Technical Capabilities Necessary for Systemic Risk Regulation: Summary of a Workshop

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Technical Capabilities Necessary for Regulation of Systemic Financial Risk

Summary of a Workshop

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Although the reviewers listed above have provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations, nor did they see the final draft of the report before its release. The review of this report was overseen by Peter Bickel of the University of California at Berkeley. Appointed by the National Research Council, he was responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the rapporteurs and the institution.

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Introduction and Major Outcomes of the Workshop

Goals of the Workshop

The financial reform plans currently under discussion in the United States recognize the need for monitoring and regulating systemic risk in the financial sector. To inform those discussions, the National Research Council held a workshop on November 3, 2009, to identify the major technical challenges to building such a capability. The Workshop on Technical Capabilities Necessary for Regulation of Systemic Financial Risk was organized in response to the letter of August 27, 2009, from Senator Jack Reed of the Senate Banking, Housing, and Urban Affairs Committee to the National Academies specifically requesting an appraisal of the data and analytical tools available for systemic risk regulation (Appendix A). Senator Reed identified the following key issues that need to be examined "in considering reforms to financial oversight," specifically with respect to systemic risk:

- What data and analytical tools are currently available to regulators to address this challenge?
- What further data-collection and data-analysis capabilities are needed?
- What specific resource needs are required to accomplish the task?
- What are the major technical challenges associated with systemic risk regulation?
- What are various options for building these capabilities?

Because every systemic event is unique with respect to its specific pathology—the various triggers and the propagation of effects—the workshop focused on the issues listed above for systemic risk in general rather than for any specific scenario. Thus, by design, the workshop explicitly addressed neither the causes of the current crisis nor policy options for reducing risk, and it attempted to steer clear of some policy issues altogether (such as how to allocate new supervisory responsibilities). More than 40 experts representing diverse perspectives participated in the workshop (Appendix B).

Some Underlying Observations

A basic observation shared by several workshop discussants is that recent decades have seen rapid change in the financial system—driven by innovation and deregulation—that has altered the mechanisms and pace of financial intermediation to such an extent that regulatory tools, processes, and data have fallen behind. The far more numerous and increasingly complex linkages among financial institutions of all types, with essential linkages extending beyond the banking sector and beyond domestic U.S. institutions, suggested to many discussants that the monitoring of systemic risk has become a more urgent and far more complex problem than in the past. George Sugihara of the Scripps Institution of Oceanography emphasized the importance of understanding systemic risk holistically as a "dynamic," nonlinear problem, as opposed to atomistically as a decomposable, static problem that can be addressed by simply aggregating risks across independent firms.

It was widely acknowledged at the workshop that the United States currently lacks the technical tools to monitor and manage systemic financial risk with sufficient comprehensiveness and precision. While some of the building blocks are available, many workshop participants pointed to major gaps that remain. Andrew Lo of the Massachusetts Institute of Technology presented a simple mnemonic for capturing the range of information that a systemic risk regulator will need to monitor: namely, the "four L's" of *leverage*, *linkages*, *liquidity*, and *losses* across the financial system. Assembling a holistic perspective will require significant additional data as well as new models and research. Myron Scholes of Stanford University pointed out that even with information on leverage and linkages, liquidity and losses can only be simulated with interacting models. Other elements identified in the workshop were capital, maturity mismatch, and risk concentrations.

Christine Cumming of the Federal Reserve Bank of New York added that risk at the firm level cannot be truly assessed unless the much broader context of overall risk positions and risk dynamics in the financial system is understood. Decision makers at financial institutions, given access to more reliable knowledge about their total risk exposure with respect to proposed actions, should be better able to manage those risks. This more complete understanding could provide help to the following:

- Institutions, in recognizing how they share in creating and being affected by systemic risk;
- Markets, in setting values; and
- Regulators charged with moderating markets and firms.

Market efficiency will be enhanced by improved intelligence about what is going on in the system as a whole. Yaacov Mutnikas of Algorithmics observed that risk analysis has developed almost exclusively to manage firm-specific risks, and that the aggregate of firm risk is not necessarily equal to systemic risk. Firm-based analysis ideally takes into account the market responses and stresses that information about losses in other financial firms produces, so it provides partial analysis of feedback effects. Full analysis of system risks, however, must incorporate more complex interactions, which, as recent experience has shown, can be especially dangerous. Furthermore, individual firms have their own scenarios of concern, which are not necessarily those of greatest significance to the overall system. Thus, to manage systemic risk, new analysis capabilities and appropriate data will be needed.

Major Points for Policy Makers

Although this one-day workshop was not aimed at developing consensus conclusions, there were some recurring themes that are relevant for policy makers:

- Today's tools of financial risk analysis will need to be augmented to provide information needed for the regulation of systemic financial risk. As implied above, existing capabilities to value individual instruments and manage firm-specific risks and capture system-wide exposures are not a sufficient foundation for systemic risk management.
- The new understanding that is necessary for systemic risk management calls for new, or extended, mathematical models. These models would be designed to capture better the extensive linkages among firms and markets, the dynamic interactions among the firms

and markets, and the potential for any of these to change according to the state of the system (e.g., in shifting from normal times to distressed times).

