

Systemic Risk, Macro Shocks, and Macro-prudential Policy¹

1. Introduction

Since the financial crisis of 2007-2009, authorities all over the world have begun to add macro-prudential policies to their arsenal of measures against risks to financial stability. Judging that “the Union needs a specific body responsible for macro-prudential oversight across its financial system, which would identify risks to financial stability and, where necessary, issue risk warnings and recommendations for action to address such risks”, the European Union has created the European Systemic Risk Board (ESRB), one of the new European Supervisory Agencies (ESAs), with the specific mission to “conduct... macro-prudential oversight at the level of the Union.”² The Capital Requirements Regulation and Capital Requirements Directive of 2013 provide explicitly for a “number of tools to prevent and mitigate macro-prudential and systemic risk”.³ Member States have created new macro-prudential authorities or asked existing institutions, such as central banks or traditional bank supervisors, to take on the additional task of macro-prudential oversight.

For all its prominence in the legislation, however, there is no established definition for what the term “macro-prudential” actually means. The legislation lists certain tools, most importantly *countercyclical capital buffers*, but is unclear about how “macro-prudential oversight” and macro-prudential policies relate to “systemic risk” and to “micro-prudential” supervision. The term “systemic risk”, which also figures prominently in the legislation, is itself unclear.

This lack of clarity is dangerous. Without a coherent conceptual framework for assessing systemic risk and deciding on macro-prudential policies, the policies become arbitrary and possibly harmful. As I will explain below, some of the purposes that have been

¹ Previous versions of this paper were presented at the General Board of the European Systemic Risk Board (ESRB) in March 2012 and at the Nederlandse Bank’s High-Level Seminar on “Making Macroprudential Policy Work in Practice”, June 10, 2014. Without implicating them, I thank Harald Benink, Claudia Buch, Stefanie Egidy, Karolina Ekholm, Christoph Engel, Wolfgang Kuhle, and Francesco Mazzaferro for helpful comments. Whereas most of the paper was written while I was Chair and Vice Chair of the Advisory Scientific Committee (ASC) of the ESRB, the views expressed are my own and should not be attributed to the ASC or the ESRB.

² Regulation (EU) No. 1092/2010 of the European Parliament and of the Council of 24 November 2010 on European Union macro-prudential oversight of the financial system and establishing a European Systemic Risk Board.

³ Regulation (EU) No. 575/2013 of the European Parliament and of the Council of 26 June 2013 on prudential requirements for credit institutions and investment firms and Directive 2013/36/EU of the European Parliament and of the Council on access to the activity of credit institutions and the prudential supervision of credit institutions and investment firms. For an overview of the tools, see European Systemic Risk Board (2014).

mentioned for macro-prudential policy are actually in conflict with each other. The conflicts need to be properly spelled out so that the tradeoffs can be properly handled.

The term “macro-prudential” seems to go back to a speech that Andrew Crockett, as General Manager of the Bank for International Settlements (BIS), gave before the Eleventh International Conference of Banking Supervisors in 2000.⁴ In this speech, he pointed out that prudential supervision must be concerned with developments of the financial system at a macro level, as well as the micro level of each individual institution. He warned that trying to ensure the safety and soundness of individual institutions, one by one, might “deliver too little, because ...unless the authorities take into account the impact of the *collective behaviour of institutions on economic outcomes*, they may fail to monitor risks and take remedial action appropriately.” A system crisis is much more damaging than an individual bank failure, and system risks cannot be understood without a system perspective.

At the time, Crockett’s speech did not have much of an effect. Spain introduced countercyclical capital provisioning, a measure which we now see as a key macro-prudential policy, but that measure seems to have been motivated by monetary policy concerns, rather than macro-prudential considerations; the Bank of Spain worried that the decrease in interest rates that accompanied Spain’s entry into the European Monetary Union might lead to excessive inflation. Subsequently, this measure came to be seen as a stroke of genius, providing Spanish banks with an extra buffer that reduced the impact of losses in the initial stages of the financial crisis. By that time, it had become clear that, just as Crockett had warned, micro-prudential supervision had been unaware of the buildup of risks in the years before the crisis. With hindsight it seemed that a “macro” approach might have provided some warnings and led to preventive policies.

Today’s notion of “macro-prudential” oversight and policies seems to be an amalgam of Andrew Crockett’s warnings, of the experience of 2008 showing that these warnings were justified, and of the Bank of Spain’s having already used a “macro-prudential” policy. Such an amalgam does not provide us with a good basis for understanding what precisely is involved.

The policies that have so far been pursued under auspices of “macro-prudential” oversight give an impression of haphazardness. The ESRB’s recent review of macro-prudential policy in the EU exhibits a long list of measures taken by the authorities in different member states.⁵ The list is heterogeneous, not only with respect to the measures themselves but also with respect to the reasons given for them: Credit growth and leverage, misaligned incentives, maturity mismatch – the list looks like an extension of micro-prudential thinking. Some measures actually look like national add-ons to the micro-prudential rules that the Capital Requirements Regulation has harmonized across the EU. What then makes them “macro-prudential”?

Crockett (2000) related macro-prudential concerns to “systemic risk”, understood as “the likelihood of the failure, and corresponding costs, of significant portions of the financial

⁴ See Crockett (2000).

⁵ See European Systemic Risk Board (2015).

system.” The term “systemic risk” is actually quite old.⁶ Traditionally, it referred to *risks arising from the propagation of shocks inside the financial system*. In the most extreme version, it was feared that problems at a single, possibly small, bank might have repercussions for other institutions so that eventually the entire financial system might be at risk.

In the wake of Crockett’s warnings, and of the events of 2007 - 2009, the term “systemic risk” has come to be used more generally for any *risks to the financial system as a whole*. In the political arena, it has also come to be used for *risks to the overall economy from problems in the financial system*. Of course, one must also worry about *feedback effects* by which shocks to the financial system can have repercussions in the real economy, which in turn feed back into the financial system, from there back into the real economy, etc.

These different notions of systemic risk differ from each other. For example, in the S&L crisis in the US in the 1980s, savings institutions were in trouble because they had followed similar strategies and were similarly exposed to the risks of a hike in interest rates and a downturn in real estate markets. Propagation inside the financial sector played no role, nor did the S&L crisis have much of an effect on the macro-economy. It did, however, impose a major burden on taxpayers.⁷ The Swedish crisis of 1992 was also due to different banks’ having pursued parallel strategies, which led to parallel exposures, again to the risks of a hike in interest rates and a downturn in real estate markets. In this episode again, propagation inside the financial system played a minor role (except between real-estate subsidiaries and parent banks), but the crisis induced a severe credit crunch, making the Swedish recession of the early nineties the sharpest since the Great Depression of the thirties. Finally, contagion inside the financial sector played a major role in 2007 – 2009 as the impact of the initial losses from US real-estate lending was magnified by several mutually reinforcing propagation mechanisms.⁸

For analytical purposes, it is important to take account of the distinctions. Any analysis of systemic risk should consider each form of systemic risk as a problem in its own right, without presuming that “systemic risk” is just about a credit crunch or just about domino effects of defaults on counterparties. Recognizing the different forms of systemic risk and designing policies to match them is a major challenge for macro-prudential policy.

In the following, I will provide a more systematic account of “systemic risk”, with particular emphasis on the multiplicity of contagion mechanisms and the challenges that this multiplicity poses for macro-prudential analysis and policy making. I will also explain why macro-prudential policy concerns and policy mandates are ambiguous and why different

⁶ In Hellwig (1998a), I suggested, somewhat ironically, that, for lack of a more precise analysis, “systemic risk” might actually be *defined* as “the ultimate justification for banking regulation”.

⁷ According to Curry and Shibut (2000), the total costs of the S&L crisis amounted to \$153 billion, of which \$124 billion was covered by the government and \$29 billion by the industry.

⁸ For detailed accounts, see Hellwig (2009) as well as Ch. 5 in Admati and Hellwig (2013). Remarkably, the International Monetary Fund’s *Global Financial Stability Report* of April 2007 and the Bank for International Settlement’s *Annual Report* in June 2007 provided fairly accurate accounts of the subprime crisis in the United States, but overlooked the potential for contagion and therefore very much underestimated the impact of the subprime crisis on the global financial system; see International Monetary Fund (2007) and Bank for International Settlements (2007).

objectives can be in conflict with each other. Thinking about the tradeoffs and setting priorities is a major challenge.

2. Shock Propagation in the Financial System

There are several distinct channels by which systemic interdependence of financial institutions can induce contagion. Any assessment of shock propagation in the system must take account of all of these channels, separately and in combinations.

2.1 Contractual Dominos

The most direct channel of contagion involves *domino effects through contractual relations*. If one institution goes bankrupt, all institutions with claims on the defaulting institution are damaged. Their claims are frozen, at least initially, and they must expect to take losses as claims on the debtor may not be repaid in full.

Thus, on September 15, 2008, the insolvency of Lehman Brothers caused the money market mutual fund Reserve Primary to “break the buck” because their portfolio of \$62 billion including \$800 million in loans to Lehman Brothers that were impaired. The news that the value of a Reserve Primary share had dropped below \$1 caused a run. Before the end of the week, some \$60 billion had been withdrawn, and Reserve Primary was closed shortly thereafter. On September 16, 2008, the insurance company AIG was bailed out because authorities in the United States feared that an insolvency of AIG might seriously damage all institutions to which AIG had sold credit default swaps. In these examples, contagion involves the failure of an institution to fulfil its obligations under *existing contracts*.

2.2 Disappearance of Potential Contracting Partners

Sometimes, we also see contagion effects from the *disappearance of an institution as a potential contracting partner*. If an institution is regularly active in a certain market and others rely on being able to trade with or through this institution, the institution’s failure forces these institutions to change their plans, perhaps leaving them exposed to risks that they had expected to shed through appropriate contracts.

Thus, when Reserve Primary and other money market funds were run upon after the Lehman bankruptcy, they were no longer available as a source of funds for banks, e.g., the Belgian-French bank Dexia or the German bank Hypo Real Estate that had been using the money market to fund the excess coverage for their covered bonds. Another example is the disappearance of Lehman Brothers as a market maker in certain CDS and repo markets, which caused problems for financial institutions that had relied on these markets for their risk management. If a potential counterparty for hedge contracts disappears, the hedge strategy has to be reconsidered, and possibly the risky positions must be reduced.

2.3 Information Contagion and Hysteria Contagion

A second channel involves *information contagion*. Information showing that one institution is in trouble can be relevant for the assessment of other institutions that are believed or known to have similar risk exposures as the institution that is in trouble. Thus, Reserve Primary's breaking the buck caused investors to reassess the risk of all money market mutual funds and to withdraw from these institutions, in a run that was only stopped when the US Treasury's offered an analogue of deposit insurance for money market mutual funds. Similarly, the fact that authorities in the US had not bailed out Lehman Brothers caused investors all over the world to reassess bank bailout prospects. This led to a sharp downturn in investors' willingness to fund banks, including a breakdown of interbank markets as banks no longer trusted each other.

There is a question as to whether "information contagion" is always based on information. Could it be that investors' reactions to certain news involve an element of *hysteria*? Could it be that over-excitedness makes people exaggerate the significance of the news? And that herding effects or fears of being late in a run make for a kind of *hysteria contagion*? Was the information content of seeing Lehman Brothers declare bankruptcy sufficient to make investors worry about all banks? Were investors really justified in panicking about "Asia" when they saw that Thailand was in trouble in 1997?⁹ In the recent and still ongoing sovereign debt crisis in Europe, decision makers were worried that defaults on Greek or Cypriot sovereign debt might induce investors to lose confidence in Spanish or Italian sovereign debt even though there were and still are substantial differences between these countries in terms of fiscal problems and fiscal capacities.

In thinking about this question, we must take account of the possibility that, in certain constellations, the strategic interdependence between investors admits *multiple equilibria*, i.e., multiple behavior constellations that are mutually consistent in the sense that each participant's behavior is a best response to the other agents' behaviors. For example, if a bank uses short-term borrowing to fund long-term loans, depositors wondering whether to withdraw their money might leave it with the bank if they expect others to do the same and might wish to withdraw if they expect others to run on the bank. In this case, there would be one equilibrium in which investors leave their money in the bank and another equilibrium in which they run on the bank. With such a multiplicity of equilibria, a new piece of information can be objectively irrelevant and yet trigger a run because it affects investors' expectations as to which equilibrium is being played and what other investors are doing.¹⁰ Thus when Lehman Brothers went bankrupt, the mere symbolism of Reserve Primary's breaking the buck was enough to change investors' expectations and trigger a run.

The *empirical literature on bank runs and banking crises* suggests that contagion and runs are driven by relevant new information about the institutions in question.¹¹ However, this finding does not quite eliminate the possibility of apparent hysteria and hysteria contagion.

⁹ In Hellwig (1998c), I related this form of contagion to certain forms of superficial thinking that result from decision makers' economizing on the time they devote to analysis or to collective discussion.

