

Review of Causes, Prediction, and Prevention of Systemic Risk

Ruan Cao

International Division, Zibo Shiyuan High School, Shandong, China

levibestonline@outlook.com

Abstract. In financial market, people always ignore or underestimate the potential risk of systemic risk until black swan events emerged as an irretrievable crisis. In order to analyze and prevent from crisis that generated by systemic risk, this paper collates and presents detailed review of the causes, prediction, and mitigation of systemic risk by gathering and sifting current theoretical and empirical research. It explores the complexity and interdependence of financial systems and emphasizes how systemic risk is created via endogenous risk generation via the investment decisions of financial institutions and regulatory and market failures. Moreover, it underlines the strong demand of through legislative changes, the importance of enhanced market discipline, and well-crafted government interventions. Deliberative risk governance is presented as a practical and necessary strategy when it comes to addressing stakeholders in the risk management process to achieve legitimacy and consensus. The research ends by advocating for a comprehensive strategy for risk management to strengthen the resilience of the global financial system and reduce the probability of future potential crisis.

Keywords: Systemic risk, financial crisis, market discipline, financial stability, economic stability.

1. Introduction

Global economic stability is significantly threatened by systemic risk—that is, the potential collapse of a whole financial system or market. This concept developed especially prominence during the financial crisis of 2007-2008, which underlines the complex interconnections among financial institutions and the consequent possibility for cascade collapses. Policymakers and financial authorities still prioritize systemic risk even with significant legislative changes and improved market discipline rules applied during the crisis.

Main causes of systemic risk include financial systems' natural complexity and interdependence, through several channels—including interbank lending, payment systems, and derivative contracts—financial institutions are lined and form a dense network of relationships. Therefore, the collapse of one institution may set off a chain reaction that causes general financial unrest. Furthermore, aggravating systemic vulnerabilities is the endogenous generation of risk by financial institutions motivated by their investment decisions and risk control strategies. Further exacerbating the issue are rewards based on short-term performance and regulatory structures lacking addressing of system-wide risks.

Focusing on recent studies and theoretical developments before 2020, this study attempts to offer a thorough overview of the present knowledge of systemic risk. It will look at advanced risk assessment models including agent-based and network models, which provide strong systems for evaluating and forecasting systemic risk. This paper will collect and discuss ways to identify and apply the early warning indicators, which are considered to be essential tools for mitigating potential crises. Successful prevention measures will also be examined in this paper, including enhance market discipline, superior government interventions, and thorough legislative changes. It would be helpful to make consensus and strengthen the credibility of legislative actions if the stakeholders are integrated during the risk management process, which summarized as deliberate risk governance. In terms of the policymakers, tackling the root causes of systemic risk and implementing a more comprehensive strategy for risk management might not only strengthen the resilience of the global financial system, but also reduce the possibility of future crises generated.

2. Causes of Systemic Risk

2.1. Complexity and Interconnectedness

The main cause of the systemic risk could be explained as its two unique characteristics—intricate nature and interconnections of financial systems. Renn pointed out that intricate complexity, cross border impacts, stochastic correlations, and non-linear cause and effect patterns with less public attention contributes to systemic risks [1]. There are lots of channels to make financial institutions linked together, such as interbank lending, payment networks and derivative contracts. This interdependence implies that extensive instability could be affected by the collapse of one institution because of domino effect.

There was a new real-life example happened on July 19, 2024, which is helpful to illustrate how systemic risk led by a crisis in only one sector. A significant number of Windows system devices experienced malfunctions due to a “defect” in the content update of the CrowdStrike software security company. Numerous banks, media organization, and airlines were severely affected by this unexpected event. The ports and flights in several nations, including the United States, Australia, the United Kingdom, Germany, etc., experienced different levels of disruption, resulting in widespread panic and instability in the global stock market. Consequently, due to the unexpected issue faced by a single company, the crisis was then passed to airlines, technology giants like Microsoft, and supermarkets through intricate and interconnected relationships. This led to the crisis spreading to the global market.