- Similarly, the new understanding of systemic risk management will require the use of more and better data. The creation and validation of those models will rely on some data that are not currently used and perhaps not currently available. However, there were a variety of views expressed at the workshop as to what data should be collected. One view argued that complete transaction records in cash and derivatives markets would be the appropriate level of data collection. A more widely held view was that no one knows enough to say what data are needed.
- A new understanding of systemic risk management is just beginning to develop. Inevitably, systemic risk management capabilities will be built up iteratively, starting with the imperfect data and models that are currently available and refining both as research improves our understanding.

Several workshop participants commented that the questions in Senator Reed's letter are valid and generally approachable and that they could be answered through a careful study, which would constitute a solid step toward setting up a systemic regulatory capability. Nevertheless, it will take a long-term, multidisciplinary effort to build up this capability fully, and the structure is not in place yet for that effort. A good deal of research is needed to guide the development of effective systemic financial risk regulation.

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Major Themes of the Workshop Discussions

From the workshop discussions, nine major themes emerged. Points raised in connection with each of those themes are summarized in this chapter.

Need for a Common Language for All Securities and Financial Contracts

An important building block for systemic financial risk regulation is the development of a common nomenclature and language to enable the unambiguous aggregation and interpretation of data collected from firms by regulators. Virtually all data on complex financial instruments and risk measurements (and many other data) are captured differently by different firms, and this is a major limitation facing any effort to analyze risks that cut across firms and markets. Standard transaction type and entity identifiers would, for instance, be helpful in enabling a regulator to spot concentrations of risk that otherwise might be obscured. It would also enable more transparency, thus facilitating investors' understanding of the products that they purchase.

At present, it is expensive merely to assemble consistent, specific information that would enable appropriate analysis, disclosure, and oversight. Many workshop participants noted that there is a need for unique identifiers for the wide range of over-the-counter derivatives and financial contracts, analogous to the numbers developed by the Committee on Uniform Securities Identification Procedures (CUSIP) that provide a standardized and unique way to identify many types of securities. Just knowing the prices of these instruments is not enough; a systemic risk regulator also needs to know a fair amount of detail about the contract terms of the instruments in order to perform aggregation and make comparisons across firms. Every firm has its own way of capturing this detail, and much discussion at the workshop addressed the benefit of a common language.

To the extent that such common nomenclature would be shared among firms, it would also improve firms' ability to evaluate their risks because, for example, terms and conditions would be unambiguous. The identification for complex or customized financial products is not as straightforward as it is for conventional financial products. It would be important to capture both nominal terms and related counterparty commitments with some specificity. Although some workshop participants said that there would be even greater clarity, among other benefits, if products or instruments were themselves standardized, many argued strongly against pushing that concept too far, since many end users value the customization of transactions to meet their specific exposure profiles.

One participant argued that a requirement that firms agree to standards for data collection would be useful not only to a systemic risk regulator—which would then be able to aggregate appropriate data to develop partial insight into systemic risks—but it would also be useful to firms' own operations. Such a move might also strengthen firm-level risk management. The rationale for this argument is that the back-offices in firms invest enormous resources in the reconciliation of transaction data that are booked in accordance with varying standards. If a certain level of standardization were mandatory, firms might realize cost savings by re-engineering their processes so as to capture their transactions electronically. The speaker believed that the cost savings to firms would be substantial.

Participants noted that some work on creating standard identifiers has already been done or is under way, and that this work could provide an effective foundation for a more comprehensive protocol. The task of creating standard identifiers will involve compromises, but it is essential to improving firms' and regulators' ability to understand and monitor systemic risk. Some workshop participants suggested that this task might be carried out by a joint public-private working group. This could be a first step in building the capability for systemic financial risk regulation.

Data Needed for the Regulation of Systemic Financial Risk

Many workshop participants stated that neither the regulatory system nor individual firms currently have adequate data to monitor and regulate systemic financial risk. For example, when the market for mortgage-backed securities ran into trouble in 2007, it would have been helpful to know different firms' exposures to this asset class. However, no one regulatory agency had complete information. More generally, risk professionals at firms do not necessarily examine the same tail events that would be examined by a systemic risk regulator. This is especially true if the firms' risk professionals do not fully recognize the degree to which the systemic risk associated with a given scenario is resistant to diversification or hedging. Therefore, if a regulator wants to analyze tail risk, steps must be taken to gather the relevant data explicitly.

A systemic financial risk regulator will need to make judgments regarding the following:

- When certain firms or market segments are overleveraged,
- When asset bubbles are growing,
- When exposures are becoming correlated, and so on.

In effect, the regulator will need to interpret the "four L's" of leverage, linkages, liquidity, and losses across the financial system. Workshop participant Tanya Beder of SBCC Group emphasized that context is important. For example, the degree of leverage that a firm can sustain depends both on its underlying health and on the amount and type of stress in the system. Thus, merely collecting raw transaction data is not sufficient in itself to address the problem.

