Systemic Risk and Network Analysis in Financial Stability: A Survey

Abstract

This survey paper examines the intricate relationship between systemic risk and financial networks, emphasizing the critical role of network analysis in understanding and mitigating systemic threats. Systemic risk, characterized by potential cascading failures within interconnected financial systems, poses significant threats to economic stability. Traditional risk measures, such as Value-at-Risk (VaR) and Conditional Value-at-Risk (CoVaR), often fall short in capturing the dynamic interdependencies and contagion mechanisms inherent in financial networks. The survey highlights advanced methodologies that address these limitations, offering a more nuanced analysis of systemic risk. Network analysis, through models like the Unified Marshall-Walras Equilibrium (UMWE) and DebtRank, provides a comprehensive framework for evaluating systemic vulnerabilities and enhancing financial stability. The paper also explores the dynamics of contagion and spillover networks, illustrating how financial distress propagates across sectors and markets. Case studies on interbank networks, the European banking sector, and cryptocurrency markets underscore the practical applications of network analysis in systemic risk assessment. The survey concludes by advocating for a unified approach to systemic risk evaluation, leveraging network analysis to optimize risk management strategies and regulatory policies. Future research directions include refining models to incorporate complex interactions and expanding the scope of risk sources considered. By advancing network analysis methodologies, financial institutions and regulators can better anticipate and mitigate systemic threats, contributing to the resilience of global financial markets.

1 Introduction

1.1 Significance of Systemic Risk

Systemic risk is a critical concern for financial stability, characterized by potential disruptions in financial services that can lead to widespread economic instability. The interconnectedness of financial institutions, particularly large banks, significantly contributes to systemic risk due to their essential roles in the interbank market and the observed impacts since the 2008 financial crisis. The complex interdependencies among these institutions create a precarious environment where the insolvency of a single entity can trigger cascading failures throughout the financial network, culminating in systemic crises. This risk is further amplified by intersectoral linkages, where shocks in one area can propagate distress across multiple sectors, especially during economic downturns. While regulatory frameworks like the Basel III Accord enhance individual bank resilience, they inadequately address the spillover effects across contagion channels, which are likely to dominate future financial crises. Implementing effective systemic risk management strategies, such as utilizing credit default swaps (CDS) to reconfigure interbank exposures, can mitigate cascading failures and bolster overall financial system stability [1, 2, 3, 4].

The propagation of financial distress is facilitated by the interconnectedness of banks through complex exposure networks, highlighting the necessity of understanding systemic risk dynamics [5].
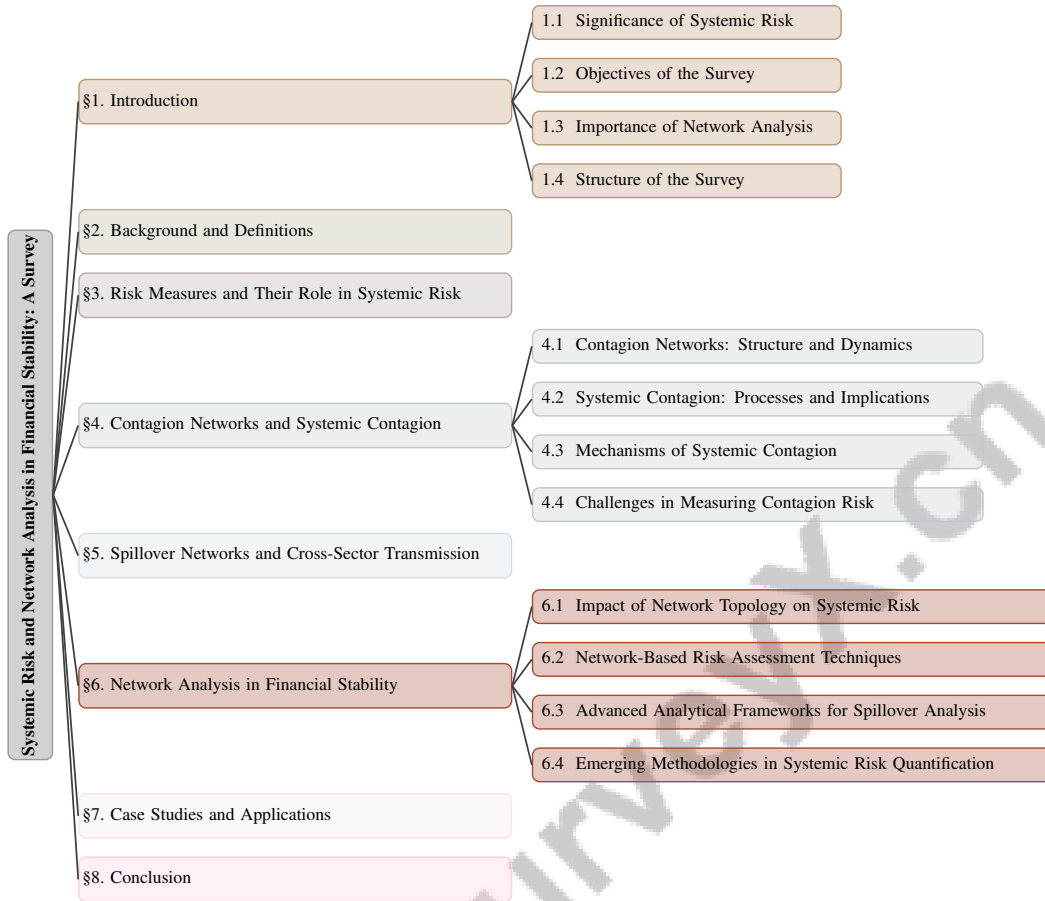
Figure 1: chapter structure

Contagion, a key aspect of systemic risk, occurs when financial shocks disseminate through these networks, posing significant threats to economic stability [6]. The influence of contingent payments and CDS can either mitigate or exacerbate financial contagion, adding complexity to systemic risk management [6].

Recent studies emphasize the heterogeneity in systemic risk structures, particularly in high-frequency trading environments, where disparities between large and small crashes significantly affect shock propagation [7]. Additionally, counterparty credit risk complicates the systemic risk landscape, as the default of a financial contract party can have far-reaching consequences [5]. The rapid contagion observed in recent financial crises underscores the critical need for robust models to assess and mitigate these risks. As financial systems evolve, comprehending the interactions and dependencies among market participants remains essential for maintaining stability and preventing systemic failures.

1.2 Objectives of the Survey

The primary objective of this survey is to elucidate the intricate relationship between financial networks and systemic risk, emphasizing the essential role of network analysis in understanding and mitigating systemic threats. This includes leveraging advanced methodologies to enhance comprehension of systemic risk, particularly the potential for cascading failures triggered by the collapse of individual financial entities [6]. A significant aim is to address the limitations of existing systemic risk measures by proposing innovative frameworks that capture complex interdependencies and stress propagation within multivariate systems, which traditional methods often inadequately represent [7].

The survey also explores the role of financial instruments, such as CDS, in managing insolvency cascades within interbank systems, providing insights into their potential to mitigate systemic risk

[1]. Furthermore, it aims to develop a comprehensive understanding of how balance sheet dynamics, coupled with contagion effects, influence banking system stability under stress [5]. By examining these dynamics, the survey endeavors to propose robust models for assessing and mitigating systemic risk, ultimately contributing to a more resilient financial system capable of withstanding future crises. Through these objectives, the survey underscores the pivotal role of network analysis in formulating effective regulatory policies to enhance financial stability.

