent literature has made progress in understanding and clarifying the problems of systemic risk in the banking sector. However at the present stage many issues remain open. We want therefore to devote the following sections to the discussion of issues that we consider as important. These issues are, (i) the modelling of cyclical credit exposures, (ii) the research on macroeconomic consequences of capital adequacy regulation, (iii) the problem of consistency between different regulatory instruments and finally (vi) problems of measuring systemic risk empirically.

5.1 Modelling Networks of Credit Exposures

We have seen that one important idea in the literature on systemic risk is the danger of contagious failures of institutions. To address the issue of contagion risk, we need however a framework that allows to analyze networks of bilateral credit exposures with default risks. The understanding of such structures is a necessary condition to assess the ability of different instruments of regulation to prevent contagious failures of banks. At present the theory of contagion is probably not developed enough to do so but progress has been made.

Perhaps closest to issues of interbank markets is a recent paper by Allen and Gale (2000a). Allen and Gale study a simple liquidity insurance model in the tradition of Diamond and Dybvig but they consider different "regions" with different liquidity shocks at the interim period. They show that as long as there is no aggregate liquidity risk a functioning interbank market that exchanges ex ante claims on liquidity, is able to smooth liquidity provision between regions. Regions with liquidity shortage enter into insurance with regions which face a liquidity surplus. Allen and Gale find that only aggregate liquidity shocks are critical for contagion. They find that not only interconnectedness as such is critical for contagion to occur but that the pattern of interconnectedness plays a decisive role.¹⁵ Depending on whether the interbank market is structured such that each region is connected to all the other regions or not, the initial impact of a financial shock is felt differently by neighboring regions. Allen and Gale find that the incomplete connection of markets leads to situations where a financial shock cannot be as easily attenuated as when there is a complete connection between regions. The importance of aggregate liquidity shocks for financial contagion is also pointed out in Aghion, Bolton and Dewatripont (2000). Lagunoff and Schreft (1999) present a related model of financial fragility based on endogenous credit links. Kyotaki and Moore (1998) present a model of contagion in which chains of trade credit in connection with endogenous asset values lead to a propagation

¹⁵This result resembles on a similar insight in a paper of Dubey, Geanakoplos and Shubik (1999), about default in general equilibrium with incomplete markets. They find that the incidence of chain reactions of default depend on the degree of the development of financial markets.

of small shocks to system-wide financial crises. Morris (2000) is a particularly interesting study of contagion, though it is not concerned with default of banks or with banking regulation. In this work the focus is rather on contagious spread of strategic behavior. The interesting aspect is that contagion is characterized directly by qualitative properties of the structure of interaction in a network. A similar approach would be very interesting to understand the unresolved issue of what exactly the role of interaction of banks in a system plays for the propagation of default in a system.

A paper which makes a step in this direction is Eisenberg and Noe (2001). These authors are not interested in the banking system or banking regulation but propose an interesting abstract framework for the modelling of cyclical credit exposures and default. A financial system is represented as a graph, with an exogenously given mutual liability structure. Each node in the graph is characterized by its equity value and its liability towards other nodes. All nodes participate in a single clearing system that is consistent with priority of debt and the limited liability of equity. The authors then show that for such a system - under mild regularity conditions and proportional sharing of residual value in default - there exists a unique clearing vector. This clearing vector thus endogenously gives a structure of default in the system given a structure of equity claims and mutual liabilities. The authors provide an algorithm for computing clearing vectors which at the same time generate information that can be interpreted as exposure of a single institution to systemic risk factors. Finally the clearing network, as formalized by Eisenberg and Noe (2001), has a complementarity structure that allows for interesting and sharp comparative static results for clearing vectors and thus for patterns of default. Though not directly concerned with banking and banking regulation, this paper provides an interesting suggestion how to approach the modelling of cyclical financial interconnections. Building on the results of these authors, there could possibly be made considerable progress to understanding issues of systemic risk as formulated in Hellwig (1995, 1997, 1998) and Staub (1998). Such models do of course not explain why these default events have large spillover costs to the real economy nor do they explain why banks take so much aggregate risk by the very nature of their business. However it can give us quite a guideline how to measure and analyze the exposure of the banking system to shocks.

