

Whelan, Karl

Working Paper

Containing systemic risk

UCD Centre for Economic Research Working Paper Series, No. WP09/27

Provided in Cooperation with:

UCD School of Economics, University College Dublin (UCD)

Suggested Citation: Whelan, Karl (2009) : Containing systemic risk, UCD Centre for Economic Research Working Paper Series, No. WP09/27, University College Dublin, UCD School of Economics, Dublin,
<https://hdl.handle.net/10197/2625>

This Version is available at:

<https://hdl.handle.net/10419/71372>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

UCD CENTRE FOR ECONOMIC RESEARCH

WORKING PAPER SERIES

2009

Containing Systemic Risk

Karl Whelan, University College Dublin

WP09/27

December 2009

**UCD SCHOOL OF ECONOMICS
UNIVERSITY COLLEGE DUBLIN
BELFIELD DUBLIN 4**

Containing Systemic Risk¹

Karl Whelan
University College Dublin

November 2009

Abstract: Systemic risk refers to the risk of financial system breakdown due to linkages between institutions. This risk cannot be assessed by looking at how individual institutions manage risks but instead requires a full understanding of how the system as a whole operates. At present, the data available to central banks and financial regulators are not at all adequate for the task of assessing systemic risk and the new European Systemic Risk Board needs to address this issue. There is a lot of exciting ongoing research devoted to measuring systemic risk and providing signals to regulators as to when and where they should intervene. However, the tools being developed are still limited in their usefulness. More pressing than the development of these tools is the development and implementation of policy measures to make the financial system more robust. These measures should include higher capital ratios, limits on non-core funding and redesigning financial systems to be less complex.

¹ This is a briefing paper delivered by the author, in his role as a member of an Expert Panel of advisors, to the European Parliament's Committee on Economic and Monetary Affairs in relation to its Monetary Dialogue with the European Central Bank.

1. The Challenge Posed by Systemic Risk

The financial crisis of the past few years and, in particular, the worldwide panic that accompanied the fall of Lehman Brothers in September of last year, has come as quite a shock to governments and financial regulators around the world. During the preceding years, there had been a growing belief that financial institutions were becoming increasingly sophisticated in their management of risks and that these practices, combined with the growth of securitisation, were helping to make the financial system more stable. That the financial crisis engulfed the whole global financial system, including banks that had conformed to perceived best practices in risk management, showed that this belief was ill-founded.

There is now a widespread recognition that existing structures of financial regulation and monitoring are inadequate and this has led to a flurry of activity aimed at putting new structures in place that will make our financial system more stable. In Europe, much of the responsibility for ensuring the safety of the system will fall on the new macro-prudential body, the European Systemic Risk Board (ESRB).

The ESRB faces many challenges. To start with, there is no clearly agreed definition of systemic risk nor is there a consistent set of well-developed tools with which regulators can measure and monitor such risk. In this paper, I will discuss these two issues---the definition of systemic risk and the tools that can be used to measure it---and then focus on the strategies that can be used to make the financial system less vulnerable to systemic breakdown in the future.

2. 2. The Nature of Systemic Risk

2.1 The IMF-BIS-FSB Definition

There are many different definitions of systemic risk. Perhaps the most relevant for the purposes of current debate is that provided by a recent briefing paper prepared for the G20 Finance Ministers and Governors by the International Monetary Fund, the Bank for International Settlements and the Financial Stability Board.² This paper defines systemic risk as

a risk of disruption to financial services that is (i) caused by an impairment of all or parts of the financial system and (ii) has the potential to have serious negative consequences for the real economy.

The briefing paper then discusses the various criteria relating to whether an institution should be judged *systemically important* or not.

In my opinion, this definition of systemic risk focuses too much on *outcomes*, on what goes wrong in a financial crisis. A better definition would focus on what leads the system as a whole to become unstable. In addition, I suspect that focusing a lot of attention on defining systemically important institutions (and then focusing regulation heavily on these institutions) is perhaps not the best way to think about tackling the systemic risk problem.

To explain what I mean by these points, consider the following example.

² IMF, BIS, FSB (2009).

2.2 A Simple Example

Consider the case of three banks, imaginatively named A, B, C. Their balance sheets are described below.