1.3 Importance of Network Analysis

Network analysis is crucial in evaluating financial stability and systemic risk, as it models the intricate dynamics and interdependencies within financial systems. This approach facilitates a deeper understanding of credit cycles and systemic risk, providing insights into the network structure of financial markets [8]. The dynamic interbank model, which incorporates mark-to-market valuation of interbank claims, exemplifies the utility of network analysis in assessing systemic risk and enhancing financial stability [9].

Modeling contingent payments over time is vital for understanding systemic risk, as it enables the simulation of risk propagation through financial networks [10]. The cascading failure model, which simulates risk propagation during financial crises, underscores the significance of network analysis in revealing systemic vulnerabilities [4]. Additionally, network analysis emphasizes the necessity of accurately modeling complex relationships within financial markets to mitigate systemic risk, drawing parallels with interconnectedness observed in physics [5].

Advanced frameworks, such as tensorial multilayer networks, provide a comprehensive perspective on interactions between multiple financial layers, capturing dynamics of financial contagion and stabilization [11]. The identification of systemically important financial institutions (SIFIs) extends beyond banks to include firms, highlighting the need for a broader understanding of financial networks and systemic risk [12].

Regulating the CDS market to incentivize contracts that reduce systemic risk exemplifies the application of network analysis in risk management [1]. Methodologies introduced by [7] propose measures for stress propagation and systemic risk that quantify interactions among variables, enhancing the assessment of systemic interactions. Collectively, these methodologies establish network analysis as an indispensable tool for evaluating systemic risk, offering innovative frameworks and models to bolster financial stability and mitigate systemic threats.

1.4 Structure of the Survey

This survey is meticulously organized to provide a comprehensive examination of systemic risk and network analysis in the context of financial stability. The paper begins with the **Introduction**, which lays the foundation by elucidating the significance of systemic risk and the objectives of the survey, emphasizing the critical role of network analysis in understanding systemic threats. Following this, the **Background and Definitions** section delves into essential concepts such as systemic risk, risk measures, contagion networks, spillover networks, and financial stability, offering detailed explanations to set the stage for subsequent discussions.

In the section on **Risk Measures and Their Role in Systemic Risk**, the survey explores various risk measures used to quantify systemic risk, highlighting their utility and limitations. This includes a discussion on common risk measures like VaR and CoVaR, as well as advanced methodologies in systemic risk quantification, such as multivariate contribution risk measures [7].

The focus then shifts to **Contagion Networks and Systemic Contagion**, where the structure and dynamics of contagion networks are examined, alongside the processes and implications of systemic contagion. This section also addresses the mechanisms of systemic contagion and the challenges in measuring contagion risk [6].

The subsequent section, **Spillover Networks and Cross-Sector Transmission**, analyzes the transmission of shocks across sectors, discussing the detection of spillover effects, sector-specific shock transmission, momentum spillover across asset classes, and the role of CDS in cross-sector shock transmission [1].

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The **Network Analysis in Financial Stability** section discusses the application of network analysis in evaluating financial systems, identifying vulnerable nodes, and understanding systemic risk. It explores the impact of network topology on systemic risk, network-based risk assessment techniques, advanced analytical frameworks for spillover analysis, and emerging methodologies in systemic risk quantification [9].

In the **Case Studies and Applications** section, the survey presents case studies from literature illustrating the application of network analysis in systemic risk assessment. This includes simulations of interbank networks, evaluations of the European banking sector, empirical studies on financial crises, and analyses of the cryptocurrency market [8].

The survey concludes with the **Conclusion**, which summarizes the key points discussed throughout the document and emphasizes the critical role of network analysis in comprehensively understanding systemic risk. This analysis involves exploring the intricate interdependencies between financial institutions, the impact of various types of systemic risks such as defaults and bank runs, and the importance of optimal regulation and measurement techniques in mitigating vulnerabilities within financial networks [13, 14, 15]. It also suggests areas for future research to further enhance the resilience of financial systems.The following sections are organized as shown in Figure 1.

2 Background and Definitions

2.1 Background and Definitions

Systemic risk involves the potential for cascading failures within interconnected financial systems, where distress in one entity can trigger widespread economic instability [4]. The complex topology of financial networks, marked by intricate interbank exposures and shared asset values, exacerbates this risk by amplifying financial shocks [12]. Traditional risk measures often fall short in capturing these complexities, necessitating advanced methodologies to model dynamic interactions and strategic behaviors during distress periods [11, 9].

Quantifying the impact of systemic disruptions relies on advanced risk measures, which are crucial yet often insufficient in the context of financial networks. Identifying Systemically Important Financial Institutions (SIFIs) is critical for effective systemic risk management due to their potential to cause significant disruptions through size, complexity, and interconnectedness [5].

Contagion networks illustrate the spread of financial distress among interconnected institutions, highlighting the role of interbank connections in propagating systemic risk [6]. The structure of these networks influences contagion dynamics, where the failure of one institution can initiate a chain reaction of defaults. Understanding these dynamics is essential for developing effective stress-testing frameworks and regulatory policies that acknowledge the interconnectedness of financial institutions [9].

Spillover networks evaluate the transmission of shocks across sectors or markets, crucial for assessing financial stability. The complexity of these networks is heightened by overlapping portfolios and indirect interconnections among financial institutions, contributing to systemic risk [12]. Additionally, the propagation of economic shocks through global supply networks highlights the vulnerability of countries to production losses due to firm failures in other nations, necessitating a comprehensive understanding of these interrelationships [11].

Systemic risk manifests in financial stability contexts when numerous agents default simultaneously, potentially leading to systemic collapse [4]. The evolution of systemic risk in response to external shocks, such as international agreements, underscores the need for ongoing research to elucidate volatility spillover dynamics among sectors. Key concepts—systemic risk, risk measures, contagion networks, spillover networks, and financial stability—are fundamental for developing robust models and regulatory frameworks aimed at mitigating systemic threats and enhancing the resilience of financial systems.

3 Risk Measures and Their Role in Systemic Risk

A thorough examination of systemic risk requires a critical evaluation of traditional risk measures, which have long been central to financial risk management. This assessment is crucial for under-