The mechanical modelling of financial systems as suggested by Eisenberg and Noe (2001) comes however at a cost. In the end the analysis boils down to the analysis of an exogenously imposed sharing mechanism that settles a structure of exogenous claims between nodes. It is an equilibrium flow problem under this mechanism. The settlement sometimes implies default of some nodes. A combination of this network structure with a model of economic behavior determining liabilities and operating income endogenously is difficult. If decisions are taken with appropriate foresight and default patterns for a given mechanism are properly anticipated by the agents quite a bit of the interdependence structure that makes the clearing network model interesting disappears. This has to do with a more fundamental problem of modelling default within standard economic optimizing models with rational agents. Such a framework makes it very difficult to capture features of real life situations where decisions are taken *ex ante* that turn out to be wrong *ex post*.

5.2 Macroeconomic Consequences of Banking Regulation

The concern about systemic risk is partially rooted in historical experiences, most importantly the great depression. Since the early work of Irving Fisher (1933) who attributed the downturn during this period to the poor performance of financial markets, these issues are widely discussed among economists. Though there has been much work on the interaction between the banking sector and the real activities of an economy most importantly by Bernanke and Blinder (1988), Bernanke and Gertler (1990) and others, the discussion about the macroeconomic consequences of banking *regulation* is still in the beginning and very few contributions exist in the literature so far. This might seem surprising since concerns about the interdependence of financial stability and overall macroeconomic performance is one of the main arguments behind most regulatory initiatives. Once a direct dependence between financial stability and economic performance is taken for granted it is clear that also regulatory initiatives must have macroeconomic consequences. Large parts of the existing literature seem to take the naive viewpoint that in the light of research on the interactions between the banking sector and the real activities of an economy it is enough to guarantee the "safety and soundness" of banks. It is not taken into account that once a regulated banking system is in place the whole equilibrium of the economy might change in a way that has to be carefully analyzed before knowing the implications of any regulatory measure. Such a naive viewpoint might miss important interdependencies between regulation and macroeconomic performance.

We now want to briefly discuss a pioneering paper by Blum and Hellwig (1995), who investigate the macroeconomic consequences of banking regulation. Hellwig and Blum are concerned that capital requirements can become a recessionary amplifier for the macroeconomy. Using a standard IS-LM framework, they analyze the effect of capital requirements on the standard aggregate demand multipliers. The basic idea is that capital adequacy regulation can bring banks into a situation where they have to cut back credit in a recession to recapitalize after an adverse shock. Especially in a situation of an aggregate shock that hits all banks at the same time, this might amplify an economic recession and increase bank insolvencies rather than prevent them.

Of course this analysis is based on the assumption that banks can not easily issue new equity and that firms can not simply substitute bank credit with other sources of finance. The effect of capital scarcity leading to a "credit crunch" has been observed and investigated by other authors most prominently Bernanke and Lown (1991) and Calomiris and Wilson (1998) among others.

As Hellwig and Blum observe, once one takes it for granted that there is a substantial cost connected to issuing new equity in bad times and that firms can not easily substitute bank finance by other sources, one has automatically a procyclical effect of bank lending no matter whether capital requirements are in place or not. However, their analysis suggests that capital requirements may act as an amplifier.

Overall one can probably claim with some right that the macroeconomic consequences of banking regulation are still poorly understood and more research is required to come to

an educated judgement about whether or not the regulatory instruments in place make economic sense or not.

5.3 Consistency between Regulatory Instruments

Throughout the literature different instruments of banking regulation are usually discussed in isolation.¹⁶ An exception is a paper by Acharya (2000) which raises the important question of how ex post policies to resolve bank failures fit together with ex ante capital adequacy regulation. In a risk shifting model, he demonstrates that inconsistent mixtures of regulatory instruments can actually increase systemic risk. He argues that internationally uniform capital adequacy regulation in a world of international banking where banks are subject to heterogeneous regimes of rescue policies can actually *increase* systemic risk. This is of particular interest in the light of the fact that one intention of the work of the Basle Committee is to provide a "level playing field" for banks across the world by arriving at a unified framework of capital adequacy rules.