The complexity of these interconnections often obscures the root causes and makes efficient risk assessment or mitigation impossible for regulators sophisticated financial devices, such as collateralized debt obligations (CDOs) and credit default swaps (CDS), may build hidden links between unrelated companies. The paucity of transparency in these instruments sometimes feeds fear and triggers market panics when the reality about their dangers finally emerges.

2.2. Endogenous Risk Creation

Morrison and Walther contend that investment decisions and risk management strategies carried out by financial institutions may generate systemic risk frequently [2]. Financial organizations may opt to invest in closely correlated assets. However, this method also exposes them to the possibility of being forced to sell these assets in a distressed market at a significantly lower price. The banks would participate as monitors since they need to align their interests with those of their stakeholders by accepting equivalent risks. Technological advancements and financing initiatives led by government might worsen risks by suddenly increasing systemic risk.

Motivating system in financial institutions has potential to generate risk within an organization. For instance, unwarranted levels of risk might be promoted by remuneration systems, which incentivize short-term performance. Bank management, facing the demand for increased profits, can choose to invest in high-yield, high-risk assets. When multiple institutions follow similar strategies, the financial system becomes vulnerable to common shocks.

In 2009, Acharya and Richardson conducted a study to analyze the correlation between the structure of financial rewards and the likelihood of engaging in excessive risk-taking behavior, which could subsequently result in increased systemic risk [3]. They argue that the bonuses tied to short term performance metrics could encourage the managers to prioritize the strategy with higher risk and higher reward instead of a more cautious approach with a stable and lower risk. This conduct might accumulate systemic weaknesses, which increase the possibility of crisis during the periods with high financial stress.

2.3. Regulatory and Market Failures

The formal recognition that the role of market discipline and regulatory frameworks in mitigating or enhancing systemic risk is what really matters. The global financial crisis (2007–2008) revealed important regulatory weaknesses — too low capital ratios, poor regulation of complex and opaque

financial products. This is reinforcing the view that despite post-crisis regulatory initiatives such as higher capital requirements and new laws designed to avoid lender haircuts, systemic risk indicators have been flat that would suggest that regulatory intervention in itself might not be a sufficient safeguard against systemic risk as long as financial institutions continue to act synchronously on their linked risks.

This is the reason that conventional regulating methods which emphasize and are focused on particular institutions by their nature will be limited, as they only target specific levels within a financial system. As an alternative strategy called macroprudential control designed for reducing systemic risk, is massively challenging when it is implemented: it would require a global approach and an ability to measure systemic risk precisely and accurately.

Next, as a measure of systemic risk that Adrian Brunnermeier propose is the CoVaR- Conditional Value at Risk. CoVaR gauges the value at risk of institutions (VaR) in crisis [4]. This statistic takes into account the potential spill-over effects of failures at single institutions, hence provides a more holistic representation of systemic risk. Such advanced methods require vast datasets and analytic capabilities that are labor-intensive for authorities to gather and maintain.

Capital Adequacy Ratio (CAR), as can be seen in formula (1).

$$CAR = \frac{\textit{Tier 1 Capital} + \textit{Tier 2 Capital}}{\textit{Risk Weighted Assets}} \quad (1)$$

Regulators use the crucial indicator known as the Capital Adequacy Ratio to make sure banks comply with statutory capital requirements and can withstand a suitable level of loss. However, during the financial crisis, many banks had sufficient CARs yet faced significant liquidity issues, highlighting the need for more comprehensive risk measures.

2.4. Technological and Economic Factors

Some of the contribution towards systemic risk can also be seen by technical advancements and economic policies. For instance, the rise of high-frequency trading has made markets wilder and flash crashes more likely. Government directed lending, among other economic policies could induce financial institutions into co-investment behavior resulting to higher systemic risk. In order to stabilize risks during crisis, Morrison and Walther note that interventions as the troubled Asset relief Program (Tarp) can help to avoid fire sales and reduce systemic risk [2]. However, these initiatives could also result in moral issues since they ask banks to take more risks in the belief that they will be rescued further down the line.