standing the complexities inherent in interconnected financial networks. Figure 2 illustrates the categorization of risk measures in systemic risk analysis, highlighting traditional measures and their limitations, as well as advanced methodologies that enhance systemic risk quantification and management. Conventional measures such as Value-at-Risk (VaR) and Conditional Value-at-Risk (CoVaR) are scrutinized for their limitations in addressing the dynamic interdependencies and contagion effects that characterize systemic risk. Recognizing these inadequacies is essential for introducing advanced methodologies that address the challenges presented by systemic risk in contemporary financial systems.
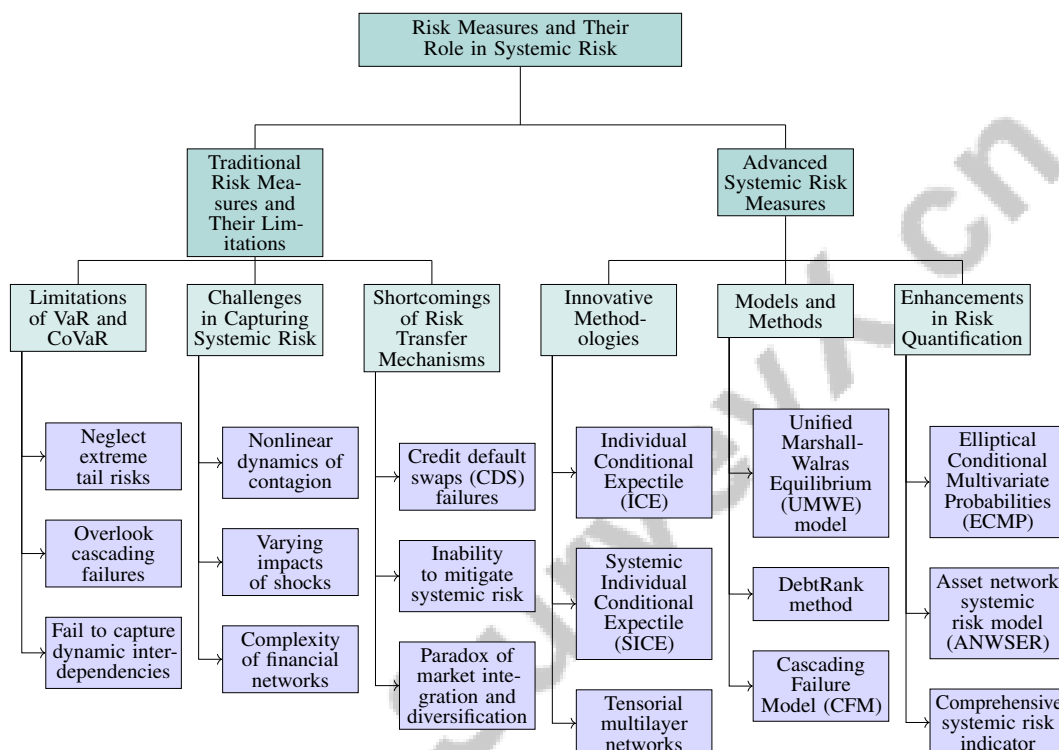
Figure 2: This figure illustrates the categorization of risk measures in systemic risk analysis, highlighting traditional measures and their limitations, as well as advanced methodologies that enhance systemic risk quantification and management.

3.1   Risk Measures and Their Limitations

Traditional risk measures like VaR and CoVaR are prevalent in financial risk management, estimating potential losses under normal market conditions. However, they fall short in assessing systemic risk within complex financial networks. VaR, which estimates potential losses over a specific timeframe at a given confidence level, often neglects extreme tail risks and cascading failures within interconnected systems. Similarly, CoVaR, which considers expected loss conditional on another institution's distress, fails to capture the dynamic interdependencies and contagion mechanisms present in financial networks [9].

These traditional models are limited by their inability to capture the nonlinear dynamics of contagion and system-wide risk effects. They often overlook the varying impacts of shocks across different time frequencies, leading to an incomplete understanding of systemic risk [16]. The complexity of financial networks, marked by interconnectedness and risk amplification potential, complicates predictions of systemic failures [17]. The misconception that risk transfer mechanisms, such as credit default swaps (CDS), can mitigate systemic risk is evident from the failures observed during the 2008 financial crisis [18].

Calculating default probabilities and interbank trading data is mathematically complex and challenged by data limitations [12]. Methods like CoVaR, CoES, and MES evaluate risks in isolation, failing to

capture interdependence among entities, potentially underestimating systemic risk during financial stress [11]. Furthermore, processes intended to stabilize the system, such as market integration and diversification, can paradoxically induce systemic instability, highlighting the shortcomings of traditional measures [19].

The Debt-Solvency Rank, which integrates credit and liquidity shock dynamics to quantify potential loss amplification in interbank markets, exemplifies the need for advanced approaches [20]. The effectiveness of financial instruments like Contingent Convertible Bonds (CoCos) as stability mechanisms depends on interbank network structure, which can sometimes exacerbate financial fragility [21]. These limitations underscore the necessity for innovative methodologies that accurately capture the dynamic interdependencies and evolving nature of financial networks. Traditional measures often struggle to account for systemic risk associated with interconnected banks, particularly during crises, highlighting the need for advanced statistical models that incorporate economic conditions and regime shifts [8].

As illustrated in Figure 3, the limitations of traditional risk measures and the challenges in assessing systemic risk are evident, emphasizing the need for advanced approaches to accurately capture financial network dynamics.
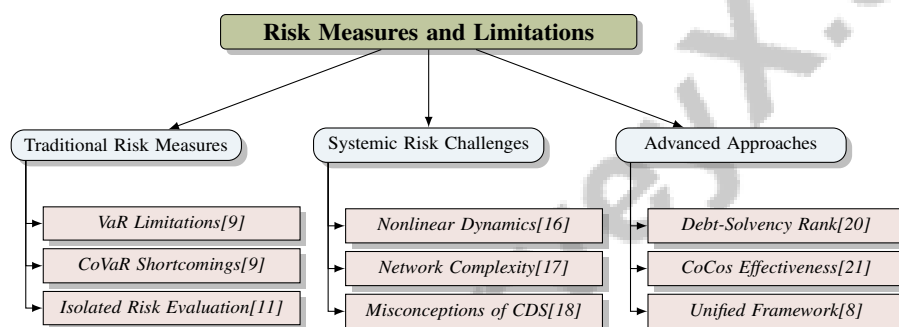

Figure 3: This figure illustrates the limitations of traditional risk measures and the challenges in assessing systemic risk, highlighting the need for advanced approaches to accurately capture financial network dynamics.

3.2 Advanced Systemic Risk Measures

Recent advancements in systemic risk quantification have significantly enhanced the understanding and management of systemic threats within financial networks. These innovative methodologies improve traditional risk measures by integrating complex dynamics and interdependencies, providing a more comprehensive analysis of systemic risk. Advances like the Individual Conditional Expectile (ICE) and Systemic Individual Conditional Expectile (SICE) enable more accurate risk assessments associated with extreme events through second-order asymptotic methods. Tensorial multilayer networks facilitate systemic risk evaluation by capturing multiple types of interbank exposures, while models assessing leverage and diversification impacts reveal optimal strategies for mitigating systemic risk under varying market conditions. Collectively, these methodologies contribute to a nuanced understanding of systemic risk, crucial for effective macroprudential regulation [11, 22, 23, 24, 25].

The Unified Marshall-Walras Equilibrium (UMWE) model enhances predictive capabilities by integrating various economic phases, providing a holistic view of systemic risk and capturing economic fluctuations affecting financial stability [8].

The DebtRank method assesses systemic risk by determining the maximum external shock a financial system can absorb without defaults, offering a critical framework for understanding financial system resilience [12]. Its application across banks and firms underscores its utility in quantifying systemic importance.

The Cascading Failure Model (CFM) quantifies systemic risk by simulating risk contagion through asset value changes, highlighting contagion dynamics within interconnected systems [4]. This model provides insights into potential cascading failures and their implications for systemic stability.

The extension of the asset network systemic risk model (ANWSER) to analyze credit default swaps (CDS) effects on financial contagion challenges traditional assumptions about risk mitigation, suggesting risk transfer does not necessarily yield a more resilient banking system [18]. This underscores the complex role of financial instruments in systemic risk dynamics.

The Elliptical Conditional Multivariate Probabilities (ECMP) method employs multivariate elliptical distributions to estimate conditional probabilities, enhancing systemic risk quantification and stress propagation modeling [7]. This approach improves modeling interdependencies and potential contagion pathways within financial networks.

Incorporating multiple risk sources and their interrelations into a comprehensive systemic risk indicator marks a significant advancement over previous methods, facilitating a more detailed understanding of systemic risk [11]. This innovation highlights the importance of considering diverse risk factors in systemic risk assessments.