¹⁰ The classical analysis of this phenomenon is given by R.K. Merton (1957). See also Diamond and Dybvig (1983).

¹¹ For a survey, see Calomiris and Gorton (1991).

Hysteria contagion can take the form of inordinate system responses to small changes in fundamentals. If participants have noisy information about the fundamentals, their reactions to the information they have may sometimes seem inordinate. But then they are not just considering what the information tells them about the fundamentals but also what the information tells them about the information that others may have about the fundamentals and about the actions that others are likely to take. Within a certain range, a small change in the fundamentals may therefore induce a large change in aggregate behavior, such as causing many people to run because they expect many others to run.¹²

2.4 Asset Price Contagion, Fire Sale Contagion

Another channel of contagion in the financial system involves markets and prices. An institution that is in difficulties may want to sell assets in order to get cash or in order to reduce its leverage. Such asset sales put pressure on market prices. If market prices go down, all other institutions that hold these assets in their trading books have to write down their positions. These write-downs reduce those institutions' equity. Because of equity requirements or because of pressure from investors who are worried about the institutions' solvency, they may feel obliged to react to these losses. If they do so by also selling assets, the spiral proceeds further.

This mechanism played an important role in the period from August 2007 to October 2008 and again in the European crisis in the second half of 2010. In the early stages of the crisis of 2007 – 2009, it was mainly driven by the banks' lack of equity, as banks that were forced to take structured-investment vehicles onto their balance sheets found that their equity was insufficient; the lack of equity was exacerbated by the losses on mortgage-backed securities (MBS), collateralized debt obligations (CDOs) etc. that they had taken.¹³ Subsequently, in the panic after the Lehman bankruptcy, the process was driven by the scramble for cash as the runs on money market funds had caused money markets to freeze. In the European crisis of 2011, liquidity concerns and solvency concerns came together as the weak equity positions of European banks caused money market investors to withdraw their funding from these banks and, in November 2011, the European Summit's mandate for banks to strengthen their capital positions caused banks to sell assets in order to deleverage.

Fire sale contagion is the more pronounced the weaker the banks' equity positions are.

¹² Whereas the early literature, including the critical assessment by Calomiris and Gorton (1991), treats runs as a facet of equilibrium multiplicity, Morris and Shin (1998) and the subsequent literature, in particular Rochet and Vives (2004) and Goldstein and Pauzner (2005) find that, with incomplete information about the underlying fundamentals, runs are a feature of equilibrium that arises if the fundamentals are sufficiently bad, even though the equilibrium is unique if agents have only private information about the fundamentals. If agents also condition on public information about the fundamentals, there may be multiple equilibria anyway, see, e.g., C. Hellwig (2002). Even with uniqueness, transition between the no-run part and the run part of the state space need not be smooth, so a small change in fundamentals may induce a disproportionately large change in outcomes.

¹³ An example was Sachsen LB, a German Landesbank with over €25 billion in structured investment vehicles. The liquidity problems of Sachsen LB were solved by a loan from the savings banks that were associated with Sachsen LB, but the bank had had insufficient equity to carry on alone and was taken over by LBBW, another Landesbank.

The reason is that, with weak equity positions, the relative impact of losses on asset holdings is larger. If equity accounts for only three percent of total assets, a 1% loss on assets wipes out one third of the equity, requiring a sale of roughly one third of the assets merely to return the equity position to 3 percent of total assets. By contrast, if equity accounts for twenty percent of assets, a 1% loss on assets wipes out no more than 5% of the equity, so to restore the twenty percent ratio one only needs to sell five percent of the assets.

2.5 Market Breakdowns

Finally, *market breakdowns* also play an important role in contagion. Such a breakdown may be due to a *breakdown of trading infrastructures*. If an institution serves as a market maker, the disappearance of this market maker can have a dramatic negative effect on all institutions that regularly rely on this particular market. As mentioned above in the context of damage from the disappearance of contracting opportunities, an example was provided by Lehman Brothers suddenly disappearing as a market maker in certain CDS and repo markets.¹⁴ Looking forward, the replacement of over-the-counter markets by markets with central counterparty clearing may reduce the system's vulnerability from market intransparency but at the same time enhance the system's vulnerability from risks to the central counterparty.

Disappearance of trading facilities can also be the result of a *market freeze*, as occurred in August 2007 when uncertainty about the proper valuation for mortgage-backed securities and related derivatives caused a breakdown of markets for these securities. For institutions that were funding such securities through short-term debt, in particular, for the structured-investment vehicles of regulated banks, this freeze was accompanied by a freeze on the funding side as the money market funds that had taken these institutions' asset-backed commercial paper were no longer willing to do so. As funding disappeared and assets were unsalable, these institutions had serious liquidity problems that required them to take recourse to the liquidity guarantees of the sponsoring banks.¹⁵

Even if a market does not freeze altogether, its functioning may be impaired by extreme volatility or large spreads. Such impairments are usually caused by information problems, in particular in situations when participants fear that their counterparty's willingness to sell an asset, or a price decline in the market, may reflect adverse information, along the lines of Akerlof's "lemons" problem, rather than any "real" trading needs.¹⁶ The more potential buyers are afraid that market developments are driven by information, the less they are willing to respond to price movements and the greater must be the price movements that are needed to clear the markets as some participants may want to sell.

In 1998, fears of such radical market reaction were one reason why the Federal

¹⁴ There is an overlap between the different effects. Market breakdowns are a special case of the disappearance of contracting opportunities on which participants had counted. Because of their pervasive impact, however, it is worth mentioning them in their own right.

¹⁵ For an account of these problems, see Gorton (2010) and Hellwig (2009). As mentioned above the sponsoring banks that had to take the structured investment vehicles onto their books then had a capital problem. See also Acharya et al. (2013) and Krishnamurthy et al. (2014).

¹⁶ In addition to Akerlof (1970), see Bolton et al. (2011) and Hellwig (2009).

Reserve preferred Long Term Capital Management not to go into bankruptcy, with a quick liquidation of assets in a situation where markets were very jittery. At the time, the asset price externality from such a liquidation might have been very destructive because quite a number of other funds were believed to have similar positions.

Market breakdowns involve some of the same mechanisms that I have discussed before, such as the disappearance of a contracting partner on whom one had counted or information contagion. Even so, it is useful to think of them as a separate category because interactions and contagion effects here work in a somewhat different manner, anonymously, through market prices and other market signals that participants may not identify with any particular other institutions.

2.6 Combinations of Effects

The preceding discussion treats the different effects in isolation. This separation of effects is necessary in order to understand their internal logic. In reality however, the different effects are likely to appear at the same time and to reinforce each other. Thus, by a direct domino effect, the Lehman bankruptcy imposed losses on the Reserve Primary money market fund, which had lent to Lehman Brothers. Because of these losses, Reserve Primary “broke the buck”, which triggered not only a run on Reserve Primary, but also runs on other money market funds that were deemed to have similar exposures (information contagion). Because they were losing funds (disappearance of counterparties), the money market funds themselves ran on banks, in particular US investment banks (information contagion?) and European banks that were deemed to be weak. Wholesale money markets broke down. The breakdown of wholesale money market funding induced banks to scramble for cash, selling assets even though asset prices were depressed. These fire sales depressed asset prices even further. Worldwide, stock market valuations went down by over twenty trillion dollars in just a few weeks, several times the losses incurred in the burst of the tech bubble in the early 2000s. The meltdown of the global financial system was only stopped when central banks and governments intervened and provided their banks with funding and with debt guarantees.

3. Macro Risks and System Risk Exposure

I now turn to the matter of risk to the financial system as a whole. As mentioned in the introduction, risk to the financial system is sometimes seen as a result of macro shocks that affect many institutions at once and sometimes as a result of contagion effects by which difficulties at one or a few institutions infect the rest of the system.

In practice, the distinction between the two kinds of risk to the financial system is not so clear-cut because systemic risk from contagion is usually also tied to macro shocks. For contagion to be serious, the triggering shocks to individual institutions must be important and the affected institutions must be weak. Both conditions are most likely to be satisfied when the triggering shocks are in fact driven by significant changes in macroeconomic variables. Of particular interest is the case where contagion effects affect individual institutions that have

eliminated macro risks from their books by hedging and find that the counterparties to the hedges fail when the risks in question realize.

3.1 Parallel Exposures to Macro Shocks

Macro shocks typically involve such variables as interest rates, exchange rates, real-estate prices, or the business cycle. Most major financial crises have been associated with shocks to these macroeconomic variables. For example, the banking crises of the early 1980s had to do with high interest rates. The crises of the late 1980s and early 1990s again had to do with high interest rates, together with downturns in real-estate prices and in the macro-economy, both of which can at least partly be also seen as consequences of restrictive monetary policy and the high interest rates it induced. The Asian crises in the late 1990s had to do with international capital movements, developments in competitiveness and trade, and changes in exchange rates. More recently, the crisis of 2007 – 2009 started with the subprime mortgage crisis in the United States, which in turn seems to have been triggered by the Federal Reserve’s tightening of monetary policy in 2005 – 2007 and the induced turnaround in real-estate prices, though the causes lay deeper of course.

In some of these cases, the crises were due to the size of the macro shocks involved and to the parallel exposures of many institutions. An example would be the *de facto* insolvency of savings and loans institutions in the United States in the early 1980s; this insolvency was due to the interest rate shock of 1979 – 1981 raising their funding costs above the returns they earned on the long-term fixed-rate mortgages they held from the 1960s.¹⁷ Similarly, the Swedish crisis of 1992 (and several other crises of the early 1990s) involved banks having exposed themselves to significant risks from real-estate and business lending and being struck by large interest and business cycle shocks that made their funding costs go up, real-estate prices go down, and their real-estate and business loans go sour.¹⁸ The recent banking crises in Ireland and Spain exhibit a similar pattern, but in addition, they also involved an element of cross-border domino effects, from Irish and Spanish banks to the German and French banks that had lent to them.

The US savings-and-loans crisis as well as the various banking crises of the early 1990s did not involve much contagion. A given financial system was thoroughly hit but the rest of the world was not much affected. By contrast, as mentioned above, the global financial crisis of 2007 – 2009 involved not only a large macro shock, namely the real-estate and mortgage crisis in the US, but also significant magnification by global interconnectedness and contagion. Initial losses in US real-estate finance do not seem to have been larger than initial losses in Japan or even the rumored losses in US savings and loans institutions in the early 1990s, but in contrast to those earlier crises, the initial impact had worldwide effects.¹⁹

¹⁷ See, for example, Kane (1985).

¹⁸ On Sweden, see Englund (1999).

¹⁹ The International Monetary Fund’s Global Financial Stability Report of October 2008 gives estimates of market value losses on subprime mortgages and mortgage-related securities on the order of \$500-600 billion, the same order of magnitude as for the Japanese crises. For the S&Ls, in the final

In the absence of contagion risk, systemic risk can be assessed simply by looking at the different institutions' exposures to macro shocks, considering each institution in isolation and assessing to what extent they have parallel exposures. For prevention, it suffices to limit each institution's exposures to such shocks. Macro-prudential oversight must therefore focus on whether different institutions take large exposures in similar risks, or, more generally, on the correlations between the risks taken by these institutions.²⁰

Such an approach is institution-oriented but different from the prevailing approach to micro-prudential oversight and policy. The way micro-prudential oversight is actually carried out, exposures to the risks of macro shocks are not fully captured. By treating different positions as if their risks were independent, micro-prudential regulation and supervision overlook the correlations that arise from common shocks. Examples are correlations of credit risks that arise from a common dependence of loan customers on the business cycle (loans to non-financial firms) or on real-estate prices (home mortgages). The common dependence of asset prices and bank funding conditions on market rates of interest is also overlooked. Indeed for positions in the bank book, the risk that interest rate increases in the market might make funding more expensive is neglected altogether; this is the risk that caused a large part of the US savings and loans industry to be *de facto* insolvent as of 1981.

In my opinion, the neglect of correlations that arise from common shocks affecting different positions in a bank's books is already a shortcoming of micro-prudential regulation and supervision when taken on their own terms. Thus, the notion that "interest rate risk" is a market risk, which matters only through its effect on the valuation of securities in the trading book, is highly misleading. Movements in market rates of interest should be interpreted as macroeconomic shocks that create risks through multiple channels, not only the valuation of securities in the trading book. In particular, increases in market rates of interest make bank funding more difficult or more expensive, as investors ask for a rate of return that is commensurate to the market rate of interest. Such increases also tend to cause declines in real-estate prices, thus damaging the collateral underlying the banks' mortgages as well as the banks' own real-estate investments. Finally, these increases may induce defaults of debtors under adjustable-rate loan contracts as these debtors find it impossible to pay the new, higher rates. All these risks are correlated because they are driven by the same shock, a change in market rates of interest.²¹

For macro-prudential oversight, it is absolutely essential to think about exposures to macro shocks in a comprehensive fashion, taking account of all the different channels by which a change interest rates, exchange rates, or overall economic activity might affect the different institutions' positions.

accounting losses came to \$153 billion, but at the height of the crisis, observers talked about \$600-800 billion. See International Monetary Fund (2008) and Curry and Shibut (2000).