Bank A

<i>Assets</i>		<i>Liabilities</i>	
Loans to Customers	100	Retail Deposits	130
Loans to B	30	Borrowing from B	30
Loans to C	30	Borrowing from C	30
Other Securities	40	Equity Capital	10
Total	200		200

Bank B

<i>Assets</i>		<i>Liabilities</i>	
Loans to Customers	100	Retail Deposits	130
Loans to A	30	Borrowing from A	30
Loans to C	30	Borrowing from C	30
Other Securities	40	Equity Capital	10
Total	200		200

Bank C

<i>Assets</i>		<i>Liabilities</i>	
Loans to Customers	100	Retail Deposits	130
Loans to A	30	Borrowing from A	30
Loans to B	30	Borrowing from B	30
Other Securities	40	Equity Capital	10
Total	200		200

In this example, the banks are completely symmetric, in that each of them has €130 in deposits, each has borrowings from the two other banks and each has loans out to the other banks. (One may ask why these banks both borrow from and lend to each other. One reason is maturity transformation. For instance, Bank A may be borrowing short term and lending long term.)

Now suppose that Bank A makes losses of €40 on its loans. This wipes out its equity capital. In addition, it has a shortfall of €30 when it comes to meeting its liabilities. Assuming that there is no intervention so that the bank is wound up and assuming that depositors are fully protected, the bank is only able to pay back half of its loans to Banks B and C. Banks B and C now sustain losses of €15 each on their assets and this wipes out all of their equity capital.

In this example, losses at a single bank end up bringing down all the other banks. This type of stylized “domino” example, in which a single bank failure triggers further failures, helps to illustrate a useful point. In this example, all the banks are identical, so none could be judged as particularly more systemic than the others. What brings down this system isn’t the fact that the original bank in trouble was particularly special, but the interconnections in the system between the various banks.

2.3 Beyond the Domino Model

In the basic example, Bank A made a loss of €40 and this brought down the whole banking system because the system only had equity capital of €30. No additional losses occurred: For instance, at each bank, the value of the other securities remained at €40 throughout this crisis that brought each of them down.

In practice, this type of situation, in which one bank makes a catastrophic loss that brings down the whole system, is very unlikely to ever occur.

Empirical studies that have simulated the interlinkages between banks have generally concluded that the probability of one domino bringing down the whole system is very small.³

And yet systemic crises do happen. To understand why requires introducing some additional elements. In reality, the process triggering systemic risk is more likely to look something like the following:

- Bank A makes a loss of €5 on its loan book, halving its equity capital to €5.
- Bank A is now faced with a big increase in its leverage ratio—the ratio of its assets to its equity capital—from 20 (200/10) to 39 (195/5), most likely putting it either close to or below its capital adequacy requirement.
- This forces Bank A to start selling some of its securities. These were originally worth €40 but because it has to get rid of them in a firesale, the bank sells half of them and only recoups €18. The remaining assets are also marked to market as being worth €18. These events reduce Bank A's equity capital to €1.
- Banks B and C are now hit with two problems. Because Bank A has been selling its securities in a firesale, the value of their security holdings has also fallen to €36, reducing their equity capital to €6.

³ Elsinger, Lehar and Summer (2006) was one such study using UK data. They concluded: “the UK banking system appears to be very stable. In particular, the likelihood of domino effects is very low.”

Needing to shrink their balance sheets and worried about Bank A's solvency, they decide not to roll over their loans to Bank A.

- Bank A now needs to come up with the money to pay off the other banks. But with its equity almost wiped out and the value of its securities falling, it fails to do so.
- Banks B and C now start to sustain losses on their loans to Bank A and this combines with the losses on their securities to leave them as vulnerable as Bank A was after it made its initial loan losses.

In this example, a relatively small loan loss for one bank (that is, small relative to the total equity capital of the system) ends up placing the whole financial system in trouble.⁴ This occurs not just because the banks in the system are interconnected but because defensive actions by individual banks, designed to protect their best interests, end up destabilising the system.

Worth noting here are two features of this financial system that contributed to its demise:

- Had the banks had higher capital levels, the original loan losses of Bank A would have been less likely to trigger the subsequent chain reaction.

⁴ See Morris and Shin (2008) for an accessible discussion of the processes described here.