The advanced methodologies discussed significantly improve systemic risk quantification by incorporating factors like excessive leverage and portfolio diversification. These methodologies enable financial institutions and regulators to better understand correlations between individual default probabilities and their impact on systemic risk, facilitating the development of more effective risk mitigation strategies. By employing integrated approaches that analyze various interbank exposures and innovative modeling techniques, these methodologies empower stakeholders to enhance financial systems' resilience and effectively respond to financial innovation complexities and market conditions [11, 22].

4 Contagion Networks and Systemic Contagion

4.1 Contagion Networks: Structure and Dynamics

Contagion networks are crucial for understanding the spread of financial distress across interconnected systems, highlighting the complex interdependencies among financial institutions. Their structural and dynamic properties significantly affect systemic risk, necessitating detailed analysis. Research distinguishes between static and multiplex financial networks to elucidate contagion behaviors [17]. Studies on co-crashes reveal structural changes involving asset interrelations, underscoring their importance in contagion dynamics [16].

As illustrated in Figure 4, the hierarchical structure of contagion networks is depicted, focusing on various network types, modeling approaches, and contagion dynamics as discussed in recent research. This figure categorizes static and multiplex networks, highlights dynamic and stochastic modeling techniques, and emphasizes the significance of default cascades and stress testing in understanding systemic risk.

Dynamic and stochastic models that incorporate banks' interconnections and solvency probabilities offer a comprehensive view of contagion networks, emphasizing the need to consider both current conditions and future potentialities in systemic risk assessments [9]. The analysis of bipartite banking networks, consisting of banks and their assets, highlights the role of interconnected holdings in spreading financial distress [4]. Furthermore, reconstructed financial liability networks demonstrate the extensive reach of contagion across financial systems [12].

Exploring default cascades through contagion networks emphasizes pathways of financial distress propagation [6]. Methods capturing conditioning effects on multivariate distributions enhance systemic risk modeling and mitigation strategies [7]. Simulations of stylized banking systems, calibrated to reflect asset and liability distributions, provide practical evaluations of systemic losses and counterparty risk, revealing potential cascading failures and the importance of robust modeling techniques in crisis prediction [5].

The integration of advanced methodologies, including quantitative analyses of credit default swaps and qualitative financial discourse assessments, highlights the complexity of systemic risk, which is not merely a product of isolated bank failures but is deeply intertwined with broader economic conditions and interconnections. Structured factor copulas illustrate that distress probabilities among banks are influenced by regional and global factors, while tensor decomposition methods elucidate foreign exposures' contribution to contagion risk. Understanding these dynamics is crucial for developing regulatory frameworks that enhance financial stability [26, 15, 27, 28]. By analyzing

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these networks, policymakers and financial institutions can better anticipate systemic threats and bolster financial systems' resilience.
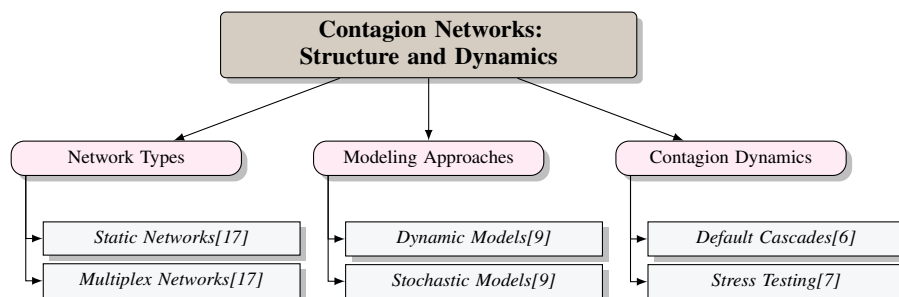

Figure 4: This figure illustrates the hierarchical structure of contagion networks, focusing on network types, modeling approaches, and contagion dynamics, as discussed in recent research. It categorizes static and multiplex networks, highlights dynamic and stochastic modeling techniques, and emphasizes default cascades and stress testing in understanding systemic risk.

4.2 Systemic Contagion: Processes and Implications

Systemic contagion describes the propagation of financial distress through a network, potentially leading to widespread economic instability. This phenomenon arises from the interconnectedness of financial institutions and markets, where the failure of one component can trigger a cascade of failures. Network theory provides a framework for understanding shock propagation through financial systems [29].

A key mechanism of systemic contagion is shock amplification through interbank lending and borrowing. Distress in one institution can impair its ability to meet obligations, creating a ripple effect among counterparties. This amplification is pronounced in tightly knit networks, where high interdependence allows localized shocks to escalate into systemic crises [29]. Integrating network theory with credit risk models, such as the PD model, offers a comprehensive analysis of these dynamics, revealing how systemic risk can emerge from localized shocks [29].

Systemic contagion has significant implications, leading to disruptions in financial markets and the broader economy. Positive correlations between crude oil and stock markets indicate that shocks in one market can transmit to others, potentially causing coordinated declines in asset values [30]. However, these correlations may weaken over time, suggesting variability in contagion effects with market conditions [30].

Market participant behavior influences systemic contagion. While cooperation among financial agents can mitigate individual risks, it may inadvertently increase systemic risk by fostering conditions for synchronized failures, especially in high-interaction environments [31]. This complexity underscores the need for regulatory frameworks that consider these dynamics.

Understanding systemic contagion processes and implications is essential for formulating effective risk management strategies and regulatory policies. By analyzing complex interconnections within financial networks and mechanisms leading to cascading failures, policymakers can devise targeted strategies, such as a Systemic Risk Tax (SRT), to mitigate systemic risks. This proactive approach enables anticipation of threats and enhances financial systems' resilience, ensuring they can withstand crises without compromising transaction volumes. Recognizing the multi-layered nature of systemic risk allows more accurate vulnerability assessments, leading to regulatory measures that balance interconnectedness benefits with safeguarding financial stability [32, 14, 33, 34, 35].
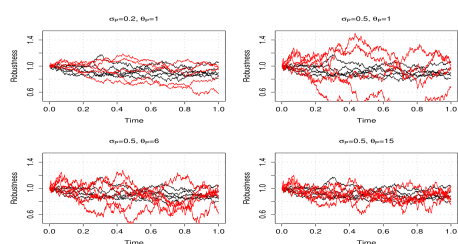
4.3 Mechanisms of Systemic Contagion

Systemic contagion mechanisms are fundamentally linked to the structural and dynamic properties of financial networks, where financial distress propagation is shaped by interconnectedness and strategic behaviors of institutions. The dynamic contagion mechanism proposed by [36] offers a robust framework for modeling defaults in a network, emphasizing continuous interactions and capital

adequacy's critical role in mitigating systemic contagion. Institutions with inadequate capital buffers are more susceptible to default, amplifying distress spread.

Small shocks can escalate into significant cascades within the network, akin to the basic reproduction number in epidemic modeling, where a cascade condition defines contagion proliferation potential [6]. This phenomenon underscores the importance of network topology and interconnection distribution in determining financial systems' resilience to systemic shocks.

Eigenvalue analysis in financial networks provides valuable insights into systemic contagion dynamics. The largest eigenvalue reflects common market effects, while others elucidate clustering and state partitioning within the network [37]. This spectral analysis is crucial for identifying vulnerabilities and understanding distress propagation pathways.

Incorporating these insights into systemic risk models fosters a nuanced understanding of contagion dynamics, enabling better anticipation and mitigation of systemic threats by policymakers and financial institutions. These models highlight how interconnectedness amplifies systemic risks, particularly during economic downturns, and suggest implementing structural firewalls between financial services to mitigate risks while promoting economic growth. Effective interbank credit coordination is vital for maintaining financial stability, as disruptions can trigger systemic crises. Ultimately, these insights deepen the understanding of factors that safeguard economic stability amidst complex market dynamics [19, 2, 38].