²⁰ Such correlations played an important role in Crockett's (2000) plea for macro-prudential oversight.

²¹ These different channels by which high interest rates damaged banks were all in evidence in the US S&L crisis in the early 1980s, as well as the many banking crises of the late 1980s and early 1990s. See Hellwig (1994a, 1995) and Admati and Hellwig (2013), Ch. 4.

3.2 Macro Risks Hidden in Correlated Counterparty Credit Risks

A simple institution-oriented approach to assessing and limiting system risk exposure is insufficient when each institution's risk incidence depends on how other participants in the system are doing. An example is provided by the Thai crisis of 1997. In the run-up to the crisis, much lending, from foreign banks to Thai banks and from Thai banks to Thai firms, had taken place in dollar terms in order to eliminate exchange rate risks for lenders. If one looked at the balance sheets of the different institutions in isolation, one by one, one would have thought that neither the foreign banks nor the Thai banks were exposed to exchange rate risk. After the devaluation of the Baht, however, Thai firms that were doing business in Baht could not pay their dollar debts to Thai banks, and, with their debtors in default, Thai banks could not pay their dollar debts to foreign banks. In trying to eliminate the exchange rate risk from their lending, the banks had merely created an additional, exchange-rate-driven credit risk.²² With a chain of transactions going from foreign banks to Thai banks and from Thai banks to Thai firms, this exposure could hardly have been seen by looking at one institution's balance sheet in isolation. The exposure to risk from a devaluation of the Baht was hidden in the correlated credit risk of their loans.

Similarly, the adjustable-rate clauses that banks used in mortgage and other long-term lending in the 1980s did not really reduce their vulnerability to the effects of higher market rates of interest but merely transformed the risk from maturity mismatch into an additional, interest-rate driven credit risk. And when the banks or building societies foreclosed on the mortgages, they had to cope with the fact that, because of the high interest rates, real-estate prices were depressed.²³

The problem pervades all uses of contracts for shifting and hedging risks. It applies to derivatives and other contingent claims as well as adjustable-rate mortgages. With the emergence of credit default swaps (CDS), it has gained even more prominence. In the crisis of 2007 – 2009, the banks that had hedged the credit risks of subprime-mortgage-backed securities and associated derivatives through CDS with AIG and monoline insurers found that the counterparty credit risks of these hedges were strongly correlated with the underlying. Such correlations are to be expected if the counterparty takes many positions whose risks are highly correlated. After all, the counterparty is most endangered when the underlying risk moves adversely and the buyer of the hedge calls on the counterparty to perform.

In a previous era, banks used to keep macro risks in their own books, but since the 1980s, they have more and more tried to get these risks off their books. This development has in part been due to a recognition that macro risks, in particular interest rate and exchange rate risks, had become larger, and that, in an increasingly competitive environment, banks were not really able to bear these risks.²⁴ In a sense, this was a reaction to the crises of the early and

²² In this context, it is pertinent to mention the ESRB's work on lending in foreign currencies; see https://www.esrb.europa.eu/pub/pdf/recommendations/2013/ESRB_2013_2.en.pdf?c63788d50e9a1b957f4f7cfb39b4b99a

²³ See Hellwig (1994a) as well as Admati and Hellwig (2013), Ch. 4, and the references given there.

²⁴ The growth of exchange rate risks was triggered by the end of the Bretton Woods regime of fixed exchange rates, which went along with a removal of capital controls and a need for international financial activities to recycle petro-dollars after the 1973 oil price increase. Nominal interest rates

the late 1980s. In part, the shifting of risks off the banks' books was also a response to the development of new techniques for modelling, managing and trading risks, in particular, through derivatives, and to new regulation that encouraged the use of these techniques.

However, when banks try to get macro risks off their books, the question is where these risks go. If they go to a party that has a comparative advantage in bearing them, the banks' risk management and risk contracting may reduce the overall risk exposure of the system. This would be the case, for example, if banks used covered bonds or mortgage-backed securities to get the interest rate risk of real-estate finance off their books, and if these securities end up with pension funds or annuity insurance providers that have long investment horizons. If instead, the risks end up with parties that are unable to bear them, the overall risk exposure of the system may actually be increased as the shifting of risks makes the banks more careless but, in the end, they may be affected anyway. This was the case with adjustable-rate lending in the late 1980s and again in subprime-mortgage lending before 2007. In the latter episode, the fact that mortgage-backed securities and collateralized debt obligations ended up with other banks, or with the special-purpose vehicles (conduits and SIVs) of other banks also contributed to system risk exposure. Quite often in such arrangements, the risks are merely moved to a place where nobody can see them but they still threaten the system.²⁵ The same is true for hedge contracts whose counterparty credit risks are highly correlated with the underlying.²⁶

3.3 Risk-Based Capital Regulation and System Risk Exposure

The use of new techniques for modelling, managing and trading risks so as to get them off the banks' books has been strongly encouraged by the Basel approach to bank regulation. The Basel approach calibrates minimum requirements for bank equity to the riskiness of the bank's assets. Depending on how risky the different assets are considered to be, they are given high or low weights, so that for example assets that are deemed to be riskless need not to be backed by equity at all. "Basel I", the 1988 international accord on minimum equity requirements for credit risks, used a very coarse scheme for risk weighting. A 1996 amendment, which extended this accord to cover market risks as well as credit risks, allowed for more sophisticated risk weighting. In particular, it allowed banks to use their own quantitative risk models to assess the market risks in their portfolios and to determine the equity needed to back them. Subsequently, "Basel II", the overhaul of the regulatory framework that was agreed in 2004, extended the more sophisticated approach, including the use of the banks' own internal models, to determine risk weights for credit risk as well as market risk.

The calibration of equity requirements to risks is meant to make the system safer. Higher equity requirements for banks that incur greater risks are meant to provide incentives against excessive risk taking, also to provide additional capacity for the absorption of losses

reached extraordinary levels in the mid-1970s, the early 1980s and again the late 1980s, largely as a result of the interplay of high inflation, inflationary expectations and monetary policy. See, for example, Hellwig (1994a, 1995).

²⁵ For extensive discussions, see Hellwig (1994a, 2009)

²⁶ See Hellwig (1995).

from those risks if they are taken and materialize.²⁷ One might also hope that this regulatory approach makes financial institutions more conscious of the need for proper risk management, inducing them to put resources into the modelling and the assessment and hedging of risks.

However, there are substantial reasons for believing that the Basel approach has actually made the financial system less safe. In the decade following the 1996 amendment to the Basel accord, banks that were subject to this regulation to reduce their equity quite substantially or, equivalently, to expand the business they did with the equity they had. For large European banks, in 1998, a ratio of equity to total assets *below* 4% was the exception, in 2007, a ratio of equity to total assets *above* 4% was the exception.²⁸ In the United States, investment banks, which were subject to Basel rules, had similarly low ratios for equity relative to total assets, much lower than commercial banks, which were required to satisfy a traditional leverage ratio requirement.²⁹ In the crisis, those banks that had used the Basel rules to economize on equity were most strongly affected. By contrast US commercial banks were less strongly affected, except for those that had a focus on real-estate lending and related investments and for those that used other means, such as off-balance-sheet activities to economize on equity.³⁰

In the crisis, many institutions came into difficulties because of risks that did not appear in their books and their models because they had been hedged and then neglected. For example, UBS Investment Bank used to hedge some of the credit risks of MBS CDOs that the bank held and to set the corresponding credit risk equal to zero in their risk model.³¹ The bank's discretion over its own risk model and its ability to use this risk model to determine risk weights for positions in the trading book played an important role here. More generally, the UK's Financial Services Authority (FSA) has found that banks' losses in the crisis were mainly centered in the trading book, that risks of positions in the trading book were greatly underestimated, and equity backing these positions quite inadequate.³²

Empirical research on the banks' experiences in the global financial crisis has shown that, in the financial crisis of 2007 – 2009, equity relative to risk weighted assets was a poor predictor of institutions' robustness to the shocks that were hitting them. By contrast, equity relative to total assets was fairly reliable as a predictor of bank robustness in the crisis.³³

Risk calibration of equity requirements is usually justified with the argument that a bank which runs more risk must be required to use more own funds. In practice however, the

²⁷ Provision of proper incentives and provision of loss absorption capacity are often mentioned as objectives of bank capital regulation. As discussed in Hellwig (2010), these objectives do not always coincide. Potential conflicts between them have yet to appear on the radar screen of the regulatory community.

²⁸ See Advisory Scientific Committee (2014 a).

²⁹ Investment banks were supervised by the Securities and Exchange Commission, commercial banks by the Federal Reserve and the Federal Deposit Insurance Corporation; the latter had kept the traditional leverage ratio regulation on the grounds that Basel II provided banks with too much leeway to game the regulation. See Ch. 11 in Admati and Hellwig (2013).

³⁰ A paradigmatic example is Citi. See Acharya et al. (2013).

³¹ See UBS (2008).

³² See Financial Services Authority (2010).

³³ See Brealey et al. (2012), Demirgüç-Kunt et al. (2013), and Haldane (2012).

calibration allows banks that claim to be running fewer risks to get away with using hardly any own funds. As a matter of logic, the two statements may look similar, but as a matter of regulatory politics, there is a huge difference. From the bankers' perspective, and sometimes the supervisors' perspective as well, the name of the game is to economize on equity rather than to raise equity requirements for additional risks.

In this context, imperfections and flaws in risk weights play an important role. If the risk weight assigned to an asset is zero or close to zero, the bank can take gigantic positions with hardly any equity at all. Examples were the French-Belgian bank Dexia and the German bank Hypo Real Estate. These banks operated large portfolios with hardly any equity because their investments, mainly public debt and mortgage debt, had zero or very small risk weights. *Inter alia*, they had invested in Greek sovereign debt, which had a risk weight of zero but had a small risk premium in the interest rate. Whereas these positions were small, the equity of these banks was insufficient to absorb the losses from the Greek default in 2012, so Dexia became insolvent, and Hypo Real Estate would have become insolvent they had not previously put the Greek debt into a "bad bank" owned by the German government.

Previously, both these banks had needed government support when interbank markets broke down in September 2008. Not having much of a deposit base, they had obtained most of their funding through wholesale short-term borrowing. The funding risk associated with this borrowing was not taken into account in the Basel rules.³⁴

Risk calibration of equity requirements under the Basel approach is not based on a comprehensive attempt to assess and manage the overall risk of an institution but on a set of piecemeal assessments of different positions. Some of these assessments are influenced by politics (zero risk weights for sovereign exposures), some by tradition (disregard of funding risks in the bank book), and some by quantitative assessments.

The quantitative assessments themselves are imperfect because the data series are short and nonstationary and some of the risks involved are constantly changing. Even when they are exogenous, correlations are notoriously difficult to estimate.³⁵ With correlations between the counterparty credit risks in hedge contracts and the underlying risks against which the hedge contracts are written, one has the added difficulty that they depend on the other positions held by the counterparty about which one may have little information.

There may also be incentives to underestimate risks in order to economize on equity. Thus, Sobott (2016) finds that banks tend to underestimate the correlation between different assets and to "overdiversify" as a way of reducing reported value at risk. Moreover, the effect is stronger with banks that find it difficult to meet their capital requirements.

The issue of incentives for risk modelling is not just a matter of relations between supervisors and banks but also a matter of relations between senior managements and

³⁴ For assets in the bank book, risks from maturity transformation, such as the risk that funding might become very expensive or even unavailable, are not taken into account in capital regulation.

³⁵ This point was already made in Duffie (2007) with respect to the correlations between the different securities in a CDO.

operational units in banks. If large bonus payments are at stake, operational units have strong incentives to misrepresent their risks to the senior management.³⁶

As mentioned above, unanticipated losses in the financial crisis were mainly associated with positions in the trading books of banks. This finding should not however be taken as a sign that all is well with risk weighting in the bank book. When the financial crisis struck, the new rules of Basel II for the assessment of risks in the bank book had barely been introduced. However, the use of internal ratings for credit risk in the bank book also leaves banks with a lot of discretion to downplay risks in order to reduce required equity. A recent paper by Behn et al. (2014) suggests that, if loans are assessed according to internal ratings, then *ceteris paribus* they are deemed to be less risky than under the standard approach; moreover, the actual risks tend to be higher.³⁷ Given that, for many institutions, the bank book is far larger than the trading book, we should be apprehensive about future developments here.