- If the maturity of interbank lending had been long term, then decisions to not renew loans would not have had much effect. In reality, many of the institutions that got in to trouble in recent years obtained much of their funding from short-term repo markets. Once these banks got in to trouble, the haircuts associated with this funding rose and in some cases their repo funding dried up altogether.

2.4 A Different Definition

In light of these examples, I will offer another definition. Systemic risk refers to the risk of financial system breakdown due to linkages between institutions. This risk cannot be assessed by looking at how individual institutions manage risks but instead requires a full understanding of how the system as a whole operates. Indeed, the mechanisms that generate systemic risk often relate to individual institutions taking decisions in the interests of their own prudent risk management.

3. Measuring and Monitoring Systemic Risk

The stylized banking crisis discussed above can be broken in to three phases. First, there are large losses on loans or securities at one or a number of banks, often stemming from the collapse of an asset price bubble. Second, the weakness in one part of the banking system has an effect on other financial institutions that are connected to it. Third, the financial distress leads to a set of feedbacks via deleveraging, asset fire-sales, increased haircuts and other mechanisms.

I will discuss the practical tools that central banks and financial regulators can use to predict, model and deal with systemic risk by taking these three elements in turn.

3.1 Macro Analysis: Early Warning Systems

The seeds of financial crisis are usually sown during a boom period in which asset prices rise beyond historical yardsticks and participants in the financial system believe that risk levels are low. Only when it is too late do people realise that asset prices are going to crash, leading to defaults and financial instability. As Andrew Crockett has put it, risk is perhaps best seen as “*increasing* during upswings, as financial imbalances build up, and materialising in *recessions*.”⁵ In many cases, the asset price booms are driven by loose monetary policy and easy credit, often driven by financial innovation or deregulation.

This raises an obvious question. Why can't central banks and regulators use macroeconomic data to design “early warning” indicators? This is a particularly important issue for the ESRB because it seems unlikely to have significant direct powers, so much of its influence may rest on its ability to issue warnings to member states or financial institutions.

A number of researchers have worked on early warning systems for financial crises. A recent ECB working paper by Alessi and Detken (2009) is a particularly good example of this kind of work. Unfortunately, it does not

⁵ Crockett (2000).

yet appear that the research on early warning systems has reached the stage where one could be confident that it can have a significant influence on policy formulation.

A key problem with the early warning approach is that it can tend to deliver “false alarms” which can discredit the methodology, with its practitioners seen as “boys and girls who cry wolf.” However, when the indicators are adapted to keep the incidence of false positives, the approach then regularly fails to predict crises. Alessi and Detken report that their preferred indicator “did not allow issuing a warning signal in 40% of quarters followed by a costly boom/bust cycle and provided false alarms in 20% of quarters not followed by a costly boom/bust cycle.” With a track record of this sort, early warning indicators can be dismissed pretty easily by a policy maker who has been convinced by financial markets that “this time is different”.

“This Time Is Different” is, of course, the title of a recent book on eight hundred years of financial crises by Carmen Reinhart and Ken Rogoff (2009). Reinhart and Rogoff discuss early warning signals, arguing that:

The greatest barrier to success is the well-entrenched tendency of policy-makers and market participants to treat the signals as irrelevant archaic residuals of an out-of-date framework, assuming that old rules of valuation no longer apply. If the past we have studied in this book is any guide, these signals will be dismissed more often than not.

This negative assessment of early warning signals should not be taken as a dismissal of the usefulness of this research. It may be that such indicators

will play a useful role in heading off future crises. And it is, of course, possible that warnings based on these approaches will have more weight coming from a European Systemic Risk Board than they have had in the past. However, past experience suggests we cannot rely on early warnings, so we need to think about how to protect the financial system from meltdown when future asset price bubbles are popped.

3.2 Mapping the Financial System

Accepting that large defaults and problems at individual banks probably cannot be prevented from occurring, the ideal empirical tool for policy analysis would be a real-world model of the financial system along the lines of our Bank A-B-C example. This model could then be simulated regularly and used for realistic scenario analysis. Unfortunately, despite widespread agreement on the desirability of an empirical model of the inter-linkages in the financial system, there are many data problems that make such analysis difficult.

