FROM CONTAGION TO CONTAINMENT: A REVIEW OF SYSTEMIC FINANCIAL RISK AND REGULATORY GOVERNANCE

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Abstract

In an era that is characterized by digitalization and climate-sensitivities, systemic financial risks have become increasingly complex. They threaten the stability of the global market, which is interconnected. This study aims to address a crucial gap in existing literature by reviewing historical and emerging mechanisms of risk propagation alongside other preventive tools. The study used the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) 2020 methodology to shortlist 46 peer-reviewed open-access articles published between 2021–2025. These articles were sourced from ScienceDirect and categorized into three thematic areas: historical propagation, emerging risks, and innovative prevention mechanisms. The review confirms that traditional drivers such as bank failures and interbank contagion remain relevant, as put forth by Andrieş et al. (2022). Additionally, it establishes that modern threats include disruptions caused by to big financial system, climate-transition-shocks, and crypto-financial instability (Crandall, 2025). Hence, technological interventions like artificial intelligence (AI)-based stress testing, blockchain-based transparency, and environmental, social, governance (ESG)-driven risk mitigations are reshaping the financial risk landscape. However, they face regulatory and governance barriers. Thus, the findings of this study primarily emphasize the need to globally harmonize policy frameworks that integrate sustainability, real-time monitoring, and digital innovation. This study entails an integrated, forward-looking synthesis for policymakers who seek resilient financial architectures in an era of technological transformation and environmental uncertainty.

Keywords: Systemic Financial Risk, Risk Propagation, FinTech, Blockchain, ESG, Financial Stability, Risk Management

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1. INTRODUCTION

Systemic financial risks have emerged as critical threats to financial stability amidst a global economy that is complex and interdependent. Systemic risk today is more relevant than in the past as the players in the economic system are now increasingly interconnected. The speed of flow of goods, money, and people is all increasing (Pacelli, 2024). These risks are primarily defined by their potential to trigger widespread disruptions across the financial systems. They not only arise from traditional sources such as bank failures and macroeconomic imbalances but also from newer phenomena such as financial technology (FinTech)-driven credit expansion, climate-related financial shocks, and cryptocurrency market volatility (Undheim et al., 2024; Meinerding et al., 2022; Jalan & Matkovskyy, 2023). In this context, the 2008 global financial crisis (GFC) demonstrated how the collapse of systemically important institutions can cascade

across national borders. The activities of large financial intermediaries produced contagion-like threats as credit derivatives peaked to about US $60 trillion in 2007 (Markose, 2012). More recently, the COVID-19 pandemic (Rizwan et al., 2020; Pacelli, 2024), the rise of decentralized financial (DeFi) institutions (Ali, 2024), and climate-based stress events (Reinders et al., 2025) have exposed fresh vulnerabilities in the architecture of modern financial systems. Although existing literature has examined various dimensions of systemic risk, there is limited research that integrates historical propagation channels, emerging digital-era risks, and the evolving toolkit of mitigation strategies within a unified analytical framework. Past studies focus predominantly on institutional reforms and do not account for recent developments in blockchain transparency mechanisms, green FinTech, or environmental, social, governance (ESG)-related fragilities. Therefore, this study aims to fill the corresponding gap in the literature by offering a comprehensive systematic literature review (SLR) of peer-reviewed articles that were published between 2021 and 2025. For this purpose, the study resorts to Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) to ensure transparency and replicability. This study bridges legacy insights with contemporary challenges. Overall, it contributes to a more integrated understanding of how systemic financial risks propagate and how institutions can better prepare for them in the age of digital finance and climate uncertainty. The paper addresses the following research questions:

RQ1: What are the primary historical and emerging mechanisms driving systemic financial risk propagation?

RQ2: How have prevention mechanisms evolved over time, and what are their strengths and limitations?

RQ3: What role do emerging technologies and ESG frameworks play in systemic risk prevention?