Imperfections in risk assessments are unavoidable, for incentive reasons as well as data availability and reliability. Typically these imperfections cause financial institutions to underestimate the risks in question. Underestimation of risks makes the regulation less stringent. In this context, as mentioned, imperfections in hedges and neglect of correlated counterparty credit risks play a major role. From a system perspective the underestimation is likely to be most serious when the risks in question are correlated across institutions because they are jointly driven by macro shocks. The paradigmatic example is AIG selling CDS for mortgage-backed securities and CDOs for \$500 billion without anybody appreciating that the risks in those contracts were correlated because they were driven by macro variables such as interest rates and real-estate price developments.

If the hiding of risks makes market participants and supervisors underestimate the overall system risk exposure, the use of advanced techniques to manage and trade risks, which seems to reduce the exposure of the individual institution, may actually increase the exposure of the overall system to adverse macro shocks. We must therefore be concerned that, in the modern system of risk management and risk trading between financial institutions, system exposure to macro risks is no longer discernable by looking at each bank's books individually and then considering the correlations. Instead, we must be afraid that system exposure to macro risks is hidden in correlated counterparty credit risks and that adverse macro shocks play out through contracting dominos and other forms of shock propagation in the financial system.³⁸ This is the essence of the 2008 experience with AIG.³⁹

³⁶ A 2008 report by Swiss bank UBS to its shareholders documents substantial governance problems and governance failures in relations between UBS senior management and UBS Investment Bank.

³⁷ The study uses German data for the years 2006 – 2011. Certain peculiarities of the sequencing of the introduction of Basel II in Germany enable the authors to overcome the identification problems involved.

³⁸ A warning about this development is given in Hellwig (1998a).

³⁹ Thus, in its 2007 Annual Report, the insurance company American International Group (AIG) writes: “approximately \$ 379 billion ... of the \$ 527 billion in notional exposure of AIGFP's super senior credit default swap portfolio as of December 31, 2007 represents derivatives written, for financial institutions, principally in Europe, for the purpose of providing them with regulatory capital relief rather than risk mitigation.”

4. Are Macro Risks Problematic?

4.1 How Much Macro Risk Is Appropriate?

From a normative perspective, a key question is how much macro risk should actually be taken and who should bear this risk.⁴⁰ If we place the safety and soundness of banks above all other objectives and if we think of macro risk as a threat to the safety and soundness of banks, we might conclude that banks should not bear any macro risk at all. If they do incur macro risk anyway, but we want depositors to be fully protected from such risks, we must be arguing that someone else is better suited to bear them, e.g. taxpayers.

From the perspective of general economic theory, such assessments require careful analysis, rather than rhetorical flourish about the harms of bank failures and financial crises. On the first question, macro risks may appear as an unavoidable side effect of an efficient allocation of resources for investment. If we want to live in houses rather than tents, someone must bear the risk that the market values of these houses vary over time, in a manner that cannot be foreseen *ex ante* and that is associated with changes in market rates of interest. Further, if financing arrangements for these houses involve an element of maturity transformation, someone must bear the refinancing risks, which are also at least partly associated with changes in market rates of interest. Standard welfare analysis tells us that it would be efficient to have such risks shared by everyone in proportion to the person's degree of risk tolerance. Why then do regulators insist on the need to protect depositors from all risks?

In this context, mention is often made of the importance of liquidity provision by banks, the fragility of banks that is thereby introduced and the need for deposit insurance as a means of preempting runs and thereby reducing fragility.⁴¹ Investors often do not know when they will want to liquidate their investments so as to use the funds for other purposes. By allowing them to withdraw their funds at will, banks provide them with insurance against this uncertainty. If investors' needs for their funds satisfy a law of large numbers, banks can do so even when their own assets, such as housing loans and mortgages, are nontradable. However, since investors' funding needs are not observable, such contracting is potentially vulnerable to runs.

This traditional argument does not however answer the question I posed. In dealing with this question, it is important to distinguish between liquidity provision and maturity transformation.⁴² Take the example of a traditional US savings institution with a portfolio of mortgages with an average maturity of roughly twenty years. Consider a term savings deposit with a maturity of seven years, the longest maturity that used to be offered. Why should the return that the depositors gets after seven years be fixed in nominal terms, rather than tied to the value of the mortgage portfolio or, since the mortgage portfolio itself may not be

⁴⁰ I first raised this question in Hellwig (1994a). See also Hellwig (1998 b, 2009).

⁴¹ See, e.g., Diamond and Dybvig (1983), Gorton (2010).

⁴² The distinction is introduced in Hellwig (1994a). Gorton (2010) emphasizes the need for liquidity transformation without considering the possibility of separating the two. See also Admati and Hellwig (2013), Ch. 10.

observable, the market rate of interest at that time? The above answer to the question why it may be efficient to allow investors to withdraw before the underlying real investments have matured contributes nothing to answering the question why the amounts they withdraw should be independent of the intervening realizations of macro shocks.

In Hellwig (1994a), I found that such independence need not actually be efficient. Whereas liquidity transformation by banks is highly desirable, maturity transformation need not be. For a model involving interest rate risk (due to aggregate productivity or preference shocks⁴³), I showed that it would be efficient to give all investors the opportunity to trade all their assets at all dates, with a proviso that investors who end up wanting to liquidate their holdings early should bear the interest-induced valuation risks of the long-term assets and investors who end up wanting to liquidate their holdings late should bear the interest-induced re-investment opportunity risks of the short-term assets that intermediaries had funded with the investors' resources. The arrangement could be implemented by having intermediaries issue short-term and long-term debt with perfect maturity matching in relation to their assets, with a proviso that, if an investor wanted to sell long-term debt before it matured, he could do so at the prevailing market price and if an investor wanted to reinvest the returns from maturing short-term debt, he could do so at the prevailing rate of interest. The analysis also showed that this outcome would emerge as a market equilibrium if banks could commit to maturity matching.

4.2 Why Do Banks Bear so Much Macro Risk?

The preceding discussion raises the question why banks in the real world bear so much interest rate risk and, more generally, so much macro risk. One answer to this question might be that contractual arrangements with this risk allocation receive a subsidy from the government, e.g. through deposit insurance schemes with government guarantees. This hypothesis is partly confirmed by the observation that the introduction of deposit insurance in the United States was followed by a significant increase in the average maturities of mortgage portfolios of US savings and loans institutions, from eleven years to twenty years.⁴⁴

However, this cannot be the entire story. Maturity transformation had been important long before deposit insurance was introduced, for example, in the rush of German banks in the decade before World War I to get "cheap deposit funding".⁴⁵ Note also that the scramble to acquire and hold mortgage-backed securities and CDOs in the years before the financial crisis, by US investment banks and by structured-investment vehicles of European banks, can hardly be ascribed to deposit insurance, as the funding involved asset-backed commercial paper, rather than protected deposits. From the perspective of my 1994 analysis, one might have thought of mortgage securitization as a device to free bank balance sheets from the interest-related risks of real-estate finance, passing these risks on to investors with long horizons, such as pension funds and life insurance companies that had long-term liabilities

⁴³ Whereas the version of the paper that was published in the *European Economic Review* only allows for an aggregate productivity shock, the original working paper version also allowed for aggregate preference shocks.

⁴⁴ Benston et al. (1991).

⁴⁵ Riesser (1910).

and might be more concerned about avoiding re-investment opportunity risk than about avoiding interim valuation risk.⁴⁶ Yet, most of these securities ended up in banks and were funded by very short-term debt.⁴⁷ The 2008 UBS *Report to Shareholders on UBS'S Writedowns* reports that, at some point, UBS Investment Bank, a major player in the creation of CDOS out of mezzanine asset-backed securities, decided to keep the AAA-rated tranches of the securities they created in their own books because they earned a few basis points more than AAA-rated government debt!

The literature on bank funding and bank behaviour that I know does not provide a satisfactory explanation.⁴⁸ A large part of this literature, which includes the work on liquidity provision by banks that I mentioned above, proposes to explain observed patterns of bank funding and bank behaviour as solutions to specified information and incentive problems. This work assumes that shocks to bank returns are non-contractible. It thereby excludes most macro risks *a priori*. Macro shocks leave traces in indicators that are not manipulable by individual institutions, in market rates of interest, in exchange rates, in stock market indices, and in various indicators of aggregate economic activity. According to Holmström's (1979) informativeness principle, contracting with information and incentive problems should condition on such indicators. A literature that *assumes* that such conditioning does not take place is hardly able to *explain* the phenomenon.⁴⁹

Another part of the literature focuses on the incentives that bank funding choices provide to bank managers and shareholders, including the incentives for future funding choices. This work assumes that financial contracts cannot fully precommit the behaviour of bank managers and shareholders and notes that, if there is significant funding by debt, then the bank's owners and managers have strong incentives to engage in risk taking – after all, they obtain all the benefits from positive surprises and they share some of the costs of negative surprises with the bank's creditors (or the deposit insurance system).⁵⁰

I expect this line of argument to provide the key to the question of why banks are so much exposed to macro risks, in particular interest rate risk, but I am as yet unable to make the argument tight. Why would a tendency to take risks that are excessive relative to what would be taken in a first-best world focus macro risks rather than some other risks. Indeed, we have seen banks go under because they took excessive risks that were not related to macro

⁴⁶ Such institutions would be the traditional holders of covered bonds in Europe, a type of security that transfers the interest rate risk of the collateral from the issuer to the holders without diluting incentives for creditworthiness assessments by also transferring the asset-specific risks.

⁴⁷ International Monetary Fund (2008).

⁴⁸ For an extensive discussion of this point, see Hellwig (1998b).

⁴⁹ As discussed in Hellwig (1998b), this criticism applies also to the suggestion of Calomiris and Kahn (1991) that short-term debt finance of banks is a device to impose discipline on bank managers. The criticism also applies to the later incarnations of this suggestion in Diamond and Rajan (2000, 2001), or indeed the *Squam Lake Report* (French et al., 2010) which relies on this work. For a detailed discussion, see Admati and Hellwig (2013b).

⁵⁰ Standard references for this excessive risk taking effect are Jensen and Meckling (1976), Stiglitz and Weiss (1981). Dewatripont and Tirole (1994) interpret the behavior of American savings and loans institutions in the 1980s in these terms; Berglöf and Sjögren (1998) do so for the behavior of Scandinavian banks after the 1980s deregulation.

shocks but involved, e.g. large exposures to individual borrowers.⁵¹ And how is excessive risk taking related to maturity transformation and the allocation of interest rate risk. At least on a purely abstract level, negative maturity transformation, i.e., a use of long-term funding to invest in short-term assets might also be a form of excessive risk taking.

Concerning the first issue, why excessive risk taking tends to involve macro risks, an explanation may come from the fact that macro risks, i.e., risks that remain significant even when they are efficiently shared in the overall economy, are likely to carry a risk premium so that expected returns are higher. To the extent that the managers pay attention to expected returns, they will tend to go into investments that earn such risk premia, especially if they can fool themselves and others about the risk-return tradeoff. UBS Investment Bank retaining securities of their own creation because they earned a few more basis points provides an example. (This consideration may also explain why many banks often take similar positions and why macro shocks, when they occur, tend to affect many banks at the same time.)

On the second issue, what does excessive risk taking have to do with maturity transformation, I note that moral hazard affects subsequent funding choices as well as investment choices. Admati et al. (2018) show that, once a bank (or indeed any firm) is deeply in debt, its managers and shareholders have strong incentives to increase the debt even further and no incentive at all to reduce it. They will in fact do so unless incumbent debt holders are able to coordinate and to influence the later funding decisions. Such coordination may be expected when a handful of banks lend to a nonfinancial firm but is hardly possible when funding is provided to a bank by thousands of small investors or by twenty money market mutual funds. Even covenants may be ineffective; for example, a covenant prohibiting the issue of new debt that has higher or equal priority as the outstanding debt still permits an issue of junior debt that may increase managerial incentives for risk taking, which hurts incumbent debt holders.⁵²

To protect themselves against this form of moral hazard, potential creditors are likely to insist on higher interest rates from the beginning. They may also insist on shorter maturities in order to reduce their exposure to moral hazard in subsequent funding decisions, or to participate in the taking advantage of incumbent debt holders when the short-run debt they provide needs to be rolled over. In the analysis of Brunnermeier and Oehmke (2013), with a fixed investment size, a fixed investment horizon, and zero equity, this consideration induces a “maturity rat race”, with minimal maturities as the only equilibrium outcome. In the analysis of Admati et al. (2018), minimal maturities do not forestall the “leverage ratchet effect”, i.e. the tendency of debt to be ratcheted up over time. In both settings, the moral hazard at work can induce large efficiency losses, even for the bank itself and its shareholders. They would benefit from the introduction of a commitment device for their future funding choices.

⁵¹ Examples are Continental Illinois, which was bailed out in 1984 after it had purchased a portfolio of bad loans from a failed Oklahoma bank without appropriate due diligence, and German private bank Schröder, Münchmeyer, Hengst, which was bailed in 1983 after it had suffered severe losses from of a very large exposure to a leading producer of construction machinery who went bankrupt.