A good understanding does not yet exist about which linkages contribute to systemic risk, and there is much theoretical work to be done on how financial crises propagate in interconnected markets and on specific topics, such as liquidity. Just knowing positions does not give a clear indication of whether a liquidity freeze could occur, and access to data for every transaction would not necessarily foretell future illiquidity episodes because those episodes depend heavily on how firms react to different stresses.

For systemic regulation to be effective, it is not enough for a regulator to know every firm's exposure to, say, mortgage-backed securities and how the firms and the markets related to mortgage-backed securities interact. The regulator would also need to know what "levers" to pull, and knowing that depends on the answers to questions such as how those firms will respond to different regulatory actions. If a systemic risk regulator knew enough to recognize that a small number of firms in a certain market were all holding the same positions, what actions should be taken? Should a "concentration warning" be signaled to market participants, or should intervention be undertaken? Should the regulator tell each firm to divest some percentage of its position in that security, or tell one firm to divest a larger fraction? What is the most effective course, and what are the ramifications of each action? Simply gathering and analyzing position

data might not inform those decisions. Moreover, is it necessary for the regulator to pull a lever? If the regulator made these data public, would that be sufficient to ensure that firms would take care of this risk concentration? Or would such an action lead to undesirable responses such as flight from that risk? These are questions that might be answered through research into financial system dynamics. Currently, not enough is known about the causes of systemic financial risk and the potential effects of alternative mitigation steps that might be taken by regulators.

What is the necessary level of granularity of the data? One view expressed at the workshop was that every trade and contract should be reported to regulators in a timely fashion. Another was that data with somewhat less granularity, including lower frequency, would be easier to examine and interpret, with some suggesting that the capacity to collect highly detailed data on demand would also be required. A third view was that no amount of detail would at present be adequate for the task of systemic regulation since, without models in place first, one would not know how to analyze these data. It will not be possible to develop a relevant suite of models without agreement on the relevant system-wide facts that the models must explain. In short, many at the workshop questioned whether anyone can currently say what data are needed for the regulation of systemic risk. As models and analytics are improved and advance our understanding of systemic events and their dynamics, it is likely that data needs will become more sharply defined. David Rowe of SunGard summed up this matter by saying that the establishment of a systemic risk regulatory capability will have to be an iterative process, one that will evolve as more is learned.

Some data of potential value are already collected centrally. Included are those in regulatory reports filed by financial institutions or other data provided by those institutions to supervisors, the Federal Reserve's Flow of Funds accounts, the records of market utilities such as the Depository Trust and Clearing Corporation (DTCC), tables compiled by the Bank for International Settlements, or data generated by shared trading platforms and the operations of financial institutions. However, access to these data is carefully controlled, and they are not necessarily available, or not available in the degree of detail required, for analyses that would inform systemic risk regulation. Workshop participants raised a number of issues that would have to be addressed in order to make these data more readily useful for guiding systemic risk regulation:

- The quality of the data would have to be examined and possibly improved,
- The existing level of granularity of the data might not be well suited to systemic financial risk regulation, and
- Protections, some mandated by Congress, would have to be reconsidered.

Most workshop participants who commented about existing data sources did not view them as a panacea, and participants expressed caution about making them more widely available. Despite this, Beder said that they do contain some important centralized sources of information that may provide a window into some aspects of systemic risk. Thus it might be valuable to start with analysis of these data if privacy and policy issues can be resolved.

In a breakout session, Charles Taylor of the Pew Charitable Trusts proposed a three-pronged strategy for data collection:

1. *Broad indicators at the level of markets plus aggregates of firm measures*.

2. *Data that illuminate how institutions address their own risk management*—not only the reporting of it but also how they process risk information. The goal of this information would be to provide an opportunity for regulator feedback. This process is, of course, already carried out at the individual supervisor level. Taylor's concept—which was not discussed in depth at the workshop—could make that feedback process more scientific, consistent, and transparent, and therefore more useful for systemic risk management. It could also provide insight about hidden sources of systemic risk, as mentioned in the final section in this chapter, on human behavior.
3. *Data that would be defined through ongoing research to model systemic risk*, which is expected to point to new types of indicators as both the financial system and knowledge about it evolve.

The purpose of these three prongs is to enable the systemic risk regulator to react to the next crisis or, ideally, to anticipate it.

Some Signals That a Systemic Regulator Might Monitor

In various remarks, workshop participants suggested that a systemic financial risk regulator might monitor risk concentrations, profits, unusual escalations in asset prices, and other indicators as signals of potential instabilities. Unfortunately, it is difficult to know whether an excess is a systemic risk or a business opportunity. Risk concentration was also suggested as an important indicator, but not one that is easy to measure in a definitive sense. The reporting of counterparty relationships might enable improvements to this capability, or there might be some more specific approaches. The evaluation of various potential indicators of emerging systemic risks is an ongoing topic for research.

Other measures proposed involved the velocity of transactions and variances in valuation. Some workshop participants suggested that velocity in the system—how rapidly new instruments are being developed, how frequently an individual buys a house, how many times the same piece of risk get repackaged, and so on—might be correlated with systemic risk. Thus, tracking velocity (suitably defined and measured) might be a form of systemic risk monitoring. Beder reported that her breakout group had suggested, for example, that regulators might monitor the difference between mark-to-market values and those produced through widely used theoretical models, especially given the observed divergence of these two indicators during both overheated and dislocated markets.