To answer these questions, the paper has been organized into 6 sections. Section 2 provides the literature review that distinguishes between historical and emerging risk drivers. It identifies the innovative prevention mechanisms that help mitigate the risks. Additionally, Section 3 explains the methodology. It outlines the PRISMA-based study selection and categorization criteria. Section 4 presents the findings. It categorizes 46 high-quality studies into historical propagation mechanisms, emerging risks, and innovative preventive tools. This is followed by Section 5 that discusses how these findings inform existing regulatory frameworks and identifies areas for future research. The final Section 6 concludes and reflects on the implications for global financial governance and policy design.

2. LITERATURE REVIEW

2.1. Historical context of systemic risk propagation

In the past, the propagation of systemic risk has been associated with liquidity crises, credit market shocks, and bank failures. The analysis of interbank network features has highlighted the role of large financial firms as global nodes in a financial contagion (Cuba et al., 2021). As an illustrative example, the participation of systemically important banks (SIBs) in shock transmission has been examined in detail, with results showing an amplifying role played by network interdependencies in crises undercapitalized conditions (Andrieş et al., 2022). Another important dimension of risk propagation through history is macroeconomic and credit market cycles. Activity on start-up credit black markets and its structural shock effects on business investment, finance, and asset stability (Zabavnik & Verbič, 2024). Likewise, financial contagion modeling studies reveal that global crises worsen risk spillover across financial markets (Rigana et al., 2023). Moreover, studies show that widespread digital transformation, such as real-time payment systems and online banking expansion, can significantly reduce overall bank systemic risks (He et al., 2025). The efficiency of bank liquidity creation also serves as a counterbalance to systemic vulnerability during macro-shocks (Tan et al., 2024). Various stress-testing mechanisms are available to monitor these risks, although the reliability of such assessments is often limited by data sparsity and behavioral market uncertainty (Tabachová et al., 2024). However, a recent systematic review underscores how digital finance innovation poses new contagion pathways despite being valuable for monitoring risks (Liu et al., 2025). This is particularly apparent when regulatory oversight is inadequate.

2.2. Emerging risks in modern financial systems

FinTech and digital financial systems have recorded an increased influence on systemic risks. Credit expansion driven by FinTech has introduced opportunities as well as vulnerabilities. There exists a positive correlation between the adoption of FinTech and systemic risk spillover across banking systems, which in turn highlights channels like cyber threat and operational dependence (Petrík, 2023). Researchers have thus underscored the threats to cybersecurity, regulatory arbitrage, and operational inefficiencies as primary concerns (Koranteng & You, 2024). Moreover, Cuadros-Solas et al. (2024) suggest that consumer lending, which has been facilitated by FinTech platforms, can destabilize financial markets in case they are not properly regulated. Institutional analysis in 2023 emphasized the need for international supervisory cooperation (Silva-Buston et al., 2025). This would help manage cross-border FinTech risks more effectively. Furthermore, climate-related financial risks have also emerged as significant systemic threats. Carè et al. (2024) explore how central banks incorporate climate risk stress testing into financial stability assessments. They have emphasized the gaps in regulatory frameworks. Additionally, Le et al. (2023) have also provided evidence regarding climate transition risks and how they affect bank liquidity alongside the stability of credit. This is particularly true across emerging markets. However, Lee et al. (2022) found that climate risk entails a negative correlation with the creation of liquidity across international banking contexts. Furthermore, both physical and transitional climate risks significantly impair the lending growth of banks alongside their profitability (Chalabi-Jabado & Ziane, 2024). Thus, without regulatory adaptation, such risks may perhaps worsen the financial vulnerabilities over time.