⁵² A key result in Admati et al. (2018) shows that, even if the funding mix had previously been chosen to minimize funding costs in the sense of the traditional tradeoff approach, once the funding is in place and given, if corporate tax rates are strictly positive and even if only junior debt is allowed, a re-optimization will indicate a desire to issue yet more debt.

Statutory regulation can provide such a commitment device. Equity requirements give all participants that the effects of overhanging debt on future funding mix choices, in particular the further evolution of leverage, will be limited. Maturity regulation may reduce the impact of the maturity rat race. This may be beneficial to participants even without considering the systemic implications of maturity transformation.

Since Jensen and Meckling (1976), the theoretical literature on financial economics has been shaped by the research program that we should interpret the phenomena we observe as being incentive efficient, i.e. second-best arrangements that take account of incentive and information problems. The research program has been enormously fruitful, but there is a danger that it may become ideological, in the Marxian sense of an ideology as a doctrine develop to justify the phenomena we observe as being appropriate without any further policy intervention. It is therefore important to realize that incentive efficient is not the same as efficient and second-best is not the same as first-best. Arrangements that are merely incentive efficient and merely second-best may well benefit from government intervention to change the conditions under which such contracting occurs. For example, a government subsidy for fire extinguishers may well provide a welfare improvement in the allocations induced by contracting for fire insurance under moral hazard.⁵³ In the present context, with an inability to commit future funding as a major source of moral hazard, statutory regulation may well provide an improvement over second-best contracting in the absence of commitment.

5. The Assessment of System Risk Exposure

For supervision and macro-prudential policy, it is important to have a sense of what the risk exposure of the financial system actually is. Before 2008, this issue did not receive much attention. Policy makers, regulators, and supervisors thought that, if they looked at each institution individually and if each institution was found to be safe and sound, then the system as a whole would also be safe and sound. The cataclysm of 2008 showed that this reasoning had been flawed. In the following, I explain why it is not enough to look at each institution by itself and why a systemic approach is needed. I also discuss some of the difficulties that may arise.

5.1 The Need for a Systemic Approach

At some point in the early 1990s, when I was working on the efficient allocation of interest rate risk in the economy, a person from Swiss Bank Corporation (SBC) with whom I talked about my research told me that, as far as his bank was concerned, this was a non-issue: SBC was using asset and liability management through money market borrowing and lending so as to match maturities in the bank's balance sheet and eliminate interest rate risk.⁵⁴ I was puzzled because, at the time, Swiss banks were still struggling to cope with the effects of the

⁵³ This observation is due to Arnott and Stiglitz (1986).

⁵⁴ A few years later, this person would have referred to interest rate swaps as a means of maturity mismatch management on a daily basis. See Staub (1998).

1989/1990 interest rate hike on their funding costs, not to mention the downturn in real-estate markets and the increase in credit risk.

Could it be, I asked myself, that, as they were engaged in asset and liability management, these banks were not actually aware of the extent of maturity transformation they were engaging in? The following thought experiment might indicate a problem. Suppose that there are three banks A, B, C, all of which have \$1 billion and one dollar in real-estate loans, \$1 billion in deposits, and one dollar in equity. In addition, bank A has made short-term loans of \$100 billion to bank B, bank B has made short-term loans of \$100 billion to bank C, and Bank C has made short-term loans of \$100 billion to bank A. Each bank individually believes that it has \$100 billion in short-term assets and \$101 billion in short-term liabilities, which seems like almost perfect maturity matching, reducing interest rate risk “almost” to zero. Yet, the banking system as a whole is transforming deposits into mortgages. Whatever interest rate risk is inherent in this maturity transformation by the system as a whole and is not apparent in the banks’ books must be hidden in the counterparty credit risks of the short-term debt.⁵⁵

In another thought experiment, consider a system with 480 institutions and suppose that institution n funds itself by borrowing at a maturity of $n-1$ months and invests its funds by lending at a maturity of n months. Each institution probably believes that it is almost perfectly maturity-matched. The system as a whole, however, is transforming demand deposits into 40-year mortgages. Here again, much of the interest rate risk that is associated with this substantial maturity transformation by the system as a whole is not discernible from the individual institutions’ balance sheets but is hidden in the counterparty risks in interbank borrowing and lending. These risks themselves are difficult to see because, for example the credit risk in bank 200’s lending to bank 201 depends on the credit risk in bank 201’s lending to bank 202, etc., and clearly, any one bank is unable to assess its counterparty’s counterparty’s counterparty’s.... credit risk. To assess the overall system’s risk exposure properly, one must look beyond these individual institutions and appreciate that the system as a whole is transforming demand deposits into 40-year mortgages.⁵⁶

The examples are contrived, artificially constructed to make a point. But consider the following chain of transactions in subprime mortgage origination and securitization: Money would go from an investor to a money market fund. In return for asset-backed commercial paper, the money market fund would give the money to a structured-investment vehicle of a regulated bank. The structured-investment vehicle would use the money to buy CDOs from a special-purpose vehicle (SPV) of an investment bank. The investment bank (or its SPV) would buy mortgage-backed securities from special-purpose vehicles of other investment banks. These other investment banks (or their SPVs) would buy the mortgages from the originating mortgage banks. The mortgage banks would lend the money to their mortgage clients, and the clients would use it to buy their houses. The chain of transactions had fewer than 480 elements, but it was long enough to allow the participants – and the supervisors – to delude themselves about the extent of maturity transformation, liquidity risks, credit risks, and incentives.

⁵⁵ The argument is taken almost verbatim from Hellwig (1994b).

⁵⁶ For an extensive discussion and interpretation of this example, see M. Hellwig (1995).

Academics shared the delusion. An example is Gorton's (2010) assertion that, though nominally concluded for thirty years, subprime mortgage lending involved hardly any maturity transformation. According to Gorton, subprime mortgages were designed so as to be replaced by new mortgages after two or three years and therefore could be regarded as being effectively "short-term" loans.⁵⁷ This argument neglects the problem that the renegotiation after two years might be unsuccessful because the debtor is unable to comply with the new conditions that the creditor wants to impose. For example, the debtor might be unable to pay the higher interest rates that the creditor wants to impose or needs to impose because his own financing conditions have changed.⁵⁸ This is another instance of the problem that shifting certain risks to another party may merely transform this risk into a counterparty credit risk.⁵⁹

The important point is that the mortgage loans served to finance long-term assets. The long-term nature of the assets gives rise to certain risks that affect the financing relation even if they are not apparent from the contracts. The house that is financed by a mortgage loan has an economic lifetime of several decades; during this lifetime, the accommodation services that this house provides are, by and large, given and can hardly be adapted to changes in the economic environment. In particular, the accommodation services cannot be adapted to changes in market rates of interest that affect refinancing conditions and/or the market value of the property.

As mentioned above, the refinancing risks and valuation risks of long-lived assets cannot be avoided, but must be borne by someone. If the ultimate financier is a short-term investor, these risks must be borne by someone else, and the intermediation chain *must* involve some maturity transformation. This maturity transformation, however, may only be recognizable by looking at the entire chain of transactions, asking, what are the "real" assets that are being funded, what are the risks associated with these assets, and who is ultimately bearing these risks.

If, along the chain, someone is trying to hedge risks with third parties such as AIG, who are these third parties and what do we know about their place in the financial system and their ability to fulfill their obligations? There is thus a need for transparency about *all* parts of the financial system. Traditional arguments of the sort that hedge funds need no regulation because their investors are sophisticated enough to fend for themselves are moot when it comes to the systemic implications of such shadow banking institutions for the system's risk exposure. The importance of this concern is underlined by the fact that, in August 2007, the sudden realization of the extent to which MBS and CDOs had been held in shadow-banking institutions contributed greatly to the panic and to the decline in prices. Market participants

⁵⁷ Gorton (2010).

⁵⁸ As discussed in Hellwig (1994a), this had been the experience of UK building societies with variable-rate mortgages in the late 1980s. For a more systematic account of risk allocation in real-estate finance in the run-up to the crisis, see Hellwig (2009).

⁵⁹ Gorton (2010) downplays the problem of credit risk in subprime lending and overlooks the endogeneity of this risk. He negates the incentive effects of securitization prospects on quality control in origination (pp. 138 – 144), without however discussing the contrary evidence, for example in UBS (2008) or in Ben-David (2011) (which had been available as a working paper as early as 2007). For early discussions of the incentive problem and of the difference between mortgage securitization and covered-bond finance, see Hellwig (1994a, 1998b).

had always known that structured-investment vehicles and the like held a lot of such securities, but they were shocked to learn that these holdings amounted to a trillion dollars and that, therefore, almost from one day to the next, securities originally worth a trillion dollars were in search of funding or of equity backing.

5.2 *Slow versus Fast Dynamics in Macroeconomic and Financial Systems*

In thinking about systemic risks and financial crises, it is important to see that different types of processes have different time structures. Processes involving asset markets and asset prices tend to be very fast, much faster than macroeconomic processes. The link that is often made between systemic risk analysis and “macro-prudential” policy suggests that we should think about systemic risks in the time frame of macroeconomic processes like the business cycle.

However, *financial developments can proceed in patterns and at speeds that have little to do with conventional macroeconomic processes*. An example is given by the slow implosion of the financial system between August 2007 and August 2008 that I mentioned when I discussed the propagation of shocks through fire sales. This implosion involved the interplay of asset price declines, fair-value accounting, lack of equity, deleveraging and again asset price declines. In this example, crisis propagation in the financial sector developed on its own, without much of a link to the real economy (except for the US real-estate downturn that triggered the financial downturn in 2006/2007). Because the system dynamics went unchecked, they grew to macroeconomic dimensions taking the real economy down when the final implosion came after the Lehman bankruptcy.

The systemic developments during this period involved asset markets and asset prices. *Asset markets involve stock variables, asset prices have fast dynamics*. By late September 2008, massive changes were taking place each day. By contrast, *most macroeconomic processes involve flows of aggregate demand, aggregate production, new lending, investment, etc. These flow variables have slow dynamics*, with a time frame on the order of quarters or years, rather than days or hours.

The difference in the time structures implies that, in a crisis situation, problems at the level of stock variables, in bank balance sheets, asset positions and asset prices cannot quickly be taken care of by measures involving flows. If asset price declines force a bank to take losses, the resulting imbalance between the bank’s assets and its equity cannot be corrected by a cutback in new lending because the flow of new lending is small relative to the stocks. Similarly, a correction of the imbalance by retained earnings would take a fair amount of time.⁶⁰

A new equity issue would help right away but, for reasons discussed in Admati et al. (2018) and in Section 4.2 above, banks tend to be unwilling to issue new equity. In the absence of an equity issue however, *imbalances at the level of stock variables in banks’ balance sheets can only be corrected by deleveraging*, by asset sales or by callbacks of

⁶⁰ After the turnaround of US monetary policy in 1990, it took about two years of high profits and retentions until bank equity was sufficiently rebuilt for them to expand lending again.

outstanding loans. Asset sales may cause asset prices to fall even further. Callbacks of outstanding loans may create chaos for the borrowers whose assets may be even more illiquid than the loans.

As yet, we do not have the methods that we would need to integrate asset market dynamics and macroeconomic dynamics while taking account of the different time frames of different processes. A better understanding of these dynamics seems crucial, however, if we are to understand how systemic risks might play out in a crisis.

5.3 “Measurement” of System Risk Exposure versus “Story Telling”

In the aftermath of the financial crisis, important work has been done on the quantitative assessment of systemic interdependence. Adrian and Brunnermeier’s (2016) measure of conditional value at risk (CoVaR) provides information about the extent to which an individual bank’s value at risk changes if one or several other banks or the entire financial system is hit by adverse developments. Brownlees and Engle’s (2016) SRISK measure provides information about the expected shortfall of a bank’s equity relative to regulatory requirements conditional on a market decline exceeding a given threshold. In both approaches, one can use the measures for individual institutions to obtain aggregate measures of CoVaR or of SRISK, which are then interpreted as measures of systemic risk, with individual banks’ contributions to the aggregates as measures of the impact they have on the system.

Informative though these measures are, it is not quite clear what they mean. What are the underlying structures, what the underlying causation mechanisms? Do the correlations reflect the common exposures of banks with parallel positions to the same shocks? Or do they reflect the interdependence of banks through contagion? In the latter case, the individual bank’s contribution to the aggregate as a measure of the impact it has on the system might reflect a relevant external effect, in the former case, it is not clear that there is a relevant externality.

If the different measures are all very high at the peak of the crisis, what does that tell us? Is there more to this observation than to the fact that a thermometer shows high temperatures when the house is on fire? The correlations given do not tell us much, if anything at all, about the actual interdependence. Looking forward, what elements of the data generating processes can we take to remain the same as the industry moves from one fashion to the next, having learnt to avoid mistakes of the past and engaging in new adventures? Can the numbers in bank balance sheets be given the same meaning even if as the hedge strategies of the banks change?