(a) Robustness of a model with varying parameter values[39]

(b) The image is a table of contents for a research paper or book chapter.[40]

Figure 5: Examples of Mechanisms of Systemic Contagion

As shown in Figure 5, the example on "Contagion Networks and Systemic Contagion; Mechanisms of Systemic Contagion" provides a comprehensive insight into the dynamics and structural aspects of systemic contagion through illustrative figures. The first figure highlights the robustness of a model under varying parameter values, showcasing four subplots that track the model's stability over time. This visualization employs a range of colors, notably red and black, to differentiate between parameter settings, with the robustness of the system measured on a scale from 0 to 1 along the y-axis. Such a depiction underscores the model's resilience or vulnerability in response to parameter adjustments. Complementing this is a table of contents from a research paper or book chapter, which outlines the structured exploration of systemic contagion mechanisms. It begins with an examination of default contagion on a weighted, directed random graph and concludes with a section dedicated to proofs, providing a clear roadmap for readers to navigate the intricate discussions and analyses contained within the document. Together, these elements offer a detailed framework for understanding the interplay of factors that contribute to systemic contagion in financial and networked systems [39, 40].

4.4   Challenges in Measuring Contagion Risk

Quantifying contagion risk within financial networks presents numerous challenges due to complex interdependencies and dynamic interactions among institutions. A major hurdle is integrating market data with bilateral exposure data, often resulting in incomplete assessments of banks' risk profiles [27]. This integration is crucial for accurately capturing contagion pathways and understanding systemic risk propagation.

Many models rely on discretization and assumptions of node independence, which may not fully reflect real-world financial networks' complexities [41]. These models often focus on interbank exposures and may overlook other contagion channels, indicating challenges in accurately measuring contagion risk [19]. Additionally, failing to account for conditional payments required by insurance or

credit default swap (CDS) contracts can lead to ill-defined clearing solutions, complicating accurate modeling of contagion dynamics [10].

Interconnected exposures in financial networks can lead to systemic risk if not effectively managed [1]. The intricate web of financial relationships and potential for cascading failures necessitate sophisticated models that can accurately capture these interdependencies. However, many methodologies struggle to address these complexities, often resulting in underestimation of systemic risk.

Challenges in assessing contagion risk underscore the need for advanced analytical techniques and models that integrate diverse data sources, accurately capture complex interdependencies, and provide a nuanced evaluation of systemic risk. Recent advancements in text-to-network analysis, tensor decomposition methods, and multi-layer network frameworks enable a deeper understanding of bank interrelations and implications for financial stability, particularly in the context of heightened global interconnectedness [27, 15, 11, 42]. Addressing these limitations will enhance financial institutions' and regulators' ability to anticipate and mitigate systemic threats, improving financial systems' resilience.

5 Spillover Networks and Cross-Sector Transmission

5.1 Detection of Spillover Effects and Financial Contagion

Detecting spillover effects is essential for understanding financial contagion, revealing how shocks in one sector can destabilize the entire system. The Network Momentum approach leverages a graph learning model to infer asset relationships based on momentum features, enhancing spillover detection across asset classes [43]. This method underscores the significance of dynamic interdependencies among financial assets, offering insights into momentum-driven spillover effects.

Figure 6 illustrates the key methodologies and insights in detecting spillover effects and financial contagion, highlighting Network Momentum, Causal-NECO VaR, and the role of global market interconnectedness. By integrating machine learning with financial network analysis, Network Momentum identifies latent connections and directional spillovers often overlooked by traditional models. It not only improves spillover detection but also provides predictive insights into potential contagion pathways. The Causal Network Contagion Value at Risk (Causal-NECO VaR) exemplifies this capability, capturing directional influences and volatility effects among assets, aiding financial institutions in navigating market turbulence [44, 43].

The interconnectedness of global financial markets amplifies spillover effects, as demonstrated during the COVID-19 pandemic when lockdowns triggered contagion among 51 major stock markets, exposing systemic vulnerabilities. The dynamics of credit contagion, particularly via instruments like credit default swaps, illustrate how defaults cluster and propagate, leading to instability during economic stress. These insights highlight the need for improved regulatory frameworks to manage contagion complexities in today's interconnected financial landscape [45, 46, 28]. Advanced methodologies like Network Momentum represent significant advancements, offering tools to capture the intricate web of relationships underpinning financial contagion and systemic risk.

5.2 Sector-Specific Shock Transmission

The transmission of shocks across sectors is crucial for systemic risk analysis, revealing how interconnected financial systems propagate distress beyond initial impact points. Sector-specific shock transmission is influenced by intricate interconnections among financial institutions, markets, and sectors; distress in one entity can trigger cascading adverse effects across the system. For example, supply chain shocks can lead to substantial financial losses, as firm failures within a network propagate risks and amplify expected losses for banks. The financial sector often acts as a critical link between otherwise loosely connected economic sectors, exacerbating systemic risk during downturns [2, 47, 48, 15, 49]. Network analysis models these interconnections, providing insights into how shocks cascade through systems, potentially leading to crises.

Credit and liquidity channels serve as primary mechanisms for sector-specific shock transmission, where interdependent institutions amplify shock effects. Integrating network theory with credit risk models, such as the PD model, allows comprehensive analysis of these dynamics, highlighting sys-
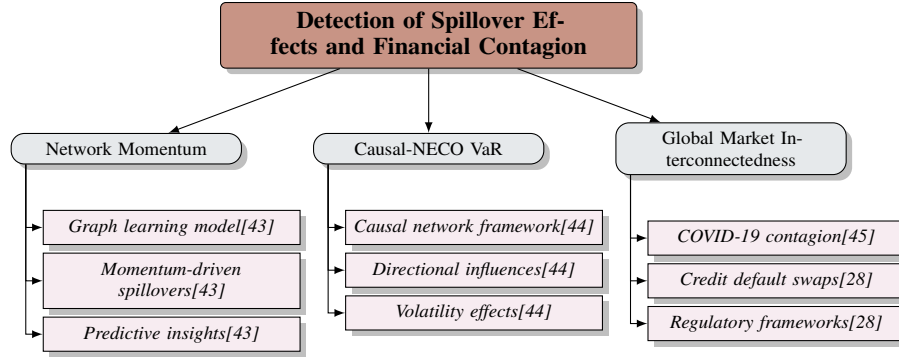
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Figure 6: This figure illustrates the key methodologies and insights in detecting spillover effects and financial contagion, highlighting Network Momentum, Causal-NECO VaR, and the role of global market interconnectedness.

temic risk potential from localized shocks [29]. Overlapping portfolios and indirect interconnections complicate shock transmission [12].

The implications of sector-specific shock transmission for financial stability are profound, as these shocks disrupt markets and the broader economy. Positive correlations between the crude oil market and stock markets illustrate how shocks in one market impact others, potentially causing coordinated asset value declines [30]. However, these correlations may weaken over time, indicating contagion effects vary with market conditions [30].

Market participant behavior significantly influences shock transmission across sectors. While co-operation among agents can reduce individual risks, it may paradoxically increase systemic risk by fostering synchronized failures, particularly in high-interaction regimes [31]. This complex interplay underscores the need for regulatory frameworks that account for these dynamics.