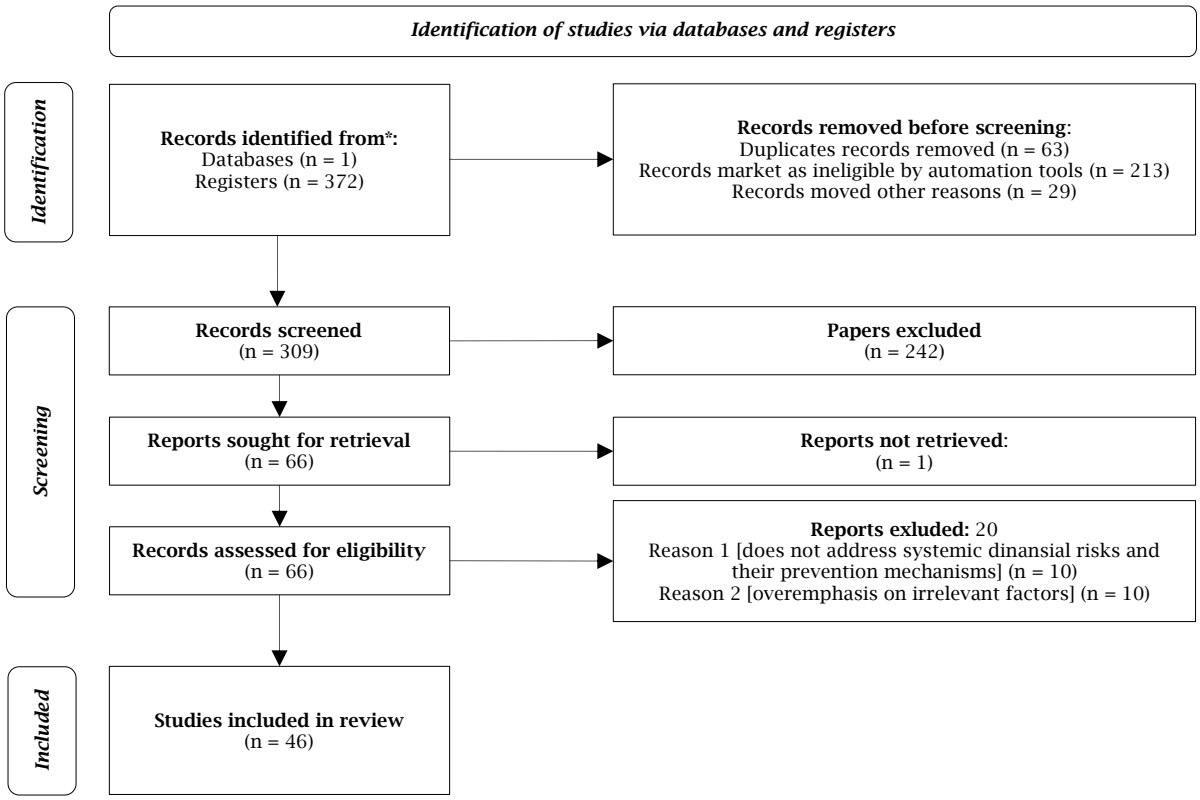
2.3. Innovative prevention mechanisms and future directions

Technology-driven financial risk mitigation strategies are being promoted by researchers to counter systemic risks. For instance, Chuliá et al. (2023) showed that machine learning applications in financial testing employ AI-driven models that improve predictive accuracy and enhance regulatory oversight. A recent deep learning framework combining CNN and BiLSTM demonstrated strong performance in systemic risk prediction, with an F1 score of 0.88, signaling its promise in early-warning systems (Cheng et al., 2025). Moreover, green FinTech solutions are also used as a method to improve risk resilience given the issue of climate-related shocks (Murè et al., 2024). Broby and Yang (2025) highlighted the need to precisely define green FinTech and propose a six-step litmus test to ensure environmental integrity and avoid greenwashing. Furthermore, Loukoianova et al. (2024) outlined practical applications of FinTech in climate finance, emphasizing its potential to enhance transparency and mobilize sustainable investments. Additionally, blockchain technology is yet another emerging tool for risk prevention. This is particularly true for supply chains and financial transactions. Shi and Yang (2025) have demonstrated how blockchain-based transparency mechanisms can improve financial stability. Empirical evidence from Australia shows that blockchain adoption by major banks is positively associated with improved operational efficiency and profitability (Almadadha, 2025). On similar lines, Jahanbin et al. (2023) have emphasized the role of these technologies in reducing fraud and ensuring compliance in financial networks. However, despite these advancements, a novel supply-chain-integrated stress testing model reveals that interdependencies between real-world supply disruptions and financial exposures can amplify systemic risk by up to 70%, highlighting the need for combined network and blockchain analysis (Fialkowski et al., 2025). The adoption of emerging technologies in financial risk management is often hindered by regulatory inconsistencies, high implementation costs, and resistance from traditional financial institutions (Ferilli et al., 2024). Thus, it is crucial to analyze the nature of systemic financial risks and assess the efficacy of the preventive tools that exist today.