To see why there might be a problem, consider the system risk that is hidden in the correlations between the counterparty credit risks in hedge contracts and the underlying risks of macro shocks against which the hedge contracts are supposed to provide insurance. The correlations depend on the counterparties’ positions, which may be changing all the time. Even under the best of circumstances, it is notoriously difficult to obtain reliable estimates of

risks correlations.⁶¹ Time series are highly non-stationary, credit events are rare, and estimates of correlations require more observations than simple estimates of means and variances.

One may wonder whether in this context the notion of estimation or “measurement” makes any sense at all: The counterparty’s reliability depends on the counterparty’s behavior, in particular, on the other contracts that the counterparty concludes and the risks to which it is exposed under these other contracts. Some of these risks in turn depend on the reliability of the counterparty’s counterparties and so on. Counterparty credit risk is endogenous and is constantly changing.

Exposure to the risk of fire sale externalities is also hardly “measurable”. The extent of the externality depends on the asset positions held by the other market participants and on the extent to which the other market participants’ equity enables them to absorb losses. As mentioned above, prior to August 2007, neither the regulators nor the market participants knew the extent to which mortgage-backed securities and CDOs were held by structured-investment vehicles and similar shadow-banking institutions without any backing by equity. If this information is not available, the risk from other institutions’ selling in a panic cannot be reliably assessed.

Even if the information were available, estimates of system risks from fire sales might not be reliable because these risks also depend on the market’s reactions to fire sales. These reactions may very much depend on the situation. A given sale may precipitate a drastic price decline if the other market participants are very nervous and very vulnerable. The same sale may involve no systemic risk at all if market participants are calm and, with but a small rebate, there are plenty of buyers for the assets that are put for sale.

The Federal Reserve’s worries in 1998 about letting LTCM go into bankruptcy provide an example. Under normal circumstances, unwinding of the LTCM portfolio would be considered unproblematic (as indeed it proved to be once the panic had been overcome), but the particular situation of September 1998, shortly after the Russian default and with many institutions held similar portfolios as LTCM, was not normal, so the Federal Reserve feared that as a result of winding down LTCM, there might be a market meltdown. Systemic fallout from fire sales of institutions in difficulties is highly contingent, as it depends on the ability and the willingness of others to acquire the assets in question.

On many occasions when I have highlighted these difficulties and expressed my skepticism about the scope for “measuring” systemic risk, I received the answer that the requisite information might be contained in market prices. For example, an individual institution’s exposure to such risks would be considered by the institution’s counterparties and would therefore affect the institution’s spread, i.e. the premium that it must pay in excess of the riskless rate when it borrows.⁶²

However, the information contained in prices cannot be better than the aggregate of the information available to participants. As a matter of principle, I do not see how the market

⁶¹ See Duffie (2007).

⁶² Charles Calomiris has on many occasions suggested that supervisors should use this risk premium as a signal about the state the institution is in; see, for example, Calomiris (1999).

participants, or the analysts on whom they rely, can overcome the difficulties that I have just sketched.

The idea that systemic risk is something to be “measured” combines the methodological traditions of finance and of macroeconomics. Estimation of return processes and return distributions is an essential element of applied finance, especially as a basis for portfolio choice. In macroeconomics, development of a dynamic stochastic general-equilibrium model, with estimation or calibration of model parameters, provides the standard basis for forecasting and for policy analysis. In the crisis of 2007 – 2009, however, the standard empirical models in finance and macroeconomics failed. Both the theoretical models and the parameter estimates and calibrations were inadequate for the situation.

It may therefore be useful to draw on methodological approaches that are used in other parts of economics. In competition analysis and competition policy, for example, about the first thing one learns is that no one theoretical model is adequate for all situations. Industrial economics has a large zoo of theoretical models, and the analyst’s first task in dealing with a competition policy “case” is to decide which model from the zoo, or which combination of such models might be relevant to understand the problem on hand. This step requires a certain element of improvisation as one has to combine models or even to develop new ones in order to take proper account of all the relevant aspects of the information one has been presented. There also is some interplay, in an iterative procedure, between the trying out of theoretical models and the collection and assessment of data, which may or may not be in a form that is suitable for serious statistical analysis. Detailed regression analysis or calibration come at a very late stage, when one begins to have a sense that one understands “the story” behind the material with which one has been presented.

I submit that a similar approach would be very helpful in trying to assess system risk exposure. In Section 2, I exhibited a zoo of possible propagation mechanisms. Although I tried to impose some structure, it is not clear that the structure I imposed will prove to be useful in practice. Nor is it clear that the zoo is complete. To the contrary, I suspect that, as we are discussing the issue, the financial sector and the overall economy may be breeding some new species of propagation effects that we do not yet know. In Section 3, I also exhibited a zoo of possible macro shocks. Not all of these shocks are equally relevant for all economies at all times. Nor are all the propagation effects equally relevant for all economies at all times.

For a proper assessment of system risk exposure, including potentially an understanding of risks whose precise similes we have not yet seen, we need to proceed as in competition analysis: Gather observations on what seems to be going on. Try to understand the “story” that underlies new developments. Think as to which animals in our zoo of propagation effects and macro shocks might be relevant; possibly also whether we should develop some cross-breeds of the animals in our zoo. All this must be done from a system perspective and going back and forth between the available data and the potential stories behind the data.

This procedure involves a certain element of ad-hockery and is anything but foolproof. However, given the way in which the economy is constantly coming up with new patterns of interaction between the different participants, it seems like the best we can do. The ad-

hockery is in fact limited if we start from the assumption that participants like to earn excess returns and that this is most easily done by taking macro risks; also that participants like to ascribe their successes to their own competence rather than the taking of macro risks and that they try to hide their exposures to those risks. Taking these basics as being the same across different cycles and episodes, one is led to focus on what macro risks they are taking and how they are hiding them this time around. In answering these question, it is helpful to take a comprehensive view, starting with the real assets that are being funded, and considering the entire chain, or chains, of intermediation and risk sharing up to those investors who are the ultimate claimants and risk bearers.

If instead we settle on a single macro model and a single mechanism for systemic risk propagation, which we then estimate and calibrate, we can be pretty sure that the next big crisis will again come as a big surprise. It is also likely to come as a big surprise if we take a partial view rather than a comprehensive view of the problem, neglecting some of the participants in the chain of intermediation.

6. Challenges for Macro-prudential Policy

6.1 Conventional Macro-prudential policies

Macro-prudential policy so far tends to focus on prevention and to do so in the context of business cycle dynamics. Such a focus seems implied by the very word “macro” . It is also suggested by the Spanish experiment with countercyclical provisioning and by the hindsight assessment of the buildup of risks before 2007 that I mentioned in the introduction. In this approach, the underlying policy concern is with the effects of financial conditions on new lending and, through new lending, on the real economy and possibly back from the real economy on the financial system. The main focus is to restrain the buildup of credit risks so as to avoid a sharp crisis when the bubble bursts. And when the cycle turns, reversing these policies should provide some leeway to also smooth the downward movement.

The main tools of macro-prudential policy, such as countercyclical capital buffers, increases in loan-to-value ratios, or increases in margins and haircuts are all intended to slow the buildup of risks by restraining lending sprees.⁶³ In particular, countercyclical provisioning is intended to restrict the buildup of credit and of risks when the macroeconomy is doing well and everybody is optimistic, so nonfinancial firms and households want to borrow in order to invest in machines or in real estate, and banks are happy to lend to them.

Discussions about the use of these policy tools focus on the conditions under which to use them, what indicators to use for their imposition to prevent an excessive buildup of risks and what indicators for reversing them. My discussion in the preceding section suggests that

⁶³ For an overview over the different tools under the EU’s Capital Requirements Regulation and Directive, see ESRB (2014). An account of the uses that have been made of these tools is given in ESRB (2015).

one should not try to be over-precise in these matters. Given my skepticism about measurement, I expect that no one indicator will prove to be the best in all situations. Use of these policy tools will require an element of judgment, an assessment of “the story” that is underlying current developments.

Relying on judgment requires discretion. Discretion raises problems of commitment. According to an old saying, no one likes the punch bowl to be taken away while the party is going strong. Allowing an element of judgment into the application of macro-prudential tools on the upswing of the cycle may therefore imply too much leniency, if not on the side of supervisors, then possibly on the side of the government, which may have ways to affect supervisory action, directly, by fiat, if the supervisory authority is subordinated to the government, or indirectly, by political means, if the supervisory authority is legally independent. In this context, it is worth recalling that the same supervisor who invented countercyclical provisioning was unable to interfere with the buildup of a real-estate bubble, presumably because the alliance of local and regional banks, real-estate developers and politicians was too strong.

There is a tradeoff here between the need for discretion to deal with the fact that any indicator is likely to be imperfect and the need for commitment, which might be provided by having a fixed rule that ties macro-prudential policy to an indicator. From the perspective of market participants, there may also be a risk that regulatory discretion might lead to a multiplicity of arbitrary interventions.

6.2 The Need for Circuit Breakers

The discussion about macro-prudential policy is mainly focused on prevention. There has been relatively little discussion on what to do when risks realize and the financial system gets into trouble. Under what conditions should macro-prudential regulation be loosened? What is to be done if a mere loosening of macro-prudential regulation is not enough to stop the downward trend?

These questions are particularly relevant when problems in the financial sector concern stock variables in the balance sheets of banks, such as stocks of nonperforming loans, stocks of cash, debt and equity levels. As mentioned above, attempts to correct for an insufficiency of equity through deleveraging can have very adverse consequences for the system as a whole. Such developments should be on the radar of macro-prudential supervision just like the slow buildup of risks during the upswing of a business cycle.

Some help may come from a relaxation of countercyclical capital requirements, which are of course defined in terms of stock variables. This may be insufficient however, either because increases in asset risks and asset risk weights neutralize the effect, or because, in a crisis, required equity depends at least as much on the attitude of lenders, e.g. money market funds that provide repo loans, as on the regulatory rules.

In the past, such developments have not been on the supervisory radar. The slow implosion of the global financial system from August 2007 to September 2008 went unchecked. The final and radical implosion after the Lehman bankruptcy went unchecked until governments and central banks committed vast amounts of money to provide capital, guarantees, and liquidity support, and even then it took some time for the system to catch its breath. The implosion of the European financial system in 2011 went unchecked until the European Central Bank provided banks with additional funding under its Long-Term Refinancing Operation (LTRO), amounting to a trillion euros.

Given these experiences, we must think about how to introduce circuit breakers into the system. If we cannot manage to introduce circuit breakers into the financial sector itself, we are left with governments and central banks as the ultimate backstops. This raises serious issues for fiscal policy, even to the point where fiscal feasibility is in doubt; it also raises serious issues for the credibility of monetary policy. These issues are reinforced by concerns about moral hazard as the financial industry learns that it can rely on the “Draghi put”.

The following matters seem worth thinking about:⁶⁴ First, substantially higher equity requirements than we currently have would dramatically reduce the procyclicality of capital regulation, as well as the vulnerability of individual institutions. As mentioned above, if the initial equity is 2% of total assets, a loss of 1% of assets cuts the equity in half and requires ten times as much deleveraging to restore the initial equity ratio than if the initial equity had been 20% of total assets. Substantially higher equity requirements would also ensure that, if the chain of intermediation is lengthened, each additional element in the chain adds more loss absorption capacity. Substantially higher equity requirements might even reduce the need for specific macro-prudential measures in the upswing; the problem of discretion that I discussed above would thereby be reduced.⁶⁵

Second, eliminating the ability to reduce equity requirements by risk weighting would substantially reduce incentives for artificial interconnectedness. Risk weighting is usually justified on the grounds that banks which take greater risks should be required to have more equity funding. In practice this means that banks which claim to be taking smaller risks are allowed to get away with more borrowing. An asymmetric application of risk – weighting, imposing stricter requirements on banks that take more risk without reducing equity requirements for banks that claim to take less risk, would not only make the system safer by avoiding the manipulation of risk weights to maximize borrowing; such a regime would also remove incentives to use hedge contracts so as to make risks seem to disappear while in fact they have just been hidden. Interconnectedness would be substantially reduced.

Third, we need to make sure that, if banks must deleverage, there is a good chance that they will find ready buyers. In thinking about corrective measures at the level of stock

⁶⁴ On the first two of these points, see Hellwig (2010), and Wissenschaftlicher Beirat (2010). On all four points, see Chapters. 5, 10, and 11 in Admati and Hellwig (2013).

⁶⁵ This was suggested to me by Harald Benink after my presentation at the Nederlandse Bank workshop in June 2014.

variables, it is important to appreciate that *the system as a whole can only change its holdings of these variables if there are third parties willing to buy or sell assets*. If all banks engage in deleveraging, and there are no third parties willing to buy, the system may not even have a new equilibrium at all, i.e. there is no limit to the downward dynamics.