Acharya considers a simple two banking world with risk shifting incentives, where one bank - the international bank - operates in the home and the foreign country. Two regimes are contrasted. In the first case an international uniform capital adequacy with an internationally uniform rescue policy is considered. The other case considers a uniform capital adequacy rule but rescue policies with different levels of forbearance. Suppose that one country is pursuing a more forbearing rescue policy than the other one. As the rescue policy becomes more forbearing, the banks chartered in the more lenient regime take on higher risks. More importantly, however, the international bank increases its risk taking in *both* countries. Thus there is a destabilizing spillover effect in international banking arising from the inconsistencies between uniform capital adequacy rules and heterogeneous rescue policies.

This argument advanced by Acharya (2000) points out an aspect that has not received much attention in the literature so far. The whole package of regulatory instruments that is in place has to be consistent with the goals of achieving an optimal allocation of risk among all the claimholders of a bank. Thus providing a "level playing field" in one dimension of banking regulation while ignoring consistency with other instruments in place might destabilize rather than stabilize the banking system.

Thus, once again, this argument by Acharya reiterates one of the basic themes of this survey: once one proceeds from a single institution viewpoint to a system perspective on regulation, new aspects arise, which remain unnoticed in a single institution perspective. Since the reality of modern banking is of course a world where many heterogeneous banks interact, the system perspective is probably the most relevant one.

¹⁶To be fair we have to mention that practitioners as well as some other authors who discuss issues of financial stability and banking regulation from a more applied perspective have pointed out the importance of combining different instruments of regulation in a consistent way. For instance Llewellyn (2000) uses the term of a *regulatory regime*. We want to stress however that at the level of economic models of banking regulation, which are our main focus in this survey, these issues are rarely discussed in greater detail.

5.4 The Assessment of Systemic Risk

While the theories of systemic risk that are related to incentive problems give us little clues how to measure systemic risk empirically, the papers by Hellwig (1995,1997,1998) and Staub (1998) set an agenda that is clear in principle but unresolved in practice. Their requirement finally insists to identify macroeconomic factors that are relevant for the risks borne by banks and to get a view about the aggregate exposure of the banking system as a whole taking all correlations properly into account. Such an ambitious agenda requires a fairly detailed picture of interbank relations.

Interbank lending and OTC derivative transactions between banks have increased substantially in recent years (see Bernard and Bisignano 2000). From the perspective of controlling systemic risk, interbank transactions are of particular interest. Banks use the interbank market mainly for two purposes. First, it provides a possibility for short term liquidity management. For this kind of interbank activities, short term money market transactions are the most important ones. Second, interbank markets are used for derivative transactions for purposes of professional risk management.

From the viewpoint of systemic risk this creates a potential for chain reactions of default through mutual credit exposures. In view of the bank run literature and the fact that interbank exposures are not covered by insurance schemes, Staub (1998) also sees a potential of bank run problems between individual banks.

Little is yet known about the actual extent of risks in the interbank market. Some of the reasons have been mentioned before when we were discussing the danger of hidden aggregate exposures in the banking system. Information on bilateral exposures are frequently not available. A paper by Furfine (1999) tries to give a conservative estimate about the danger of potential contagious bank failures caused by interbank linkages. He attempts to estimate the potential for contagion in interbank relations by a simulation study using a unique data set on bilateral exposures of banks in the federal fund market. Furfine uses payment flow data from Fedwire, the Federal Reserve's large value transfer system, to uncover bilateral federal funds transactions. Using historical experience about the recovery rates of institutions with exposures to a failing bank, Furfine translates bilateral exposure data into expected loss data. For a set of different failure scenarios, Furfine finds that multiple failure rounds are unlikely and that aggregate assets at subsequently failing banks would never exceed 1 percent of total commercial banking assets. Gorton and Rosen (1995), in an investigation of U.S. commercial banks find that the banking system as a whole faces little net interest risk from swap portfolios. Sheldon and Maurer (1998) in a study of the Swiss banking crises during the late eighties and early nineties, also find little support for the danger of domino effects through the network of interbank relations. In a detailed empirical study of the international interbank market, Bernard and Bisignano (2000) find evidence for contagion between regions. These authors also raise the issue that international interbank lending in conjunction with implicit guarantees through the safety net of the country in which banks are chartered, creates severe moral hazard problems and might be a source of instability. However, a clear empirical picture of risks in interbank transaction has not yet emerged.