Several workshop participants noted that it would be beneficial for a systemic risk regulator to see gross (unnetted), rather than net, disclosures. As a financial firm becomes more distressed and approaches failure, its counterparties will manage transactions more tightly, potentially making it difficult for the firm to manage its gross positions, and the firm's failure will require the effective unwinding of both long and short positions of the firm by market participants unless netting arrangements are in place.

Barry Schachter of Moore Capital Management reported on his breakout group's discussion of the potential for finding leading indicators of trouble. One perspective in that group was that this is a futile goal, because by the time indicators provide unambiguous signals, a problem may have reached the point at which little can be done to reverse or mitigate it. Another perspective was that market-based data, such as credit spreads or volatility, might provide useful signals, although

concern was expressed that it is not known which measure of volatility would be most useful. Some participants noted that the market might misprice some of these key variables, thereby undermining their usefulness as early-warning signals, as was the case during the run-up to the current crisis. Another view is the network perspective, which would look for such things as measures of changes in interconnectedness that might indicate a reduction in stability or resilience. At present it is not known what those measures should be.

There was some breakout discussion on the need to use past bad and good times as benchmarks for determining where we are in certain cycles (e.g., the leverage/volatility cycle). Such an approach might lead to a broader range of stress test scenarios for firms to address. Some way of characterizing what constitutes a "normal" market is also needed, and that in itself is a daunting task. Different state variables might be more important during systemic events than in normal times. Regulators might specify the state variables for which data should be collected and aggregated and the stress test conditions that market participants should apply.

Several workshop participants suggested that the Supervisory Capital Assessment Program (SCAP) exercise of February 2009 might be a good starting point from which to build. That exercise "allowed supervisors to measure how much of an additional capital buffer, if any, each [of the 19 largest U.S bank holding companies] would need to establish today to ensure that it would have sufficient capital if the economy weakens more than expected."[1] Joseph Langsam of Morgan Stanley suggested possibly extending this model to incorporate leverage and liquidity cycles. Several participants observed that the exercise facilitated good communication among economists and modelers from industry and government, supervisors, and financial institution managers and might have changed the dynamic among those groups, a positive side effect with long-term salutary consequences.

Monitoring Networks of Counterparty Risks and Exposures

Schachter reported that his workshop breakout group had agreed that the data currently available publicly are insufficient for spotting many conditions that can lead to a systemic financial crisis. Firm-specific data, viewed in isolation, do not necessarily illuminate all relevant sources of risk; the exposures of a firm's counterparties are also important. Indeed, Schachter noted that there can be real systemic risk even if individual financial institutions are doing an ideal job of controlling their firm-level risks. Since systemic risk arises from a complex and multilayered set of relationships—for example, counterparty risk exists in a cascade of relationships—it is an understanding of the relationships (and their dynamic properties) that is essential to systemic risk regulation. To achieve such understanding, models of networks may be needed.

Regulators should know the risks to the system of a failure of any given counterparty. Thus some members of Schachter's breakout group pointed out the value of data that improve the understanding of the dynamics of the network and the system. Better understanding of network relationships represents an opportunity to enhance the models used by regulators and the Federal Reserve. More generally, crisis detection must cast a wide net because, in a globalized world, systemic problems can be triggered by such a wide variety of geographically dispersed actors and situations. A better understanding of these networks could lead to better risk management by individual banks as well as better systemic risk management.

[1] From http://www.federalreserve.gov/newsevents/press/bcreg/bcreg20090507a1.pdf, accessed November 24, 2009.

Taylor pointed to the failure of Herstatt Bank in 1974. It was a small bank outside the purview of U.S. regulators, but its midday failure resulted in significant foreign exchange settlement losses and extended disruption in the ensuing operation of those markets. The experience with Herstatt is an illustration of the fact that we can export our risks and we can be affected by risks from other countries. In the current crisis, highly leveraged Icelandic banks neared default owing to losses on securities and derivatives positions, with serious consequences for depositors and regulators in the United Kingdom. Analogously, the current crisis was in part precipitated by subprime loan problems, which were viewed as being on the regulatory fringe of the U.S. financial sector. Other participants added that systemic risk monitoring will have to extend to firms beyond those in the core banking system and to instruments that might not currently be classified as regulated securities or transactions.

J.B. Silvers of Case Western Reserve University summarized the comments in his breakout group as pointing to the need for insight into the whole counterparty interconnectivity network. In large measure, today's data and models illuminate only the first-level impact of a crisis. In order to understand systems behavior, such as how an initial impact might affect exposures in other firms or sectors, much more understanding of interconnectivities will be needed, including how those connections might behave or change under stress conditions. Of course, attaining this level of understanding involves modeling as well as data. The stress tests applied in the spring of 2009 to the largest banks rested on relatively simple models of risk based on the behavior of financial measures computed from currently available data and without the interconnectivities proposed in the workshop. Measures of interconnectivity both imply and demand more sophisticated models to accompany them. These must be developed in parallel to be effective. The importance of understanding the topology of dynamic networks is well known in the natural sciences where, for example, in fields such as ecology and epidemiology the identification of ever-changing critical nodes (keystone species or superspreaders) can inform how epidemic collapse occurs and spreads.