Technology affects systemic risk in numerous ways, it could be a double side sword for systemic risk. It could be said that fintech boosts efficiency and risk control. Alternatively, they may also present contemporary threats including risks around cybersecurity or the potential for technical failures across the financial system. As a result, economic policies take the form of weighing between costs and benefits that come with technological advancement.

Brunnermeier et al. explore how use of blockchain and artificial intelligence technology can reduce or increase systemic risk [5]. For example, using blockchain technology can decrease exposure to the counterparty while providing complete transparency through irreversible transaction records. On the flip side, widespread adoption of blockchain technology may create new systemic vulnerabilities in case a failure or compromise exposes how vulnerable it is.

3. Prediction of Systemic Risk

3.1. Risk Assessment Models

Work in constructing high-dimensional, highly interdependent models of financial systems has grow out from network science. As these are increasingly better in capturing the complexity and interdependence present globally, the analyst ability to predict systemic risk is amplified. In this way, traditional risk models typically do not work because they tend to focus on particular firms rather

than the system as a whole. New research has emphasized the inclusion of interdependency among risk cluster in systemic risk models and explored multisource data.

One way to model systemic risk is using two models, agent-based models (i.e. replicating the interactions of many agents in financial system) and event-driven ones. This in turn can be used for the feedback loops and non-linear dynamics, which define systematic risk as they progress throughout time. Network models are used to understand the behavior and topology of financial networks, which helps in identification of potential failure points as well as channels whereby contagion can reach one or more institutions.

Haldane and May further [6] recommends to get a handle on systemic risk in financial systems using network theory. They argue that financial networks share properties with other complex systems, such as power grids and ecological systems. Network analysis tools enable researchers to identify the key modes and links, which may contribute to higher risk at a systems level. This approach provides a more coherent view of the financial system as whole and allows also to detect potential vulnerabilities not visible from such basically institutional perspective.

3.2. Early Warning Indicators

The early warning indicators are searched for in the systemic risk predictions, and so on. These signals can include common macroeconomic factors such as GDP growth and unemployment rates, along with measures of financial market conditions like credit spreads or stock market volatility. As Reen suggested, early warning system should be adaptable: they ebb and flow with new information and emerging trends [1]. This requires collaboration between university researchers, financial institutions and regulators to develop and refine prediction models.

These early warning signals, meant to identify those weaknesses before they turn into full-blown crises, include measures such as the ratio of short-term debt to total debt (liquidity risk) or financial institution connectedness (typology contagion). Machine learning forms the other side of this coin, allowing systemic risks to be detected in advance by identifying patterns or outliers.

The IMFs considers the development of composite early warning indicators that combine a number of criteria to better capture systemic risk [7]. The composite indicators can uncover, among other things lines of risk such as market volatility, market leverage, and liquidity conditions. There is potential for a more robust early warning system in composite indicators that combine multiple sources and types of analysis.

Score for Financial Stability, as can be seen in formula (2).

$$Z = \frac{E(ROA) + \left(\frac{K}{A}\right)}{\sigma(ROA)} \quad (2)$$

Z-score: This is the most commonly practice indicator of financial distress that employs return on assets (ROA), equity capital (K) and standard deviation of ROA. These results indicate either a high or low risk of insolvency depending on if the score is higher (more stable) or lower (higher chance of bankruptcy).

3.3. Network Analysis

It was found that network analysis has significantly aided in predicting systemic risk. End to end mapping of links across financial institutions aids academics in their quest for identifying vectors for failure and estimating epidemic risk. Morrison and Walther highlight the extent of reduced systemic risk prediction when aware of financial system network topology [2]. Network analysis is asl helpful to identify “too big to fail” entities for if their collapse would bring down the whole system.

Using network theory to financial systems means examining several network characteristics including centrality, clustering, and connectedness. Degree centrality and betweenness centrality are two centrality measures that help to pinpoint important institutions with strong connections that are absolutely vital for the operation of the financial system. via means of localized shocks, closely linked subgroups that can increase systemic risk might be exposed via clustering techniques.