3. METHODOLOGY

This study uses an SLR approach. It analyzes the propagation and prevention mechanisms of systemic financial risks. As financial risk is an evolving field of research, the interdisciplinary nature of the study prompts the use of the PRISMA 2020 methodology. This allows rigorous selection, maintains transparency, and ensures replicability in the study. This study has been inspired by the framework followed by Martiny et al. (2024) and Galletta et al. (2024). Both these studies have used a similar PRISMA mechanism for their respective research on determinants of ESG performance and analyzing greenwashing in the banking industry as an emerging risk. In the context of this paper, the PRISMA framework guides the identification, screening, eligibility assessment, and inclusion process of relevant literature. Each of these aspects has been comprehensively specified throughout this section. This framework guarantees the incorporation of high-quality, peer-reviewed studies that address the research objectives of the corresponding study directly. This systematic review was structured to directly address the study's three research questions: *RQ1* (risk propagation mechanisms) was informed by studies categorized under 'Historical' and 'Emerging risks'; *RQ2* and *RQ3* (evolution of prevention mechanisms and the role of technology/ESG) were addressed through literature categorized under 'Innovative prevention mechanisms'. The PRISMA process is illustrated in the flowchart below as per the 2020 flow diagram for systematic reviews.

Figure 1. PRISMA flow diagram



3.1. Identification of studies

A comprehensive database search was conducted before settling on ScienceDirect to gather peer-reviewed journal articles. This platform, operated by Elsevier, has an extensive collection of published literature with online access and is also an online citation index (Mengist et al., 2020). ScienceDirect was chosen for its extensive coverage of recent open-access publications, particularly in the fields of FinTech, ESG finance, and systemic risk. Its interdisciplinary scope made it well-suited for capturing both financial and technological dimensions of emerging risk. Thus, articles adhering to systemic financial risks and their prevention mechanisms were gathered from this database. In this regard, to ensure the relevance and quality of the studies included, the following search filters were used:

- Publication year: 2021–2025 (to focus on the recent developments in systemic risk research).
- Document type: Only journal articles.
- Subject area: Economics, econometrics, and finance (to maintain relevance to financial risk management).
- Access type: Only open-access articles were included to ensure accessibility and replicability.
- Language: Articles published only in English.

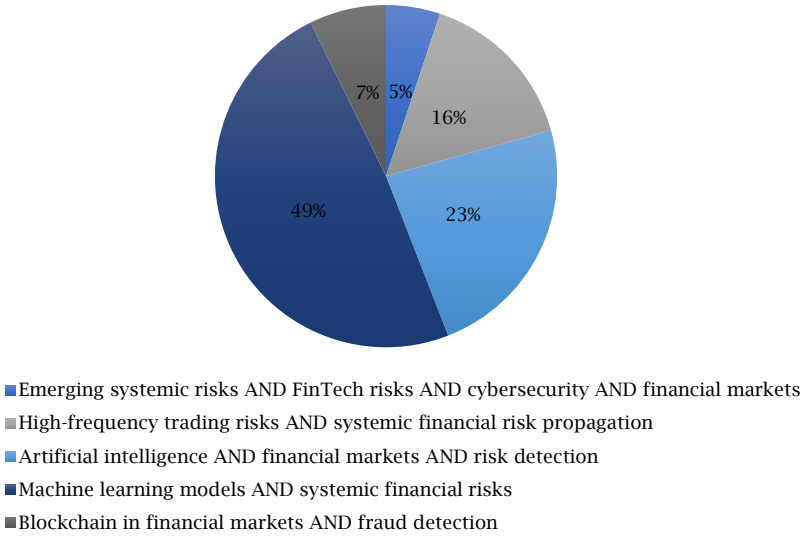
A combination of keywords and Boolean operators was used to retrieve articles that fit within the scope of the research. The primary Boolean search strings used and the number of studies found under them have been summarized in Table 1.