In a recent wide-ranging speech, ECB Executive Board member Lorenzo Bini-Smaghi emphasised the need to use firm-level data to assess systemic risk in this fashion but noted that the “the information available to bodies entrusted with financial stability functions but without a supervisory mandate is far from satisfactory.”

I would go somewhat farther than this in relation to the question of data availability. Even among institutions with a supervisory mandate, there are

many shortages of data. The following is an incomplete list of data shortages:

1. Existing statistical reporting to central banks does not always provide the full picture in relation to the consolidated assets and liabilities of large and complex financial institutions, including off-balance sheet activities.
2. While central banks can request information on interbank liabilities, such data does not appear to part of current consolidated statistical reporting by banks. Existing research employing network analysis—modelling the full set of interactions between all institutions in the system—has used publicly reported totals for interbank borrowing and lending and then applied educated guesses about the full matrix of interbank positions.⁶ Such data usually come from annual or quarterly reports, so they cannot be used to map the financial system on a daily or weekly basis.
3. Information about assets on the trading books of financial institutions and the nature of exposures due to derivative instruments is often limited. Typically, book and market values are only reported quarterly. A roughly similar situation exists regarding counterparty risk exposures. Both of these types of exposure can change very rapidly.

⁶ Examples include Elsinger, Lehar and Summer (2006) and Aikman et al (2009).

4. There is very little available information on the interactions between non-regulated entities, such as hedge funds, and the rest of the financial system.
5. There are huge data gaps in relation to cross-border financial exposures, a point discussed in a recent briefing paper for the G20 prepared by the IMF and Financial Stability Board.⁷

These examples make it clear that bodies charged with monitoring systemic risk face significant challenges in terms of data collection. The ESRB should address these challenges by:

- Taking the lead in setting out a common framework within Europe for regular (no less than monthly) collection of information relevant for assessing systemic risk, including detailed data on assets and liabilities, maturity profile, major exposures, as well as responses to scenario analysis relating to macroeconomic shocks.
- Ensuring that this framework extends beyond banks to other types of financial institutions. AIG, it should be recalled, was not a bank but turned out to be the perhaps the biggest single source of systemic risk in the global financial system.
- Insisting that these data are not simply collected in isolation but are centralised for analysis at the ESRB. In turn, the ESRB should co-

⁷ IMF, FSB (2009).

operate with the IMF and the BIS to allow for global sharing of data for systemic risk analysis. This idea of an international “credit register” has been recommended by the De Larosiere report.

Addressing all of these difficulties represents an enormous challenge. MIT’s Andrew Lo has likened the effort required to produce useful data for systemic risk analysis to the work done in creating national accounts, which facilitated the development of modern macroeconomics.⁸ One of the problems associated with this effort will be sorting out the legal issues associated with handling highly confidential information and sharing it across multiple agencies in multiple countries. Another issue brought into focus during the crisis is that some institutions had difficulty in aggregating consolidated risk exposures across their group structure of companies.

While the scale of the task in relation to data collection is considerable, it should not be insurmountable. Most of the information that a systemic risk regulator would require from financial institutions should be accessible from their risk management system. As such, an additional benefit from the data collection exercise is that it may help to diagnose institutions with inadequate risk controls.

3.3. Modelling Financial Distress

The shortage of adequate data with which to adequately map the financial system means that attempts to empirically model the system via “network analysis” are unlikely to give us more than illustrative simulation tools.

⁸ Lo (2009).

However, even if we had a perfect dataset, there are serious limits to how far this type of network analysis can get us in assessing systemic risk.

As I noted above, standard analyses of the linkages between banks tend to suggest that the domino effect is unlikely to ever topple a financial system. However, these analyses assume that the only loss in asset value stems from the initial loss by the first domino bank, with all other asset values remaining the same. The global financial crisis has taught us that reality looks more like our second example above, where banks take defensive actions in response to an initial shock and these actions result in fire-sales that further reduce asset values.

Some important work on extending network analysis is being done at the Bank of England via the development of their Risk Assessment Model for Systemic Institutions (RAMSI). As far as I know, the model is the first of its kind to realistically integrate macroeconomic shocks and their effects on credit losses. In addition, it contains a firesale mechanism, so that prices of particular types of assets depend negatively on the quantity of those assets being sold. It also contains a mechanism for modelling the process whereby a bank's access to certain funding markets can close if its conditions worsen.