Glasserman and Young explore how systemic risk can be evaluated and possible areas of intervention found using network models [8]. They contend that network analysis can shed important light on the possibility for epidemic and the efficacy of several regulatory policies. By spotting extremely central institutions, for instance, authorities might focus interventions more precisely to stop the spread of systemic risk.

4. Prevention of systemic risk

4.1. Regulatory Reforms

To prevent systemic risk, it is necessary to implement extensive regulatory reforms that specifically target the root causes that contribute to financial instability. Notable changes encompass:

(1) Enforcing high degrees of capital reserves for financial institutions will help them to improve their capacity to bear losses and reduce the risk of insolvency during periods of economic crisis.

(2) Macroprudential regulation is also about adopting rules where we give stability and health of the whole financial system top priority as opposed to focus on specific institutions.

(3) Stress tests have a key role in assessing the capacity of financial institutions to resist different types of shocks, once used on more than an ad hoc basis.

Enhanced capital requirements ensure that banks have sufficient loss-absorbing capacity to withstand financial shocks. To make banks more resistant to risks, the Basel III framework introduced stricter capital requirements and leverage ratios. Of course, these measures must be accompanied by robust enforcement and continued monitoring to ensure that they are followed.

Macroprudential regulation is also trying to prevent the emergence of systemic risks, caused by parallel behavior from financial institutions. This includes things like countercyclical capital buffers that compel banks to accumulate their stock of reserves during booms, and then release them in other direction during recession. The use of targeted macroprudential instruments became another trend: for example, too high leverage ratios in certain industries or overextended credit growth were properly subject to discretion of regulatory authority.

Stress testing tests the robustness of financial institutions to fictitious adverse events. So those tests allow authorities and firms to design a failover strategy for their system as well as understand the possible weak points. Stress test results may also influence the decisions carried out by governments to require that banks increase their capital or liquidity buffers.

Tarullo highlights that stress testing must be part of a larger regulatory regime [9]. According to Tarullo, stress testing ought to be not only an examination of how individual institutions hold up in bad times, but also the possibility for systemic risk. Including systemic risk scenarios into stress tests helps authorities better grasp the possible effects of negative shocks on the whole financial system and create more efficient regulatory reactions.

4.2. Market Discipline

Strengthening market discipline is another key element to mitigate systemic risk. According to Morrison and Walther, market discipline is limited in part because banks are required to hold stricter tiers of equity above long-term debt, which diminishes a reliance on short term borrowing [2]. It will incentivize banks to adopt reasonable risk management measures and reduce any associated spillover investment actions.

Greater transparency and disclosure rules reinforce market discipline through hard means. This will aid banks in making market participants better judgements with more information on their risk exposures and finances. This can therefore put pressure on banks to more properly control their risks.

Calomiris and Herring explore how market discipline helps to reduce systemic risk [10]. They contend that by adding still another level of control, market discipline can enhance government policies. For instance, mandating banks to produce contingent convertible bonds (CoCos) can provide incentives to help them to keep sufficient capital. When a bank's capital falls below a specific level,

CoCos automatically turn into equity, therefore shielding against insolvency and matching the interests of loan holders with those of regulators.

4.3. Government Interventions

Government interventions should be carefully planned to avoid generating moral hazards even when they can reduce systemic risk during crises. Programs for asset purchase can help to bring stability, but they should be supplemented by actions that prevent too risky behavior. Tying bailout money to particular criteria, such lowering leverage or enhancing risk management strategies, for instance, helps to minimize moral risks.

Government actions might be liquidity support, capital infusion, and asset purchase initiatives among other kinds. Emergency loan programs and other liquidity support tools aim to stabilize financial institutions under temporary funding constraints. Whether via subordinated debt or direct equity investments, capital injections help banks' balance sheets to be strengthened and confidence rebuilt. Programs for asset purchase, such those carried out during the financial crisis, can assist to clear troubled assets from banks' balance sheets and enhance market operation.