George Sugihara of the Scripps Institution of Oceanography suggested extending thinking about financial networks from a natural science perspective. One might use that lens to explore generic behaviors of the financial markets viewed as a complex, evolving, dynamic system (analogous to ecosystems). In particular, this might entail monitoring growth in the homogeneity (reduction in the diversity) of the network that increases the number and strength of linkages. Such changes are known to increase cross-correlation and predispose natural systems to collapse.

Sciences such as ecology and epidemiology have long focused on understanding the relationship between diversity changes and system stability. Translated to the financial network, instability would occur with increased linkage strength as each institution is affected more by the balance sheets of neighboring institutions. If this analogy holds, Sugihara suggested that increased correlation among institutions and markets could be one of a set of generic early-warning signs for identifying impending system vulnerability. Considerations related to diversity (heterogeneity) might also apply to institutional structures, products, consumer populations, and so on. These models can be compared and contrasted with the general equilibrium models widely used in economics, the simplest versions of which have a representative agent with no diversity but with well-defined risks.

Regulators Need New Analysis Tools

Workshop participants noted that no one model will suffice for everything. Rather, there is a need for a suite of models, some coarse-grained and some fine-grained, some at the macro level and some at the micro level. There was some recognition that, as models are developed to help in systemic regulation, the need for a dynamic view must be taken into account. That is, the models must be able to adapt to changing topologies and networks, because the connections that exist among financial firms change during the buildup to a crisis and during the crisis itself. Systemic financial risk supervision must be able to track such changes in a timely fashion.

There was some discussion in Schachter's breakout group about the challenge of monitoring systemic risk when such risks have not first been properly modeled and relevant data have not been collected. Data and analysis are naturally intertwined, so plans for improving both should be developed in tandem, not sequentially. Mathematical modeling is needed to represent systemic risk. Other models eventually will be needed to monitor a given firm's contribution to systemic risk. Participants in that breakout group suggested envisioning a variety of complementary models that achieve targeted improvements over the existing capabilities. These models would serve both to aggregate firm-level information and to capture the interstitial phenomena that are not modeled at the firm level such as certain tail risks. Charles Lucas of Osprey Point Consulting pointed out that systemic risk regulation requires understanding more than just position and transaction data; it also will require new macroeconomic data, models, and analyses.

Some workshop participants noted the need for regulators to model and influence negative (offsetting) feedback mechanisms, both those that exist and those that could be envisioned. As Andrew Lo of the Massachusetts Institute of Technology observed in his keynote presentation (see Chapter 3), a lack of timely feedback seems to underlie systemic crises in many engineered systems. Another participant pointed out, however, that not all feedback will induce the desired change in behavior, implying a need to learn more about what sorts of interventions can be effective and on what timescales. Schachter said that, overall, the discussion pointed to a rethinking of modeling approaches in order to understand the mechanics of systemic risk. For example, aspects such as the dynamics of liquidity generation and erosion are still poorly understood.

Yaacov Mutnikas of Algorithmics pointed to the potential value of a regulator's being able to run sector-wide stress tests without relying on firms' models and involvement, which can lead to delays and can signal regulators' areas of concern, which could become self-fulfilling. This is not a capability that currently exists to a meaningful degree in any U.S. financial regulator. During times of liquidity failure, in particular, the ability to perform stress tests quickly and quietly could be very valuable.

Privacy and Other Issues That Limit the Regulatory Use of Data Already Collected

The workshop discussion suggested that systemic risk regulation requires more comprehensive access to data at a detailed level than is currently available to any single regulator. A full assessment of the regulators' access to data will require comprehensive study, including an analysis of applicable statutes, but the discussion highlighted several points. First, the access by regulators to data is limited by their statutory authority, which determines their

jurisdiction over specific legal entities and/or markets, and systemic risk regulation may require data collection beyond the scope of currently regulated entities. Second, regulators are granted broad access to information subject to constraints and penalties for its misuse, because such data may involve information that has commercial and competitive value or that involves the privacy of individuals; even U.S. government nonregulatory statistical agencies seek to safeguard commercially valuable data and consumer privacy. Third, U.S. regulators face constraints in sharing information with one another, and the international sharing of data by regulators remains subject to substantial impediments. Fourth, data may need to be available to researchers in academia, research institutions, and the financial industry so that the models and tools proposed in the workshop can be developed.

In these respects, the situation is not the same as with, say, meteorology, where governments are free to gather all the data that they need and can afford. There is a tension here about what data to collect, about what supervisors and systemic financial risk regulators should be expected to do, and about the conditions under which (and restrictions on how) data may be shared among regulators and with researchers whose work might provide the measures and models to assist the regulators. These are major policy questions that will require research and debate. Beder reported that her breakout group thought that good progress has been made in mathematical and technology-based transformations that protect the owners of the data.