This is very exciting work and I'm sure that the ESRB will fully engage in further developing this type of analysis. Models like RAMSI are likely to be highly valuable simulation tools for understanding systemic risk. However, without sufficiently detailed and timely data, these models may still be of limited usefulness in telling systemic risk regulators when and how to intervene.

Moreover, it will never be possible to fully simulate how financial crises will play out. Even in the simple example above, there were a number of decisions that would be very difficult to model in an empirical manner, such as whether Bank A could have raised outside equity capital after its losses and the exact point at which the other banks decided to pull their funding from it. It simply may not be possible to reduce the full complexity of financial crises to an econometric model.

3.4 Modelling Linkages with Market Data

A final source of information for assessing systemic risk is market data. For instance, regulators traditionally use the Value at Risk indicator to assess the riskiness of a bank's portfolio: This measure describes the level of asset returns such that with some chosen probability j , the bank's asset returns should be above this level. However, this doesn't tell us much about what happens to other institutions when this bank reaches this VaR level of asset returns.

Adrian and Brunnermeier (2009) suggest a method for estimating the Value at Risk of the whole financial system conditional on a portfolio of specific institution being at its Value at Risk level. They suggest that this measure gives us an idea of how individual institutions may contribute to aggregate systemic risk. It could be argued, however, that this is a very specific measure of systemic risk. For instance, Adrian and Brunnermeier note that if a large "systemic" institution is split into n identical clones, the Co-VaR of the large institution is exactly the same as the CoVaRs of the n clones. In

reality, however, systemic risk regulators are likely to feel that none of the n clones are quite as systemic as the large institution. Still, the CoVar measure is useful in the sense that it gives a sense of how multiple institutions adopting the same trading strategy can contribute to systemic risk.

The default probabilities implied in Credit Default Swap prices are also useful market data. The IMF's April 2009 Global Financial Stability Report shows how Adrian and Brunnermeier's methodology can be used to model the extent to which a default at one institution is likely to trigger other defaults.⁹ The IMF analysis shows the CDS data suggested that both AIG and Lehmans were extremely sensitive in 2008 to defaults at a number of other institutions. One drawback of these measures is that they rely on the market to assess the risk associated with individual institutions. However, markets tend to underestimate risks prior to a crisis which may limit the usefulness of these measures.

3.5 Conclusions on Measuring and Monitoring Systemic Risk

I will draw a few conclusions from the above discussion.

First, while the failure of some institutions is more likely to trigger a systemic financial crisis than others, preventing future crises will require more than simply identifying "systemic institutions" and regulating them closely. It is likely that many financial institutions will fit any useful definition of systemic. And the failure of institutions that may not appear to be systemic may still cause severe stress for the financial system if their

⁹ See pages 86 to 90 of IMF (2009).

failure triggers contagion effects, forced assets sales, and withdrawals of funding from other institutions.

Second, a full understanding of systemic risk requires a detailed understanding of the various linkages between financial institutions. Currently, the data collected by central banks and financial institutions falls well short of what is required to adequately assess systemic risk. Ideally, over time, systemic risk regulators can develop realistic models that can be used to assess increases over time in the potential for a meltdown in the financial system and intervene accordingly. However, it appears that we are currently some distance short of this ideal. An analogy from macroeconomics may be useful. Systemic risk policy is likely to feature roles for both rules and discretion. Network models may be very helpful in designing better rules and in assessing the impact of discretionary judgement calls but discretionary actions will remain important.¹⁰

Third, research on developing macroeconomic early warning indicators and proxies for systemic risk based on market data is to be welcomed. However, such research will never be foolproof and should be seen as part of a process of developing a range of systemic risk indicators.

4. Containing Systemic Risk

It is clear that there is much that can be done by the new ESRB and other agencies to better measure systemic risk. But we cannot rely on these

¹⁰ See Bank of England (2009) for a discussion of this idea.

initiatives to prevent systemic breakdowns from occurring again. More needs to be done. Specifically, we need to change the structure of the financial system to be more robust.

Here are five initiatives that can be taken to reduce the problem of systemic risk.