This observation raises questions about the advisability of regulating different sectors, e.g., banks and insurance companies in parallel fashion and thereby inducing parallel behaviors. We should think about complementarities between the different parts of the financial system and make sure that regulation does not prevent different types of institutions from stepping in if banks have problems and want to sell assets. “Level playing fields” should not be a concern in dealing with institutions that have different roles and different funding structures and that ultimately pose different regulatory concerns.⁶⁶

To avoid deleveraging spirals, it may also be desirable to require banks to respond to equity shortfalls by issuing new equity, rather than deleveraging. Banks will resist such requirement, claiming that equity is costly. However, most of the costs of new equity are private costs to the banks’ shareholders, which are balanced by benefits to the banks’ creditors and possibly taxpayers. Banks will also claim that they are *unable* to raise new equity. This may be true, but then the bank is likely to be insolvent and should be put into a recovery and resolution regime anyway. If the bank is solvent, i.e. if the value of its assets exceeds its liabilities, then, following a recapitalization, the new value of its assets exceeds the liabilities by at least the amount of the recapitalization. Hence there is a share price at which the new shareholders are willing to provide the funds that are to be raised. The price may be such that the old shareholders suffer a lot, but that harm to the old shareholders results mainly from the devaluation of the option to default on their debt. I find it difficult to argue that the option to default on one’s debt should benefit from the constitutional protection of ownership rights.

Fourth, viable recovery and resolution procedures that permit the temporary maintenance of systemic functions of banks are essential. Given that the principle of multiple-entry resolution for institutions with legally independent subsidiaries in different jurisdictions is unlikely to be removed in the foreseeable future, such procedures may require that systemically important subsidiaries be managed in such a way that their activities can at least temporarily be continued outside the parent corporation as well as inside. This consideration suggests that such subsidiaries should satisfy certain stand-alone criteria not only with respect to funding and liquidity but also with respect to procedures and infrastructure, for example IT systems. Such requirements may reduce the efficiency of the institutions but this cost is likely to be outweighed by the benefits of greater system stability.

Finally, we need to question the rules of contract law and bankruptcy law that have contributed to the increase of money market funding of banks over the past fifteen years.

⁶⁶ With hindsight, it seems clear that the banking lobby’s complaints in the early 2000s about insurers’ not being subject to the same equity requirements for derivatives should have been taken as a signal of malfunctioning. So should have been the observation that bankers, rather than insurers and pension institutions, were the biggest investors in mortgage-backed securities and CDOs.

Whereas in the past money market funds would mainly invest in short-term government debt and non-financial commercial paper, since the early 2000s, they have shifted to funding banks. In one interpretation, this was a reaction to China's investing surpluses in short-term US government debt. In another interpretation, it was a reaction to legal changes in US rules concerning the treatment of asset-backed commercial paper and repos in bankruptcy. The privileged positions of these forms of short-term debt in bankruptcy are convenient for the short-term lenders. They are also convenient for the borrowers who find that short-term funding is easy to come by. If one takes a wider perspective however, they are problematic because they provide borrowers and their short-term lenders with the means to dilute the positions of earlier lenders, encumbering assets and jumping the priority queue of insolvency law. And their effect on the system has been to lengthen the chain of intermediation by having money market funds get into the business of funding banks of special-purpose vehicles of banks.

6.3 Objectives and Tradeoffs in Macro-prudential Policy

Objectives and priorities of macro-prudential policy are not always clear. Whereas micro-prudential policy is – at least in principle – targeted towards the safety and soundness of banks, the objective of macro-prudential policy is less clear: Is macro-prudential policy concerned with financial stability or is it concerned with macro-economic stability?

In an economic upswing, the question may seem moot. In that constellation, macro-prudential policies such as countercyclical provisioning would seem to be suitable for both, preventing an overheating of the financial sector and preventing an overheating of the economy. But what about the objectives of macro-prudential policy in bad times, when the economy is doing badly and the banks are still coping with the fallout from past mistakes? In this setting, a macro-prudential policy that tries to stabilize the macro-economy might move to loosen banking regulation so as to enable banks, perhaps even to encourage banks, to provide loans so that the real economy does not suffer from a credit crunch. In contrast, a macro-prudential policy that tries to avoid system-wide problems in the financial sector might want to clean up the banks' books, forcing them to acknowledge losses and recapitalize if necessary, rather than carry hidden losses along for an extended period of time. There can thus be a clear conflict between the two objectives of economic stability and financial stability.

The conflict is inherent in the ambiguity, mentioned in the introduction, about whether “systemic risk” refers to the risks that the financial sector might impose on the real economy or whether it refers to the risk that shocks from the real economy impose on the financial sector. As far as I am aware, this conflict has not been much addressed, let alone resolved.⁶⁷

If macro-prudential regulation works well, the conflict may well be moot. If

⁶⁷ In discussions with policy makers, I have received four assessments: (i) Macro-prudential regulation should *not* be used to stimulate the economy in a recession. (ii) Macro-prudential regulation should be used to stimulate the economy in a recession. (iii) There is no conflict because you cannot hope to redress the financial sector's problems if the economy is doing badly. (iv) There is no conflict because you cannot hope to get a sustained recovery of the macroeconomy if you don't clean up the financial sector first.

countercyclical provisioning is effective in providing for tighter regulation in good times, a loosening of this regulation would seem to provide a natural counterpart in bad times. If the countercyclical buffers are there, there should not be any problem. But what if they are not there? Right now, we have credit crunches in a number of countries that are at least partly due to banks' weak capital positions.⁶⁸ Allowing these banks or asking these banks to expand their lending to nonfinancial companies may well imply risks for financial stability in the future. The risks are particularly large, if the underlying problem is that the banks' own loan customers have problems from excessive debt overhang. If excessive debt is at the root of macro-economic weakness, can more borrowing – and more bank lending to such borrowers – be appropriate for financial stability?

As yet, we do not have a good conceptual framework for assessing the cyclicity of the prevailing regulation. In January 2009, the Academic Advisory Committee to the German Economics Ministry warned that, whereas the crisis had for a long time just affected the financial sector, the downturn of the real economy in the fourth quarter of 2008 had increased the credit risk of the banks' loan clients.⁶⁹ A strict application of Basel II would therefore enhance the imbalances between assets and equity in the banks' balance sheets (stock variables again!), with incalculable additional procyclical effects. The Advisory Committee recommended some loosening in the application of Basel II in order to alleviate procyclicality.

This *procyclicality of regulation* needs to be kept in mind when considering the behavior of banks *vis-à-vis* their loan clients and their treatment of non-performing loans. To some extent banks may just want to avoid credit events that would force them to make provisions that cut into their equity at a time of stress. From a macro-prudential perspective, this may be seen as a way to reduce pressure on the real economy.

Such *forbearance cannot be a panacea* however. In the early eighties, US S&Ls benefited from forbearance and went on to gamble for resurrection, making the cleanup of the crisis ten years later that much more expensive. Similarly, the initial forbearance in the Japanese crisis of the nineties ended up being very costly.⁷⁰ In contrast, the cleanup of the Swedish crisis was undertaken right away. The sharpness of the authorities' intervention contributed to the sharpness of the recession but the thoroughness of the cleanup contributed to the fast recovery.

The empirical literature on the subject suggests that, as a rule, prompt interventions and cleanups are to be preferred. Attempts to delay such interventions and cleanups are likely to cause a long period of low growth or even stagnation, and the eventual budgetary and economic costs of the later cleanup when it comes are likely to be much greater.⁷¹

As yet, we do not have a good conceptual framework to assess the tradeoffs that are

⁶⁸ Acharya and Steffen (2015).

⁶⁹ Wissenschaftlicher Beirat (2009).

⁷⁰ Hoshi and Kashyap (2004, 2010).

⁷¹ Caprio and Klingebiel (1996, 1997), Advisory Scientific Committee (2012).

involved. It would be desirable to consider procedures that would reduce the harmful effects of a lack of forbearance as well as the harmful effects of forbearance. For example, what measures can be taken to avoid procyclical effects of capital requirements in a time of stress? Alternatively, if there is to be some forbearance in a time of stress, what measures are needed to prevent banks from abusing the leeway they are given in order to gamble and expose the rest of the system to additional risks? And what can be done to avoid a situation where the authorities become hostages of their own past forbearance, unable to proceed with a cleanup of problems in the financial sector because their own past forbearance and their encouraging of bank lending more to already highly indebted borrowers contributed to the banks' problems?

6.4 What is the Relation between Macro-prudential and Micro-prudential Oversight?

Whether it was meant that way or not, Andrew Crockett's invention of the term "macro-prudential" served a diplomatic purpose. By creating this new category, Crockett avoided giving the impression that he was blaming micro-prudential supervisors for having neglected macro-prudential concerns. By now, this separation has become firmly enshrined in the legal documents for macro-prudential supervision, including the assignment of macro-prudential tasks to separate authorities.

However, this separation has problems. First, macro-prudential policy is implemented by micro-prudential actions, legal norms and administrative acts directed at the individual institutions, and presumably subject to judicial review like all such acts. Second, and more importantly, there is a macro-prudential element in the application of micro-prudential rules. If at some point, the micro-prudential supervisor changes for example the rules for assessing loan impairments in banks' books, the simultaneous application of the new rules is likely to have macro-effects, making for a loosening or a tightening of bank credit depending on whether the micro-rules are loosened or tightened.

In this context, there is a danger that the macro-prudential aspects of micro-prudential policies are overlooked, perhaps even as a result of turf conflicts between the different authorities. After all, if macro-prudential and micro-prudential concerns are as distinct as the terminology suggests, shouldn't the micro-prudential supervisors simply be left to do their jobs without any macro-person meddling with them?

The issue already arises at a prior level. What information will macro-prudential authorities get? Will they get information about individual institutions? From the micro-prudential supervisor's perspective, this is privileged information that the institutions have provided under the condition that it would not be divulged to third parties. From the perspective of the macro-prudential supervisor, information about individual institutions is the raw material needed to obtain an overview over the state of the financial system. To understand the "story" behind current developments, it may be necessary to know what is happening at the levels of the individual institutions because in aggregation too much information is lost.

In my view, it is important that the macro-prudential dimension of micro-prudential activity and micro-prudential information be clearly recognized and that procedures be found to ensure that macro-prudential concerns are properly seen and addressed, without doing violence to the legal obligations of micro-prudential supervisors to the institutions for which they are responsible.

6.5 The Organization of Macro-Prudential Policy

Not only micro-prudential oversight has a macro-prudential dimension. Monetary policy does and so does fiscal policy. In a sense, everything has a macro-prudential dimension.

References to the “Greenspan put” or the “Draghi put” reflect the experience that the turnaround of US monetary policy in 1990 or the ECB’s long-term refinancing operation in 2011/12 enabled commercial banks to earn profits by borrowing cheaply from the central bank and exploiting the yield curve or the risk curve to earn high margins. Conversely, monetary tightening always puts a strain on the financial sector. In the US, this could be seen in the tightening episodes 1979/80, 1989, 1994, and again 2006/07, in the euro area after the interest rate increases in 2008 and 2011.

As for fiscal policy, the ability of governments to support the financial institutions of their countries plays a major role in investors’ assessments of these institutions’ safety. And the habit of governments to impose on financial institutions for government funding or other political purposes is a major source of systemic risk. In the “euro crisis”, the nexus of banks and governments has played an important detrimental role.

The observation that everything has a macro-prudential dimension raises questions about the organization of macro-prudential policy. Who is in charge and to what extent should the other institutions take account of macro-prudential concerns and systemic risk?

The question is often asked whether the task of a macro-prudential authority should be taken up by an independent institution, the central bank, the government (the finance ministry), or a committee of different institutions.⁷² In the EU, the ESRB has the task of observing developments and issuing warnings and recommendations to the different relevant actors; the ESRB itself is mainly composed of the representatives of central banks and (micro-prudential) supervisory authorities. The member states have chosen different patterns of organization.

In this context, it is important to distinguish between the level of analysis and the level of policy making. At the level of analysis, there should be one unit that is fully devoted to the task of trying to understand what is going in the financial system, where systemic risk may be building up and where the dangers may be arising. Addressing this task should not be encumbered by any other concerns, micro-prudential, monetary or fiscal.

⁷² See Advisory Scientific Committee (2015).

At the level of policy making, it is important to ensure that all the different actors are informed about the prevailing macro-prudential concerns and about their peers' reactions to these concerns. Some consistency of policy stance across actors is called for. This being said, it should also be clear that micro-prudential oversight, monetary policy and fiscal policy cannot be made subservient to the needs of macro-prudential policy. Finding a way to calibrate the tradeoffs faced by the different actors so that the macro-prudential effects of their policies are attuned to the actual situation and are also mutually consistent is the major challenge for institution design. However, this problem is independent of the desirability of having an institution in charge of systemic-risk analysis that provides its assessments without being encumbered by other concerns.