Understanding sector-specific shock transmission is essential for effective risk management strategies and regulatory policies, as demonstrated by systemic risks highlighted in crises like the Great Financial Crisis of 2007-2008. Recognizing potential contagion pathways among seemingly unrelated sectors and developing robust predictive methodologies, such as Causal-NECO VaR, is critical for assessing risks during volatile market conditions. Acknowledging unequal exposure to economic shocks across global supply networks emphasizes the importance of tailored regulatory frameworks addressing disparities in systemic risk, particularly affecting poorer nations. A comprehensive grasp of these dynamics is vital for enhancing financial stability and mitigating future crises [47, 44, 48, 50]. By capturing the intricate dynamics of financial networks and potential cascading failures, policymakers and institutions can better anticipate and mitigate systemic threats, enhancing resilience against potential crises.

5.3 Momentum Spillover Across Asset Classes

Momentum spillovers across asset classes significantly shape financial market dynamics, influencing risk and return profiles. The study by [43] analyzes these spillovers across commodities, equities, fixed income, and foreign currencies, emphasizing the interconnectedness of asset classes where momentum-driven relationships serve as shock transmission channels, affecting market stability.

In commodities, momentum spillovers lead to synchronized price movements, impacting hedging strategies and risk management. Equities, sensitive to market sentiment, exhibit pronounced momentum effects that propagate to other asset classes, amplifying volatility. Fixed income markets, while stable, are susceptible to investor behavior shifts due to spillovers from interest rate expectations; this interconnectedness highlights systemic risk potential, as financial news cohesiveness and herding behavior exacerbate volatility and instability [51, 52, 48, 53, 54]. Foreign currencies, influenced by global conditions and geopolitical events, exhibit momentum spillovers affecting exchange rates and cross-border capital flows.

Integrating network analysis with momentum features enhances understanding of these spillovers by capturing latent connections among asset classes. This approach provides critical insights into

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momentum spillover mechanisms, revealing how momentum-driven dynamics propagate risk and influence systemic stability. Analyzing interconnections among 64 continuous future contracts highlights potential contagion pathways, enhancing understanding of systemic risk in financial markets and informing strategies to mitigate future crises [43, 48]. Identifying these interdependencies allows market participants and regulators to develop effective strategies to mitigate risks associated with momentum spillovers, contributing to market stability and resilience.

5.4 Credit Default Swaps and Cross-Sector Transmission

Credit Default Swaps (CDS) play a pivotal role in cross-sector shock transmission, creating contagion channels that amplify systemic risk within financial markets. The study by [28] highlights CDS's dual nature as risk management tools and potential systemic instability sources. While designed to protect against credit events, their widespread use and interconnectedness can lead to unintended consequences during financial distress.

The interconnected nature of CDS markets means a credit event in one sector can quickly propagate to others as participants adjust positions in response to changing risk perceptions. This interconnectedness is further complicated by overlapping counterparty exposures, where one entity's failure triggers cascading defaults across sectors. Contagion potential is intensified by CDS market opacity, complicating systemic risk assessment; this lack of transparency obscures how interconnected institutions might amplify crises, evidenced by clustering defaults during stress and destabilizing CDS effects on the network, particularly when banks use them to expand loan portfolios [55, 51, 56, 48, 28].

Moreover, using CDS as speculative instruments can increase market volatility and contribute to shock transmission across sectors. Speculators may engage in CDS trading to profit from anticipated credit events, leading to increased trading volumes and price fluctuations that spill over into other markets. This behavior can exacerbate systemic risk by establishing feedback loops, where participants' actions—driven by adaptive risk expectations—intensify vulnerabilities they aim to mitigate. Portfolio adjustments based on perceived risks can lead to chaotic dynamics, including leverage cycles and systemic instability. Excessive leverage and correlations from overlapping portfolios may further amplify these risks, especially during financial turmoil, resulting in cascading effects threatening the entire system's stability [57, 53, 48, 22].

The influence of CDS on cross-sector shock transmission highlights the urgent need for comprehensive regulatory frameworks addressing complexities and systemic risks associated with these instruments. Recent analyses indicate CDS can create additional contagion channels, potentially increasing instability in interconnected networks during stress. As demonstrated by recent banking crises, intricate financial institution relationships necessitate an evolved regulatory approach incorporating dynamic risk assessment methodologies and considering systematic and idiosyncratic factors to mitigate cascading failures and enhance stability [11, 28, 48, 58, 26]. By enhancing transparency and improving risk management practices, regulators and participants can mitigate CDS's potential to contribute to systemic instability, ultimately enhancing market resilience.

6 Network Analysis in Financial Stability

Category	Feature	Method
Network-Based Risk Assessment Techniques	Temporal and Frequency Analysis	FDCM[59]
	Probabilistic Risk Estimation	ECMP[7]
Advanced Analytical Frameworks for Spillover Analysis	Adaptive Modeling	RRT[60]
Emerging Methodologies in Systemic Risk Quantification	Network Analysis	CFM[4], ANWSER[18]

Table 1: This table provides a summary of various methodologies utilized in systemic risk assessment within financial networks. It categorizes these methods into network-based risk assessment techniques, advanced analytical frameworks for spillover analysis, and emerging methodologies in systemic risk quantification, highlighting their specific features and corresponding references.

Understanding the intricate relationships and dependencies among institutions is crucial for financial stability. This section explores network analysis, emphasizing how the structural characteristics of financial networks influence systemic risk. Table 1 presents a comprehensive overview of the diverse methodologies employed in the analysis of systemic risk within financial networks, illustrating the range of techniques and their applications in understanding financial stability. Additionally, Table

2 presents a comprehensive comparison of methodologies used in network analysis for systemic risk assessment, illustrating the significance of network topology, risk assessment techniques, and analytical frameworks in understanding financial stability. By examining network topology, insights into the pathways of financial distress propagation are gained, setting the stage for comprehensive risk assessment techniques and their implications for financial stability. The following subsection focuses on the impact of network topology on systemic risk, elucidating how these structural features contribute to the resilience or vulnerability of financial systems.

6.1 Impact of Network Topology on Systemic Risk

The topology of financial networks critically affects systemic risk by influencing how distress spreads among interconnected institutions. Structural characteristics, such as interconnectedness and emergent properties, define the resilience of financial systems to shocks, with certain configurations amplifying risks. Understanding these structures is vital for effective risk management [6].

Large banks, due to their size and trading behavior, play a dual role in stabilizing or exacerbating systemic risk, particularly during defaults. Monitoring systemic stocks and comprehending network topology are essential for managing contagion during market disruptions. The interconnected nature of financial institutions often results in feedback loops and dynamic interactions, as demonstrated by models incorporating stochastic volatility terms that capture the dynamic nature of financial interactions and distress propagation [5].

Liquidity issues, especially during high credit risk periods, heighten systemic risk, as analyses of credit and funding shocks reveal vulnerabilities in the financial system. The structure and dynamics of interbank loans and risk transfer patterns illustrate the critical role of network topology in systemic risk assessment. Simulating various network structures provides insights into how changes in topology impact systemic risk [1].

A framework accommodating various structural characteristics, including (dis)assortativity, offers a robust tool for assessing systemic risk in financial networks. This framework enables a comprehensive evaluation of how network structures affect financial distress propagation and overall system resilience [6].

The influence of network topology on systemic risk is profound, shaping mechanisms of distress propagation and determining system resilience. Recent studies indicate that topological characteristics, such as degree centrality and local sub-network environments, enhance understanding of systemic vulnerability among financial entities. A two-step analytical approach, assessing both global and community-level topological metrics, improves identification of institutions at risk during crises. The interplay of direct externalities and feedback effects within financial networks highlights the complexity of systemic risk, necessitating careful regulatory strategies to balance interconnectedness benefits against potential financial instability [13, 14]. By leveraging insights from network theory and advanced analytical techniques, financial institutions and regulators can better anticipate and mitigate systemic threats, ultimately safeguarding economic stability.