Table 1. Boolean search strings and corresponding studies found

Boolean search strings	*No. of articles*
Emerging systemic risks AND FinTech risks AND cybersecurity AND financial markets	19
High-frequency trading (HFT) risks AND systemic financial risk propagation	58
Artificial intelligence (AI) AND financial markets AND risk detection	87
Machine learning models AND systemic financial risks	181
Blockchain in financial markets AND fraud detection	27
Total	372

The distribution of the studies found via the keyword combination is shown in Figure 2. A total of 372 records were found, out of which 63 duplicates were removed. Zotero's tag and filter functions were used to automate duplicate removal and assist in preliminary title-abstract screening. Manual review was followed to ensure alignment with the inclusion criteria. This brought the count down to 309. Note that the search, screening, and inclusion process was conducted between January 5, 2025 and February 1, 2025.

Figure 2. Distribution of studies found based on keywords



3.2. Screening process

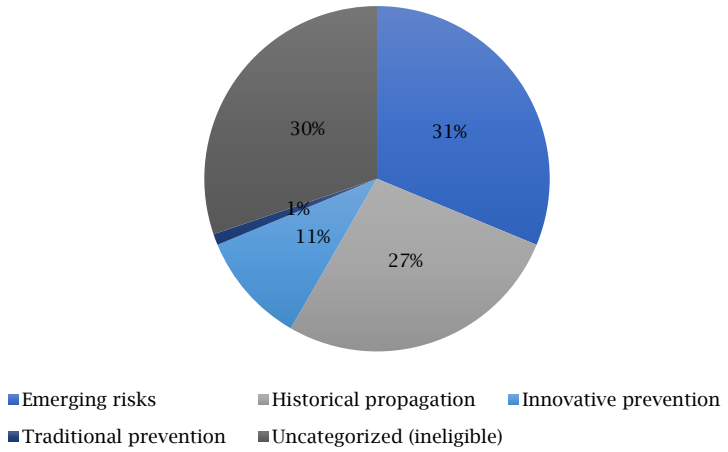
The 309 records were subjected to the first stage of screening. This involved excluding irrelevant articles based on title and abstract screening. Zotero automation was used to remove the articles that did not include systemic financial risk or prevention mechanisms in the manual tags. A total of 213 articles were then deemed irrelevant. A manual title and abstract screening was further conducted to ensure that the shortlisted articles discuss one of the following: historical or emerging financial risk propagation, traditional or innovative prevention mechanisms. The articles were manually categorized as follows:

Table 2. Categorization of post title and abstract screening

Categorization	*No. of studies*
Emerging risks	30
Historical propagation	26
Innovative prevention	10
Traditional prevention	1
Uncategorized (ineligible)	29
Total	96

The distribution of studies based on this categorization is shown in Figure 3. A total of 67 studies were sought for retrieval to facilitate the full-text review.

Figure 3. Distribution showing studies categorized by post title and abstract screening



3.3. Eligibility assessment

All 67 articles were assessed for eligibility. The articles were retrieved from ScienceDirect for a full-text assessment. As the screening process included only open-access articles, most articles were available online for free, except for 1. This article was thus removed from the list, and only 66 were included for the eligibility assessment. The inclusion criteria have remained the same as mentioned in subsections 3.1 and 3.2 collectively. The formal inclusion and exclusion criteria applied during the eligibility phase are summarized below in Table 3.

Table 3. Inclusion and exclusion criteria

Inclusion criteria	*Exclusion criteria*
Peer-reviewed journal articles	Conference papers, working papers, book chapters
Published between 2021–2025	Published before 2021 or beyond 2025
English-language articles	Non-English articles
Open access articles from ScienceDirect	Paywalled or inaccessible articles
Focused on systemic financial risk and/or prevention mechanisms	Articles on firm-level strategy, micro-level behavior, or general finance unrelated to risk propagation

Additionally, post-full text review, the articles were excluded if:

- Articles that were too generic and lacked depth in risk propagation or prevention.
- Papers with an overemphasis on unrelated financial themes (e.g., microeconomic firm strategies).