1. *Higher Capital Ratios*: In our theoretical examples above, the first “domino” bank would not have collapsed had it held sufficient capital. In this sense, while not sufficient, actions to improve the safety of individual institutions are a *necessary* condition for lowering systemic risk. The G20 has agreed that capital ratios must be increased. That’s the easy part. The hard part will be deciding over the next year or so what these higher required ratios should be and at what point the costs associated with higher capital ratios (due to more expensive capital and less efficient financial intermediation) start to prevail.
2. *Core Liquidity Ratios*: Our examples also showed how reliance by financial institutions on short-term sources of funding, such as the repo market, contributed to systemic risk. The G20’s Pittsburgh communiqué called for strengthened liquidity requirements. A strict way to enforce this would be via Lord Turner’s recommendation of a minimum required ratio of “core funding” (defined as deposits plus certain types of longer funding) to total liabilities.
3. *New Infrastructure*: Much of the systemic risk problem stems from the complex nature of interactions between financial institutions.

Andrew Haldane of the Bank of England has argued that governments should work to simplify the structure of the global financial network.¹¹ For example, governments could set up a central counterparty for interbank lending, which would simplify the system to a basic hub-and-spoke structure and reduce the potential for spillovers from the failure of an individual institution. Requiring private centralised counterparties could also help to simplify and stabilise complex markets such as those for Credit Default Swaps.

4. *Addressing Too Big to Fail*: Large financial institutions—those most likely to trigger a systemic financial crisis—should be required to hold higher capital levels.
5. *Resolution Framework*: The ESRB should take the lead in establishing an agreed EU-wide resolution framework for dealing with troubled banks. This framework needs to ensure financial stability but should also provide a credible commitment that providers of risk capital to failed banks should lose their money. Such a framework should come with sanctions for countries that fail to comply with it.

Ultimately, it should be accepted that all financial systems are subject to periods of financial instability. However, the recent crisis has taught us many lessons about the features of the current global financial system that have made it particularly vulnerable to a system-wide failure. The development of new data sources and tools to monitor systemic risk will

¹¹ Haldane (2009).

play an important role in the preventing future crises. But redesigning the system to be more stable will be more important.

References

Adrian, Tobias and Markus Brunnermeier (2009). CoVar, Princeton University.

Aikman, David and others (2009). Funding liquidity risk in a quantitative model of systemic stability, Bank of England, Working Paper No. 372.

Alessi, Lucia and Carsten Detken (2009). “Real Time” Early Warning Indicators for Costly Asset Price Boom/Bust Cycles: A Role for Global Liquidity. ECB Working Paper No. 1039.

Bank of England (2009). The Role of Macroprudential Policy.

Bini Smaghi, Lorenzo. (2009). Macro-prudential Supervision. Speech to CEPR/ESI Conference on “Financial Supervision in an Uncertain World” September 25, 2009.

Crockett, Andrew (2000). Marrying the micro- and macro-prudential dimensions of financial stability, Bank for International Settlements, www.bis.org/review/rr000921b.pdf.

Elsinger, Helmut, Alfred Lehar and Martin Summer (2006). “Using Market Information for Banking System Risk Assessment”, *International Journal of Central Banking*, March.

Haldane, Andrew (2009). Rethinking the Financial Network, Speech delivered at the Financial Student Association, Amsterdam, April 2009.

IMF (2009). Global Financial Stability Report, April 2009.

IMF, BIS, FSB (2009). Guidance to Assess the Systemic Importance of Financial Institutions, Markets and Instruments: Initial Considerations, Briefing Paper for the G20 Finance Ministers and Central Bank Governors, October 28, 2009.

IMF, FSB (2009). The Financial Crisis and Information Gaps, Briefing Paper for the G20 Finance Ministers and Central Bank Governors, October 29, 2009.

Lo, Andrew (2009). The Feasibility of Systemic Risk Measurement, Written Testimony Prepared for the U.S. House of Representatives Financial Services Committee, October 19.

Morris, Stephen and Hyun Song Shin (2008). “Financial Regulation in a System Context”, *Brookings Papers on Economic Activity*, Fall Edition.

Renihart, Carmen and Kenneth Rogoff (2009). *This Time Is Different: Eight Centuries of Financial Folly*, Princeton University Press.

Turner, Adair (2009). *The Turner Review: A Regulatory Response to the Global Banking Crisis*. UK Financial Services Authority: March 2009.