6.2 Network-Based Risk Assessment Techniques

Advanced network-based risk assessment techniques are essential for understanding and mitigating systemic risk in financial systems, enabling analysis of intricate interdependencies and dynamic interactions among institutions. By modeling these institutions as complex networks of claims and obligations, these techniques address the limitations of traditional equilibrium-based approaches and statistical forecasting methods. They incorporate contagion effects and default correlations, facilitating a comprehensive evaluation of potential losses and identification of vulnerabilities within the financial ecosystem, as demonstrated in studies applying these models to real-world scenarios like the network of European Global Systemically Important Banks [34, 29].

The method defined by [59] introduces connectedness in the frequency domain, assessing the shares of forecast error variance attributed to shocks in other variables at specified frequency bands. This enhances understanding of systemic risk by identifying frequency-specific interactions within financial networks, offering a nuanced perspective on risk propagation across different time horizons.

The copula-DCC-GARCH model, combined with statistical clustering methods as described by [61], innovatively identifies market regimes and assesses systemic risk without predefining the number

of regimes. This model captures dynamic dependencies among financial institutions, allowing for flexible and accurate systemic risk assessments across varying market conditions.

Evaluating different systemic risk metrics, including CoVaR and MES, by [62] provides insights into the effectiveness of CoD measures in capturing systemic risk. By comparing these metrics, the study emphasizes the importance of selecting appropriate measures that reflect the underlying dynamics and interdependencies within financial networks.

The multidimensional approach proposed by [7] captures interactions between multiple variables rather than limiting analysis to pairs, enhancing the ability to model complex interdependencies and potential contagion pathways for a more detailed assessment of systemic risk.

The advanced network-based risk assessment techniques presented in these studies provide innovative frameworks for understanding complex interdependencies within financial networks, highlighting the significance of bank interrelations and the systemic risks they pose. Methodologies integrating textual analysis of financial discourse, constructing complex risk networks in Internet Finance, and employing dynamic models to quantify contagion effects among interconnected institutions further enhance these assessments [15, 63, 29]. By leveraging these methodologies, financial institutions and regulators can improve their ability to anticipate and mitigate systemic threats, contributing to the stability and resilience of global financial markets.

6.3 Advanced Analytical Frameworks for Spillover Analysis

Sophisticated frameworks for analyzing spillover effects in financial networks are vital for understanding the complexity and dynamics of systemic risk. These frameworks elucidate how financial distress propagates through interconnected systems, emphasizing the identification of Systemically Important Financial Institutions (SIFIs) and their roles within the network. The approach proposed by [60] offers a dynamic and robust framework for identifying SIFIs, enhancing understanding of systemic risk within interconnected financial networks. This methodology underscores the need for adaptive models that capture the evolving nature of financial systems and potential systemic threats.

The exploration of multichannel contagion versus stabilization provides further insights into systemic risk dynamics. Findings by [54] confirm that multichannel contagion significantly contributes to systemic fragility, while multichannel stabilization enhances systemic resilience compared to single-channel approaches. This distinction highlights the importance of considering multiple pathways and mechanisms through which financial shocks spread, allowing for a comprehensive assessment of systemic risk.

Advanced analytical frameworks are crucial for developing robust risk management strategies and regulatory policies that effectively mitigate spillover effects in financial networks, particularly by modeling systemic risks associated with excessive leverage and asset liquidation strategies. These frameworks incorporate insights from recent studies on the correlation of default probabilities among financial institutions and the role of portfolio diversification in reducing systemic risk, thereby providing a comprehensive understanding of how leverage requirements impact equilibrium liquidation strategies and overall financial stability [64, 22]. By leveraging these sophisticated methodologies, financial institutions and regulators can better anticipate and manage systemic threats, ultimately contributing to the stability and resilience of global financial markets.

6.4 Emerging Methodologies in Systemic Risk Quantification

Recent advancements in systemic risk quantification have introduced innovative frameworks that significantly enhance the accuracy and comprehensiveness of risk assessments through network analysis. The concept of 'pathways towards instability' highlights the potential for network size and contract proliferation to destabilize financial systems, underscoring the importance of understanding network dynamics in systemic risk quantification [19]. This emphasizes the necessity for a network-centric approach in financial regulation and risk management, advocating for methodologies that leverage network analysis to quantify systemic risk [17].

The Joint Marginal Expected Shortfall (JMES) introduces a sophisticated methodology for quantifying systemic risk by evaluating the joint marginal impacts of two interrelated risks across varying stress scenarios. This approach enhances understanding of risk contagion and spillover effects—key factors in financial crises—while outperforming traditional risk measures like CoVaR, CoES, and MES

by offering a more nuanced assessment of how the risk exposure of one entity can exacerbate the overall risk profile of another or the system as a whole, particularly under distress conditions. Additionally, the JMES framework includes systemic risk contribution measures, enhancing its practical application in analyzing risk contagion among stock market indices [23, 65, 66]. This methodology captures complex interdependencies and stress scenarios within financial networks, offering a nuanced perspective on systemic risk.

The proposed model by [9] provides insights into how future defaults can affect current bank stability, suggesting new methodologies in quantifying systemic risk through network analysis. This model emphasizes the critical role of future interactions in shaping current systemic risk profiles, providing a framework for assessing the dynamic nature of financial networks.

The extension of the ANWSER model quantitatively assesses the systemic capital buffer ratio and its relationship with interbank networks, as highlighted by [18]. This innovation underscores the importance of considering the interconnectedness of financial institutions and their capital buffers in systemic risk assessments.

Future research directions, as suggested by [4], could refine the Cascading Failure Model (CFM) to incorporate additional factors influencing bank stability, crucial for enhancing systemic risk quantification. This approach provides a foundation for developing more robust models that capture the intricate dynamics of financial networks.

The DebtRank methodology allows for a recursive assessment of systemic importance, providing insights into financial stability [12]. This emphasizes the need for continuous evaluation of systemic importance, facilitating more effective risk management strategies.

An integrated approach to systemic risk evaluation, as concluded by [11], is essential for effective regulation. This emphasizes the need for comprehensive data and innovative modeling techniques to enhance systemic risk assessments.

Future research could explore the inclusion of partial recovery models and stochastic elements in the framework to enhance realism and applicability in systemic risk quantification, as suggested by [6]. This would provide a more accurate representation of real-world financial systems, improving the effectiveness of systemic risk management.

The emerging methodologies for quantifying systemic risk mark a significant evolution in our approach to understanding and managing financial stability. These innovative tools and frameworks address the complexities of financial interconnections, particularly through advanced modeling techniques like tensorial multilayer networks and bipartite representations of financial systems. By integrating various sources of risk, including overlapping portfolios and indirect interconnections among financial institutions, these methodologies offer a comprehensive view of systemic risk dynamics. This holistic perspective not only enhances our ability to evaluate potential contagion effects but also informs regulatory practices aimed at mitigating the extensive costs associated with systemic crises. As the academic literature on systemic risk expands, these advancements are crucial for developing effective regulatory frameworks that keep pace with financial innovation and complexity [11, 67, 22]. By leveraging these new approaches, financial institutions and regulators can better anticipate and mitigate systemic threats, ultimately contributing to the resilience of global financial markets.