7. References

Acharya, V.V., P. Schnabl, and G. Suarez (2013), Securitization without Risk Transfer, *Journal of Financial Economics* 107, 515-536,

Acharya, V.V., and S. Steffen (2015), The Greatest Carry Trade Ever? Understanding Eurozone Bank Risks, *Journal of Financial Economics* 115, 215 – 236

Admati, A., and M. Hellwig (2013), *The Bankers' New Clothes: What's Wrong With Banking and What to Do About It*, Princeton University Press, Princeton, N.J..

Admati, A., P. DeMarzo, M. Hellwig, and P. Pfleiderer (2018), The Leverage Ratchet Effect, *Journal of Finance* 73, 145 – 198.

Adrian, T. and M. Brunnermeier (2016), CoVaR, *American Economic Review* 106, 1705 – 1741.

Advisory Scientific Committee (2012), Forbearance, Resolution, and Deposit Insurance, Report 01/2012 of the Advisory Scientific Committee of the European Systemic Risk Board, Frankfurt.

https://www.esrb.europa.eu/pub/pdf/asc/Reports_ASC_1_1207.pdf?11df4e5a80c66191b2dffbfdc2ae9115

Advisory Scientific Committee (2013), The Consequences of the Single Supervisory Mechanism for Europe's Macro-Prudential Policy Framework, Report 03/2013 of the Advisory Scientific Committee of the European Systemic Risk Board, Frankfurt.

https://www.esrb.europa.eu/pub/pdf/asc/Reports_ASC_3_1309.pdf?3751fa654b42e75ce4b41e2f27bb5690

Advisory Scientific Committee (2014a), Is Europe Overbanked? Report 03/2014 of the Advisory Scientific Committee of the European Systemic Risk Board, Frankfurt.

https://www.esrb.europa.eu/pub/pdf/asc/Reports_ASC_4_1406.pdf?360c7401353df3a92d28c9a3b8700af4

Advisory Scientific Committee (2014b), Allocating Macro-prudential Powers, Report 04/2014 of the Advisory Scientific Committee of the European Systemic Risk Board, Frankfurt.

https://www.esrb.europa.eu/pub/pdf/asc/Reports_ASC_5_1411.pdf?129bb18d5774907924e3cc9a88a41b23

Akerlof, G.A. (1970), The Market for 'Lemons': Quality Uncertainty and the Market Mechanism, *Quarterly Journal of Economics* 84, 488 – 500.

Arnott, R.J., and J.E. Stiglitz (1986), Moral Hazard and Optimal Commodity Taxation, *Journal of Public Economics* 29, 1 – 24.

Bank for International Settlements (2007), *77th Annual Report*, June 2007, Basel, Switzerland.

Behn, M., R.F.H. Haselmann, and V. Vig (2014), *The Limits of Model-Based Regulation*, Safe Working Paper No. 75, Frankfurt,
http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2523383

Ben-David, I. (2011) Financial Constraints and Inflated Home Prices, *American Economic Journal: Applied Economics* 3 (2011), 55 – 78

Berglöf, E., and H. Sjögren (1998), Combining Control-Oriented and Arm's-Length Finance – Evidence from Main Bank Relationships in Sweden, in: K.J. Hopt et al. (eds.), *Comparative Corporate Governance: The State of the Art and Emerging Research*, Oxford University Press, Oxford.

Bolton, P., T. Santos, and J.A. Scheinkman (2011). [Outside and Inside Liquidity](#), *Quarterly Journal of Economics* 126, 259-321.

Brealey, R.A., I. A. Cooper, and E. Kaplanis (2012), International Propagation of the Credit Crisis: Implications for Bank Regulation, *Journal of Applied Corporate Finance* 24, 36-45

Brownlees, C. T. and R.F. Engle, SRISK: A Conditional Capital Shortfall Measure of Systemic Risk (April 4, 2016). Available at SSRN: <https://ssrn.com/abstract=1611229> or <http://dx.doi.org/10.2139/ssrn.1611229>

Brunnermeier, M., and M. Oehmke, The Maturity Rat Race, *Journal of Finance* 68, 483 – 521.

Calomiris, C.W., and G. Gorton (1991), The Origins of Banking Panics: Models, Facts, and Bank Regulation, in G. Hubbard (ed.), *Financial Markets and Financial Crises*, Chicago UP, 109 – 173.

Calomiris, C.W., and C.M. Kahn (1991), The Role of Demandable Debt in Structuring Optimal Banking Arrangements, *American Economic Review* 81, 497–513.

Calomiris, C.W. (1999), Market-Based Banking Supervision, *The Financial Regulator* 4, 33 – 36.

Caprio, G., and D. Klingebiel (1996), Bank insolvencies: Cross-country experiences, Policy Research Working Paper 1620, World Bank, Washington, D.C, 1996.

Caprio, G., and D. Klingebiel (1997), Bank insolvency: Bad luck, bad policy, or bad banking?, in: The World Bank (ed.), *Annual World Bank Conference on Development Economics 1996*, 1-26, The World Bank, Washington, D.C.

- Crockett, A. (2000), Marrying the micro- and macro-prudential dimensions of financial stability, *BIS Review* 76, 1 – 7.
- Curry, T., and L. Shibut (2000), The Costs of the Savings and Loan Crisis: Truth and Consequences, *FDIC Banking Review* 13, 26–35,
- Demirgüç-Kunt, A., E. Detragiache, and O. Merrouche (2013), Bank Capital: Lessons from the Financial Crisis, *Journal of Money, Credit and Banking*, 45, 1147-1164.
- Dewatripont, M., and J. Tirole (1994), *The Prudential Regulation of Banks*, MIT Press, Cambridge, MA.
- Diamond, D.W., and P.H. Dybvig Bank Runs, Deposit Insurance, and Liquidity, *Journal of Political Economy* 91 (1983), 401-419.
- Diamond, D.W., and R.G. Rajan (2000), A Theory of Bank Capital, *Journal of Finance* 55: 2431–2465.
- Diamond, D.W., and R.G. Rajan (2001), Liquidity Risk, Liquidity Creation and Financial Fragility, *Journal of Political Economy* 109: 287–327.
- Duffie, D. (2007), Innovations in Credit Risk Transfer: Implications for Financial Stability, mimeo, Stanford University, Stanford, CA, <http://www.stanford.edu/~duffie/BIS.pdf>,
- Englund, P. (1999), The Swedish Banking Crisis – Roots and Consequences, *Oxford Review of Economic Policy* 15, 80 – 97.
- European Systemic Risk Board (2014), Flagship Report on Macro-prudential Policy in the Banking Sector, Frankfurt, March 2014.
https://www.esrb.europa.eu/pub/pdf/other/140303_flagship_report.pdf
- European Systemic Risk Board (2015), A review of macro-prudential policy in the EU one year after the introduction of CRD/CRR, Frankfurt, June 2015,
https://www.esrb.europa.eu/pub/pdf/other/150625_review_macroprudential_policy_one_year_after_intro_crdcrr.en.pdf
- Financial Services Authority (2010), The prudential regime for trading activities: A fundamental review, Discussion Paper 10/4, London, August 2010,
http://www.fsa.gov.uk/pubs/discussion/dp10_04.pdf.
- French, K.R. et al. (2010), *The Squam Lake Report: Fixing the Financial System*, Princeton University Press, Princeton, N.J.

- Goldstein, I., and A. Pauzner (2005), Demand-Deposit Contracts and the Probability of Bank Runs, *Journal of Finance* 60, 1293 – 1327.
- Gorton, G. (2010), *Slapped by the Invisible Hand: The Panic of 2007*, Oxford University Press, Oxford.
- Haldane, A. (2012), The Dog and the Frisbee, Paper Given at the Federal Reserve Bank of Kansas City's 36th economic policy symposium 'The Changing Policy Landscape', Jackson Hole, Wyoming, <http://www.bankofengland.co.uk/publications/Pages/speeches/2012/596.aspx>
- Hellwig, C. (2002), Public Information, Private Information, and the Multiplicity of Equilibria in Coordination Games, *Journal of Economic Theory* 107 (2002), 191-222,
- Hellwig, M. (1994 a), Liquidity Provision, Banking, and the Allocation of Interest Rate Risk, *European Economic Review* 38, 1363 – 1389
- Hellwig, M. (1994 b) Banking and Finance at the End of the Twentieth Century, WWZ Discussion Paper 9426, University of Basel, Basel 1994.
- Hellwig, M. (1995), Systemic Aspects of Risk Management in Banking and Finance, *Swiss Journal of Economics and Statistics* 131, 723 – 737.
- Hellwig, M. (1998a), Systemische Risiken im Finanzsektor, *Schriften des Vereins für Socialpolitik NF 261 (Zeitschrift für Wirtschafts- und Sozialwissenschaften Beiheft 7)*, Verlag Duncker & Humblot, Berlin, 123-151.
- Hellwig, M. (1998b), Banks, Markets, and the Allocation of Risks, *Journal of Institutional and Theoretical Economics (JITE)* 154, 328-351.
- Hellwig, M. (1998c), International Contagion - the Result of Information or of Rhetoric? Contribution to a Panel Discussion on International Contagion: What is it and what can be done against it?, *Swiss Journal of Economics and Statistics* 134, 715-721,
- Hellwig, M. (2009), Systemic Risk in the Financial Sector: An Analysis of the Subprime-Mortgage Financial Crisis, *De Economist* 157, 129-207.
- Hellwig, M. (2010), Capital Regulation after the Crisis: Business as Usual?, Preprint No. 31/2010, Max Planck Institute for Research on Collective Goods, Bonn, 2010.
- Holmström, B. (1979), Moral Hazard and Observability, *Bell Journal of Economics* 10(1), 74–91.
- Hoshi, T., and A. Kashyap (2004), Japan's financial crisis and economic stagnation, *Journal of Economic Perspectives* 18, 3 -26.

Hoshi, T., and A. Kashyap, Why did Japan stop growing?, NBER working paper, National Bureau of Economic Research, Cambridge, MA, 2010.

International Monetary Fund (2007), *Market Developments and Issues, Global Financial Stability Report*, Washington D.C., April.

International Monetary Fund (2008), *Financial Stress and Deleveraging: Macro-Financial Implications and Policy, Global Financial Stability Report*, Washington D.C., October.

Jensen, M.C., and W.H. Meckling (1976), Theory of the Firm: Managerial Behavior, Agency Costs and Capital Structure, *Journal of Financial Economics* 3, 568 – 360.

Kane, E.J. (1985), *The Gathering Crisis in Federal Deposit Insurance*, MIT Press, Cambridge, MA.

Krishnamurthy, A., S. Nagel, and D. Orlov (2014), Sizing up Repo, *Journal of Finance* 69, 2381-2417.

Merton, R.K. (1957), The Self-Fulfilling Prophecy, in: R.K. Merton, *Social Theory and Social Structure*, rev. and enl. Edition, Glencoe Free Press, New York, 421 – 436;

Morris, S., and H.S. Shin (1998), Unique Equilibrium in a Model of Self-Fulfilling Currency Attacks, *American Economic Review* 88, 587-597.

Riesser, J. (1910), *Die deutschen Großbanken und ihre Konzentration*, Gustav Fischer Verlag, Jena; English translation *The German Great Banks and Their Concentration*, National Monetary Commission, Government Printing Office Washington, D.C. 1911).

Rochet, J.-C., and X. Vives (2004), Coordination Failures and the Lender of Last Resort: Was Bagehot Right After All?, *Journal of the European Economic Association* 2, 1116-1147.

Sobott, J. (2016), Underreporting by Overdiversification? Strategic Usage of Value-at-Risk Diversification, mimeo, University of Bonn. Available at SSRN: <https://ssrn.com/abstract=2874572> or <http://dx.doi.org/10.2139/ssrn.2874572> .

Staub, M. (1998), Interbankenkredite und systemisches Risiko, *Schweizerische Zeitschrift für Volkswirtschaft und Statistik* 134, 193 – 230.

Stiglitz, J.E., and A. Weiss (1981), Credit Rationing in Markets with Imperfect Information, *American Economic Review* 71, 393 – 410.

UBS (2008), *Shareholder Report on UBS's Writedowns*, Zürich, April 18, 2008.

Wissenschaftlicher Beirat beim Bundesministerium für Wirtschaft und Technologie (2009), Zur Bankenregulierung in der Finanzkrise, Brief an den Bundesminister für Wirtschaft und Technologie vom 23. Januar 2009, Berlin. (Academic Advisory Committee of the Federal Ministry for Economic Affairs and Technology, Letter to the Minister on Banking Regulation in the Financial Crisis, Berlin, January 23, 2009).

Wissenschaftlicher Beirat beim Bundesministerium für Wirtschaft und Technologie (2010), Reform von Bankenregulierung und Bankenaufsicht nach der Finanzkrise, Gutachten vom 10. Mai 2010 (Academic Advisory Committee of the Federal Ministry for Economic Affairs and Technology, Report on the Reform of Banking Regulation and Supervision after the Financial Crisis, Berlin, May 2010)