Which Data Should Be Public Information?

The transparency provided by making some data available to all can be a powerful tool to improve the market's ability to price risks that can contribute to systemic risk, such as counterparty risk. Price transparency generally improves market efficiency and liquidity, but position transparency might reduce returns from proprietary research and thus be resisted even if it does provide risk information.

For example, Beder reported that her breakout group discussed the potential value of tracking and releasing information such as the bid-ask spread for instruments on an ongoing basis, with several participants noting that spreads had widened prior to dislocations in many markets. This is a complex issue, because the behavioral responses to public information may enhance or threaten systemic stability. Further research in this area will help guide the systemic regulator's policies on disclosure.

Schachter's breakout group agreed that, to a first approximation, data that were public during the run-up to the current crisis were not adequate for enabling a regulator to have foreseen the crisis. This echoes what was said in the keynote talk by Lo: a number of people were able to publish warnings in the years prior to 2007, but the data were not strong enough to provide a definitive justification for mitigating actions. For example, there were limited data available to regulators on subprime mortgages. It might have been valuable to know who held subprime-based mortgage-backed securities and other assets that could, and in fact did, become "toxic" in the absence of plentiful market liquidity. More generally, the data available would not necessarily expose the details of the network connections and flows. Information on the "four L's" (leverage, linkages, liquidity, and losses) would have been helpful in identifying potential trouble spots and in managing through a systemic crisis.

What is the appropriate richness of detail that should be made available and to whom? The answer depends on whether the information will be available only to regulators, or also to

competitors and even to the general public. If the data are the notional values of derivative contracts, for example, accompanying information would be needed to put these data in context, such as which models were used to determine exposure, the mark-to-market values, and whether exposures are static or dynamic. One of the breakout groups concluded that data must be comprehensive, internally consistent, and suitable for feeding into analytical models. The question of which data to share—with regulators, with other firms, and with the general public—will require further study.

The Need for Stronger Training in Financial Risk Management

At several points during the workshop, various participants noted the need for more people, both in industry and government, with strong training in financial risk management. Modeling and analysis are going to be necessary no matter what system of regulation is developed. It was suggested that some federal agency might invest in extramural research that also contributes to the training of financial risk analysts. Fields other than traditional economics and finance are showing themselves to be important building blocks for advancing the understanding of systemic risk, so any such program should be multidisciplinary.

Access to data is also critical for training. Financial risk managers need access to real data in order to become well trained. In the current context, it is very difficult for academics to gain access to relevant data, with the easiest path being to consult for a bank. Myron Scholes of Stanford University pointed out that such an arrangement provides value, because an important aspect of training is to develop a real understanding of how things work, and that process can be facilitated when students and professors work with industry practitioners. It does, however, steer researchers toward those problems that are longstanding rather than their contributing to newly emerging issues of uncertain significance, because industry's timescale is shorter and its breadth of focus narrower than that of academe. This channel for data analysis also concentrates energy on questions of interest at the firm level which, as noted above, might be of limited relevance for advancing the knowledge of systemic issues. It might be necessary for the systemic financial risk regulator to sponsor research on such issues.

Several workshop participants observed that without strong support or "tone at the top" from the chief executive officer, risk managers can readily be outvoted in corporate decision making, especially when an opportunity for immediate profit presents itself and when there are great uncertainties associated with some of the worst-case risk estimates. Beder suggested that there is a need for more training of corporate managers and boards of directors with respect to risk and scientific thinking. Ultimately, this should facilitate communication about risk and its uncertainties and improve executive decision making.

Incorporating an Understanding of Human Behavior into Systemic Risk Regulation

One workshop participant noted that systemic risk is not driven solely by financial engineering; behavior, auditing rules, and governance also play important roles. Therefore, models to inform systemic financial risk regulation need at least to simulate processes of individual behavior and feedback arising from individual behavior.

Human beings have difficulty incorporating potential worst-case scenarios into their decisions. This limitation applies as much to risk managers and heads of large organizations as to anyone else. Christine Cumming of the Federal Reserve Bank of New York recalled that many have characterized the current crisis as a failure of imagination. The scale of this crisis is in part a reflection of the multiple layers of modeling and technology and associated opacity that swamped the capability of risk analysis systems to produce reliable metrics. A great deal is learned about the financial system when it is under stress, including how people behave. Cumming suggested that the methods of science might help extract from our recent experience lessons about the interplay between human behaviors and market stability.

Scholes pointed out that there is an inherent timescale associated with human decision making within organizations and that in times of high volatility, that timescale constrains the ability to make decisions as fast as the situation demands. When a shock occurs, intermediaries need time to reassess the calibration of their models, both formal and heuristic. In the meantime, intermediation can halt, leading to credit markets freezing up and a sudden lack of liquidity.