The problem of getting a clear picture of interbank exposures is a difficult one because the balance sheets banks report to the central bank usually only give aggregate positions towards other banks and the central bank. Money market transactions (see Staub 1998) are usually not reported as liabilities or claims towards other banks but are recorded as separate positions. From these positions it is not possible to reconstruct the share of interbank market positions. Derivative positions such as interest rate swaps are off balance sheet and usually not available. Interesting empirical work that tries to make progress on this problem is Sheldon and Maurer (1998) and Upper and Worms (2000). These authors take balance sheet information on interbank holdings. From these observations they get information about the total liabilities and assets banks hold among themselves. It is like observing the row and column sum of a matrix without knowing the entries. Using a procedure to estimate these entries under specific assumptions about the structure of interbank relations, these authors can calibrate from existing data a liability structure that can be used to give estimates of contagion by simulation. If such procedures to reconstruct bilateral exposures empirically can be combined with network models such as presented in Eisenberg and Noe (2001) there is potential for considerable progress towards a measure of aggregate exposure as suggested in Hellwig (1997) and Staub (1998).

6 Conclusions

Having discussed the lessons we can draw from the recent literature about the effectiveness on banking regulation to prevent systemic risk, a central message has emerged that links all the different and still fragmentary contributions. The viewpoint to analyze single institutions in isolation without taking into account all the effects that crucially depend on their interaction in a system is flawed. No matter which of the models discussed above is taken, all of them show that the system viewpoint reveals that the decisive step is to understand the simultaneous reaction of many heterogeneous institutions to regulatory measures that are imposed on the banking system.

As we have seen there is no generally accepted precise definition of the notion of systemic risk. In this case it is too much to ask how one can control or even prevent it. It might therefore be useful to bring the whole regulatory debate into perspective by looking at the issues through the well established notions provided by the economics of risk and uncertainty and the economics of market failure.

As a first step it is useful to clearly distinguish risks that are borne by the banking sector according as to whether they are diversifiable or not. Concerning the diversifiable risks, it is helpful to ask the question, whether there are externalities, information problems or incentive structures inherent in banking that lead to a risk structure that is not optimally diversified from an overall economic point of view. These themes are touched extensively in the work by Acharya (2000). If this suboptimal diversification is the problem, the literature shows that some of the instruments we know, like capital adequacy or a contingent safety net could perhaps be helpful. But if they are meant to correct a suboptimally diversified asset structure of the banking sector they have to be designed

differently than they are at the moment. If we deal with risks that are undiversifiable, the decisive question is how much exposure to these risks should be tolerated for the banking sector as a whole and how to allocate these risks between all agents in the economy in an efficient way. In this case a regulator should restructure banking supervision in a way that it is able to measure aggregate exposure of the financial sector in a meaningful way and he has to find a decision procedure to determine whether the amount of aggregate risk that the banking sector bears is acceptable. Taken together these arguments suggest that Crockett's metaphor of the regulator as a portfolio manager of the financial system might provide a useful perspective to get an economically sound and unified conceptual view on some of the issues of banking regulation connected to financial stability.

Such a conceptual view, if it proves useful, has to be complemented by empirical research. It seems not exaggerated to claim that still much remains to be done in this respect. This research should entail facts about what are the actual incentive problems in banking, it has to answer the question whether externalities as postulated for instance by Acharya are a problem and whether can we quantify them. The empirical research also has to provide an answer to the question about the aggregate risk structure of the banking system. This needs a detailed knowledge of interbank relations and interbank markets and perhaps even the construction of new statistics at the level of institutions like the BIS, which are yet not available.

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