Fischer investigates how well several government actions help to alleviate financial crises [11]. Timely and focused measures, he contends, can stop systemic risk from growing. Interventions must, he advises, be planned to prevent fostering expectations of future bailouts, which would cause moral hazard and promote risk-taking behavior. Fischer advises that regulatory changes addressing the fundamental drivers of systemic risk should accompany solutions [11].

4.4. Deliberative Risk Governance

Renn argues for governance of risks rather than risk mis-management and that this requires stakeholders to participate in the management of those issues [1]. This approach seeks to ensure participatory and transparent decision-making processes that are responsive to the multiple interests and values of various stakeholders. Deliberative risk governance would contribute to consensus building concerning methods of regulatory housekeeping and also increase the legitimacy of action taken by merging representatives from different areas, including financial institutions, administration or civil society.

This is where deliberative risk management, setting up platforms of collaboration and communication between stakeholders comes in. Through the exchange of information, perspectives and ideas these platforms can aid in promoting their interchange making decision-making more informed and holistic.

In fact, given that stakeholders may be more likely to support policies they have had a hand in formulating, this deliberative approach could bolster public trust regarding regulatory interventions.

Slovic et al. look at the benefits of adding risk governance participants [12]. They argue that stakeholder participation improves the quality of risk analyses by incorporating diverse perspectives and knowledge. This process can also help increase the acceptance and validity of legislative actions by involving stakeholders in their decisions. Slovic et al. stated that participatory methods such citizen juries and deliberative polling are one of the tried-and-true techniques for involving stakeholders and obtaining consensus regarding risk management strategies as well [12].

5. Summary

In essence, even if research of and methods to reduce systemic risk has progressed, it is still an issue requiring constant attention and improvement. The knowledge gained from current studies and real-world experiences must guide the next initiatives to create a financial system not only strong but also able to promote sustainable economic development within uncertainty. Navigating the complexity of systemic risk and ensuring long-term financial stability will rely mostly on the determination to implement adaptive and forward-looking policies. Financial institutions and governments should set a premium on potential systemic risk while making decisions. Adapting the

social structure that rapidly evolving with the help of new data, new ideas in academia and technological innovations would accumulate more reference for the future researchers. The collaboration across different stakeholders, different nations, and different sectors all over the world might be a significant premise of investigating systemic risk.

References

- [1] Renn, O. New challenges for risk analysis: systemic risks. *Journal of Risk Research*, 2020.
- [2] Morrison, A. D., & Walther, A. *Market Discipline and Systemic Risk*. Saïd Business School, University of Oxford, 2017.
- [3] Acharya, V. V., & Richardson, M. Causes of the Financial Crisis. *Critical Review*, 2009, 21 (2-3), 195-210.
- [4] Adrian, T., & Brunnermeier, M. K. CoVaR. *American Economic Review*, 2016, 106 (7), 1705-1741.
- [5] Brunnermeier, M. K., James, H., & Landau, J. P. *The Digitalization of Money*, 2020.
- [6] Haldane, A. G., & May, R. M. Systemic Risk in Banking Ecosystems. *Nature*, 2011, 469 (7330), 351-355.
- [7] International Monetary Fund. *Global Financial Stability Report: Bridge to Recovery*. International Monetary Fund, 2020.
- [8] Glasserman, P., & Young, H. P. Contagion in Financial Networks. *Journal of Economic Literature*, 2016, 54 (3), 779-831.
- [9] Tarullo, D. K. *Stress Testing After Five Years*. Federal Reserve, 2014.
- [10] Calomiris, C. W., & Herring, R. J. How to Design a Contingent Convertible Debt Requirement. *Journal of Applied Corporate Finance*, 2013, 25 (2), 66-89.
- [11] Fischer, S. The Role of Central Banks in Financial Stability: Lessons from the Crisis. *IMF Economic Review*, 2020, 68 (2), 202-217.
- [12] Slovic, P., Fischhoff, B., & Lichtenstein, S. The Social Amplification of Risk: A Conceptual Framework. *Risk Analysis*, 2016, 36 (1), 211-224.