Sugihara suggested that there could be value in an increased use of behavioral surveys to monitor and understand convergence within evolving behavioral models. That approach might improve regulators' understanding of important trends, such as the actual underwriting standards applied in practice and how they are changing over time. For example, Beder reported that her breakout group mentioned firms' use of similar risk limits as a contributor to systemic risk. She illustrated this with the common rule of limiting exposure to no more than the average 20-day trading volume. Her group suggested that it might be valuable for a systemic risk regulator to collect information on such rules. Such knowledge might also, for instance, inform the understanding of when traditional, stylized forms of risk management should be overruled by other, more dominant considerations such as sudden and contagious shifts of public mood. Several workshop participants said that such shifts of mood had contributed to the run-up to the current crisis. Sugihara speculated that emerging regulations may shape the next systemic event and that behavioral models designed to evolve stylized innovations that "skate the edge of regulation" are likely to be useful.

3
Observations from the Workshop's Keynote Presentations

The workshop keynote presentation by Andrew Lo of the Massachusetts Institute of Technology began by looking broadly at the causes of crises in other technology-based sectors besides the financial sector, such as aerospace, nuclear power, and transportation. He echoed Perrow,[1] who studied accidents and concluded that they are a normal phenomenon of complex, nonlinear systems with tight coupling. Human behavior is an important contributor in many cases, and many complex systems embed human decision making. Lo added that, in addition to tight coupling and complexity, a third necessary condition for a crisis to develop is the absence of negative feedback over an extended period of time.

Lo pointed out that simply losing a great deal of money is not what defines a systemic risk. He contrasted the current crisis, which has cost the country $1.5 trillion, with the major stock market movement on April 14, 2000, when the market lost $1.04 trillion. No one considers the latter event to have been systemic, even though it involved losses on the same scale as those of the current crisis. The difference is that people who invest in the stock market expect some downturns and were presumably aware of the risk prior to April 14, 2000. A characteristic of systemic events is that they result in losses among people who were not expecting them and were unprepared.

Many ideas have been developed for reducing systemic risk. Lo listed 14 possible policy responses that academics, policy makers, and other observers have proposed in light of the financial crisis (see Box 3.1). He observed that, over the next several years, the nation will be rebuilding its financial infrastructure for the future and it needs more, not less, financial expertise. Systemic risk *can* be measured, and people have made steps in that direction. The data available for early warnings were suggestive but not conclusive, and so more has to be done to develop an understanding that is clear and reliable enough to use in managing the financial system. All of this suggests that people with strong expertise in engineering and quantitative modeling are critical to addressing the challenge.

[1] Charles Perrow. 1984. *Normal Accidents: Living with High Risk Technologies*. New York: Basic Books.

BOX 3.1

Some Possible Steps for Reducing Systemic Risk in the Financial Sector

- Break up banks and broker/dealers that are "too big to fail."
- Create exchanges for credit default swaps and other large over-the-counter contracts.
- Create an equivalent of the National Transportation Safety Board or National Weather Service for analyzing blowups and monitoring risks.
- Require confidential disclosure regarding "network" exposures.
- Implement countercyclical leverage constraints for bank-like entities.
- Enforce "suitability" requirements for mortgage-broker advice.
- Require certification for management and boards of complex financial institutions.
- Impose more mark-to-market accounting and risk controls.
- Impose capital adequacy requirements for all bank-like entities.
- Create a new discipline of "risk accounting."
- Impose a small derivatives tax to fund financial engineering programs.
- Revise laws to allow "pre-packaged" bankruptcies for finance companies.
- Change corporate governance structure (compensation, role of the Chief Risk Officer, etc.).
- Teach economics, finance, and risk management in high school.

SOURCE: Adapted, with permission, from Andrew Lo, Massachusetts Institute of Technology, presentation at the Workshop on Technical Capabilities Necessary for Regulation of Systemic Financial Risk, Washington, D.C., November 3, 2009.

Myron Scholes of Stanford University gave a keynote presentation that discussed the costs of adjusting portfolios when conditions change. Flexible portfolios are more expensive and less profitable. One must pay for an option that gives flexibility, and the option price is high when volatility and illiquidity are high or may become high. Leverage is inherently inflexible because positions cannot easily be sold in a downturn to pay off the debt. Illiquidity also rises in a crisis. In the run-up to the current crisis, too much leverage was taken by consumers, investors, governments, corporations, and financial entities, making the system unstable.

Scholes noted that the cost of the bailout should be compared with the costs of proactive solutions such as tighter regulation. It is possible that the bailout is less expensive. Systemic financial risk regulators are essentially risk aggregators. He believes that many systemic risks can be identified by careful aggregation of firm risk measures. This must be dynamic, as the value of liquidity provision varies over time. Stable-value products are inherently unstable and might be a source of systemic risk. Debt convertible to equity when triggered by systemic events might be an important tool for increasing flexibility. Accounting must be improved to reduce the impact of false profits and short-run compensation. Overall, firms should hold bigger capital cushions. Regulation to ensure this could improve everyone's welfare. Incentives and monitoring must work together to reduce the possibility of systemic failures.

The keynote presentation by Robert Engle of New York University discussed the financial crisis in terms of two features—the failure to assess risks adequately and the incentives to ignore

risks for many market participants. Solving the incentive problems has been the primary goal of regulatory reform. Solving the risk assessment problem is at the heart of the workshop discussions.