Feature	Impact of Network Topology on Systemic Risk	Network-Based Risk Assessment Techniques	Advanced Analytical Frameworks for Spillover Analysis
Systemic Risk Focus	Distress Propagation	Interdependencies Modeling	Spillover Effects
Analytical Approach	Network Topology	Network-based Models	Multichannel Contagion
Key Features	Interconnectedness Feedback Loops	Contagion Effects	Sifi Identification

Table 2: This table provides a comparative analysis of various methodologies employed in network analysis to assess systemic risk in financial networks. It highlights the impact of network topology on systemic risk, the application of network-based risk assessment techniques, and the use of advanced analytical frameworks for spillover analysis. The table underscores the diverse approaches and their key features in understanding financial stability.

7 Case Studies and Applications

Interbank network simulations are pivotal in systemic risk assessment, offering insights into the intricate dynamics of financial systems. These simulations enable scenario exploration and evaluate intervention strategies, highlighting the interconnectedness of financial institutions. The following subsections delve into methodologies and findings from these simulations, emphasizing their role in systemic risk management.

7.1 Interbank Network Simulations

Interbank network simulations are crucial for assessing systemic risk through various scenarios and intervention strategies. Studies like [68] validate these simulations, revealing the effectiveness of regulatory measures. Simulations extend to digital assets, as shown by [69], illustrating systemic risks in both traditional and emerging financial systems, underscoring the need for adaptive risk management.

Numerical case studies, such as those by [50], demonstrate contagion processes under diverse configurations, highlighting the impact of network topology on financial stability. Algorithms like Furfine and DebtRank, employed by [70], model shock propagation, offering insights into risk transmission and potential cascading failures.

Datasets from Bankscope, utilized by [71], emphasize the global interconnectedness of banks and its implications for systemic risk. These analyses underscore the necessity of understanding global financial linkages to assess systemic vulnerabilities.

Interbank network simulations provide detailed insights into financial system dynamics, aiding policymakers and institutions in identifying and mitigating systemic risks. Advanced simulations and integrated modeling approaches enhance understanding of interconnected exposures, fostering global financial market resilience against crises [11, 72, 48, 22].

7.2 European Banking Sector Evaluations

Benchmark	Size	Domain	Task Format	Metric
NCI[51]	1,400,000	Finance	Cohesiveness Measurement	NCI, VIX
MST[73]	28	Insurance	Interconnectedness Analysis	APL, BC
MST-deltaCoVaR[74]	28	Finance	Systemic Risk Assessment	deltaCoVaR
COVID-FN[45]	1275	Financial Markets	Contagion Analysis	Dynamic Conditional Correlation, Centrality Measures

Table 3: This table presents a comprehensive summary of representative benchmarks used in systemic risk analysis within the financial sector. It includes details on benchmark size, domain, task format, and the metrics employed, highlighting their relevance in evaluating interconnectedness, cohesiveness, and contagion in financial systems.

Systemic risk in the European banking sector is closely tied to interbank connectivity. A study on 35 banks across 8 European countries by [75] highlights contagion dynamics during crises, emphasizing the role of interbank lending in amplifying systemic risk through overlapping portfolios [55]. Structural characteristics like connectivity and exposure distribution are critical determinants of systemic risk, necessitating regulatory measures to mitigate risks associated with high interbank connectivity. Table 3 provides a detailed overview of various benchmarks utilized in the assessment of systemic risk in the European banking sector, underscoring their significance in understanding interbank connectivity and contagion dynamics.

Future research should explore contagion dynamics across different systems and regulatory measures to alleviate risks [55]. Evaluating systemic risk in the European banking sector involves sophisticated modeling and empirical analyses to identify, assess, and mitigate systemic risks, enhancing the resilience of the financial system against potential crises. Integrating diverse risk factors and leveraging advanced analytics will be crucial for developing effective strategies to prevent cascading failures [11, 22, 72, 58, 50].

7.3 Empirical Studies on Financial Crises

Empirical studies reveal that network analysis is vital for understanding systemic risk propagation during financial crises. The structure and dynamics of financial networks significantly influence the spread and impact of systemic shocks. For instance, the interconnectedness of European insurers varies over time, indicating that systemic risk is more pronounced during market turbulence [73]. Positive correlations among insurers during crises highlight how interconnected networks amplify systemic risk [61].

Incorporating network analysis into systemic risk assessments and regulatory frameworks is essential. By analyzing complex interdependencies within networks, policymakers can devise effective strategies to mitigate risks associated with future crises. Understanding bank centrality, early-warning indicators, and structural vulnerabilities is crucial for enhancing financial system resilience [15, 76].

7.4 Cryptocurrency Market Analysis

Network analysis in cryptocurrency markets uncovers unique dynamics and vulnerabilities. Decentralization and high volatility pose distinct challenges for systemic risk assessment. Network analysis provides a holistic view of interrelationships among market participants, revealing contagion pathways and identifying key nodes in the financial ecosystem. Causal inference techniques help pinpoint contagion sources and evaluate diversification options, crucial for market stability [15, 46, 77].

The adaptability of network analysis, as shown by [10], is relevant in cryptocurrency markets, where traditional instruments are absent. This approach captures complex interdependencies and identifies nodes and connections that may serve as conduits for systemic risk.

Integrating network analysis in cryptocurrency markets offers a framework for understanding shock propagation dynamics. By identifying fragility sources, researchers can understand how interconnectedness contributes to volatility and crises, aiding in implementing strategies to enhance market resilience [14, 77, 78, 19, 46]. High interconnectedness and rapid transactions increase contagion likelihood, necessitating robust models to capture these dynamics. Network analysis provides insights into systemic risks, contributing to effective risk management and regulatory frameworks that enhance market resilience.

8 Conclusion

Network analysis is pivotal in understanding systemic risk, offering a comprehensive framework to evaluate financial stability and identify systemic threats. By elucidating the intricate interconnections among financial institutions, advanced methodologies optimize risk management across diverse markets. The integration of credit cycles into systemic risk models, such as the Unified Marshall-Walras Equilibrium (UMWE), underscores the importance of these tools for future research.

The findings reveal that medium-sized banks and firms can play critical roles in systemic risk, highlighting the need for further exploration of similar networks to refine risk assessments. Identifying Systemically Important Financial Institutions (SIFIs) through sophisticated methods enhances the accuracy of systemic risk evaluations, surpassing traditional measures.

Future research should enhance models to better capture complex interactions among banks and assess the impact of regulatory policies on systemic risk. Experiments with Joint Marginal Expected Shortfall (JMES) demonstrate its efficacy in capturing risk spillover effects, suggesting further development in predictive analytics. A regulatory framework that aligns financial incentives with systemic risk reduction is crucial, emphasizing the role of regulatory interventions in sustaining financial stability.

A unified approach to systemic risk assessment through network analysis supports more effective capital allocation and mitigates contagion, thereby strengthening financial stability. Future work should focus on improving data collection, expanding risk source considerations, and refining mathematical models for systemic risk evaluation. Additionally, research on stress testing multivariate systems highlights the importance of capturing stress propagation effects.

The ongoing advancement of network analysis methodologies offers significant potential for improving systemic risk management and enhancing financial system resilience. Proposed conditional

distortion risk measures provide a robust framework for systemic risk assessment, suggesting future research avenues to simplify their application. Leveraging these insights enables financial institutions and regulators to better anticipate and mitigate systemic threats, ultimately contributing to the resilience of global financial markets. While interbank lending can bolster stability, it poses a risk of systemic failure if it exceeds a critical threshold.

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