To measure risks of individual firms and systemic risks of the financial system as a whole requires both data and models. Models of volatility predict the magnitude of short-run price movements. Over longer horizons, there is a possibility that the risk itself will change, or at least that the volatilities will change. Thus, long-term risk measures must reflect the way that risks are likely to change. Counterparty exposures are important systemic risks in the over-the-counter derivatives markets, and these can be managed by a combination of central clearing, collateral contracts, and improved transparency.

Regulators should have access to counterparty exposures and position data in Engle's view. In this way, models can predict the impacts of stresses that flow through networks of counterparties and positions ultimately affecting the whole system. His talk discussed new research on systemic risk measures. Such measures can be constructed from public information or, with more precision, from nonpublic information. He argued that systemic regulators should be given access to these data and, in the meantime, should continue to develop models of systemic risks based on public financial data.

Appendix A

Letter from Senator Jack Reed to Ralph Cicerone, National Academy of Sciences President

JACK REED
RHODE ISLAND

COMMITTEES

APPROPRIATIONS
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http://reed.senate.gov

August 27, 2009

Dr. Ralph Cicerone
President
National Academy of Sciences
500 Fifth Street NW
Washington, DC 20001

Dear Dr. Cicerone:

As the United States recovers from perhaps the most severe economic and financial crisis since the Great Depression, we are learning about and seeking to repair many of the shortcomings in our financial regulatory system. Among the lessons learned is that our regulators face significant limitations in the data and analytic tools they have available to identify and mitigate potential systemic risks that cut across financial institutions, products, and regulators.

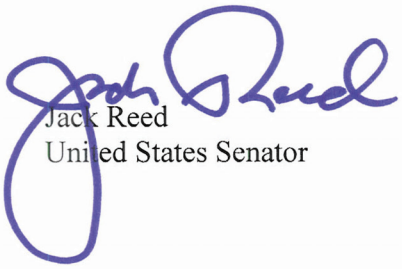
As has been identified by a number of individuals and organizations, policymakers and regulators have faced significant challenges resulting from the lack of the necessary tools to fulfill their obligations to monitor and manage the health of financial markets. Financial regulators, including any new systemic risk regulator that Congress creates, will need clear responsibility, sufficient authority, adequate tools, and comprehensive data to monitor and mitigate systemic risks.

In considering reforms to financial oversight, we must have a better understanding of the existing data and analytical capabilities of current regulators, and what specific additional tools and resources are needed to successfully modernize regulators' ability to fulfill their missions. As such, I would request that the National Academy of Sciences prepare an analysis of this issue that examines:

- the data and analytical tools that currently exist among regulators to address risks in the financial system;
- the data-collection and analysis capabilities that are needed to ensure that regulators can successfully address systemic risks in the future;
- the resource needs that are associated with these improvements;
- the technical challenges that are associated with systemic risk supervision; and
- the options that exist for building these capabilities, including high-priority research questions.

It is my hope that the National Academy of Sciences can complete this analysis by October 31, 2009. Thank you for your attention to and consideration of this request. I look forward to your response.

Sincerely,



Jack Reed
United States Senator

Appendix B

Workshop Participants

Viral V. Acharya, New York University
Tobias Adrian, Federal Reserve Bank of New York
Lewis Alexander, Department of the Treasury
Tanya Styblo Beder, SBCC Group, Inc.
Penny Cagan, Algorithmics
Mark Carey, Federal Reserve Board
Robert N. Collender, Federal Housing Finance Agency
Christine M. Cumming, Federal Reserve Bank of New York
Deborah J. Danker, Department of the Treasury
Giovanni Dell'Ariccia, International Monetary Fund
Robert F. Engle, New York University
Randall Fasnacht, U.S. Senate Banking Committee
Gregory Feldberg, Department of the Treasury
Charles Fishkin, AllianceBernstein
Darryl E. Getter, Congressional Research Service
Michael S. Gibson, Federal Reserve Board
Daniel L. Goroff, Alfred P. Sloan Foundation
Alan J. King, IBM Thomas J. Watson Research Center
Paul H. Kupiec, Federal Deposit Insurance Corporation
Joseph Langsam, Morgan Stanley
C. David Levermore, University of Maryland
Mark Levonian, Office of the Comptroller of the Currency
Nellie Liang, Federal Reserve Board
John C. Liechty, Pennsylvania State University
Andrew W. Lo, Massachusetts Institute of Technology
Charles M. Lucas, Osprey Point Consulting
Thomas J. McCool, Government Accountability Office
Allan I. Mendelowitz, Federal Housing Finance Board (retired)
David K.I. Mordecai, Risk Economics Limited, Inc.
Yaacov Mutnikas, Algorithmics
John W. O'Brien, University of California at Berkeley
Gerald Peters, GP Gallery
David M. Rowe, SunGard
Barry Schachter, Moore Capital Management
Myron S. Scholes, Stanford University
J.B. Silvers, Case Western Reserve University
Charles Smithson, Rutter Associates
George Sugihara, Scripps Institution of Oceanography
Charles Taylor, The Pew Charitable Trusts
Charles M. Vest, National Academy of Engineering
Scott T. Weidman, National Research Council