The 20 reports mentioned were excluded from the analysis. The reasons were broadly characterized into two broad categories: does not address systemic financial risks and their prevention mechanisms, and overemphasis on irrelevant factors.

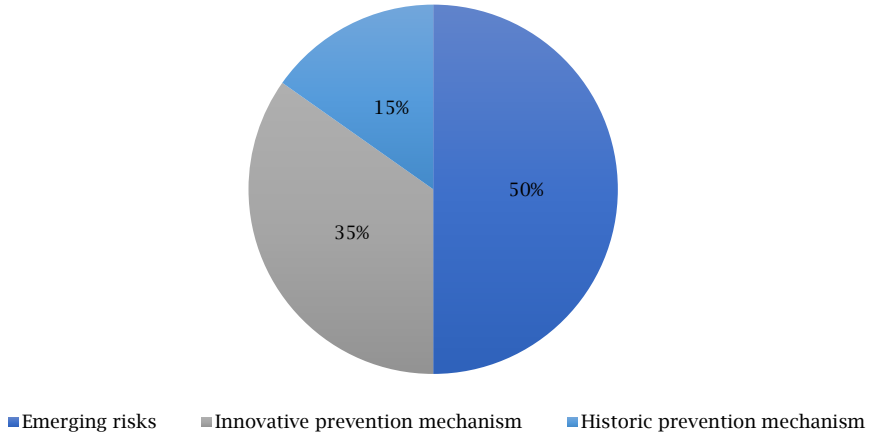
3.4. Inclusion in the review

After the rigorous screening and eligibility assessment, a total of 46 studies were included in the final SLR. The full-text review changed the categorization of some of the studies. Three categories were thus finalized, and the number of studies per category and their respective distribution of studies have been given in Table 4 and Figure 4.

Table 4. Categorization post full-text review

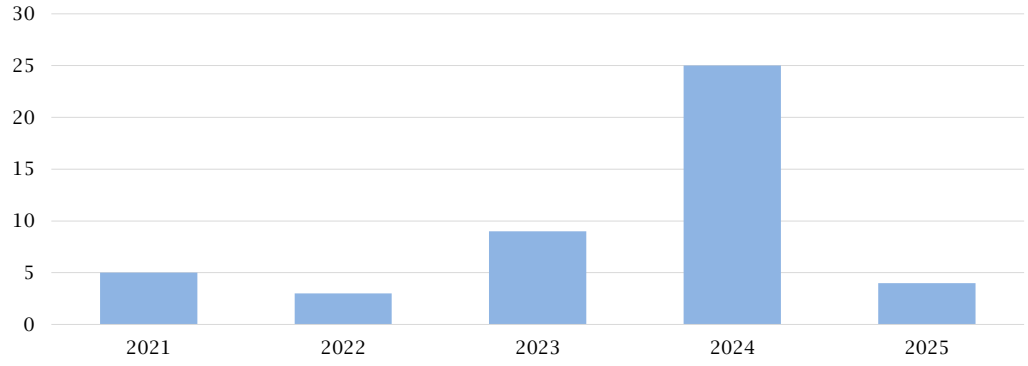
Categories	*No. of articles*
Emerging risks	23
Innovative prevention mechanism	16
Historic prevention mechanism	7
Total	46

Figure 4. Distribution showing studies categorized post full-text review



Each of the 46 included studies was manually reviewed using a thematic coding framework. A structured matrix was used to extract key variables such as: 1) *type of systemic risk discussed*, 2) *financial tools or technologies analyzed*, 3) *policy or regulatory recommendations made*, and 4) *classification under one of the three thematic categories*. This ensured analytical consistency across diverse publication types. The selected studies were systematically analyzed, and their key findings on systematic risk propagation and mitigation were extracted. The year-wise distribution of the studies is shown in Figure 5.

Figure 5. Year-wise distribution of final shortlisted studies



3.5. Alternative methodological approaches

In addition to the current approach, alternative methodologies may also strengthen the robustness of systemic risk assessment. One such approach would encompass a network analysis using interbank transaction data or perhaps systemic linkages derived from financial disclosures. These approaches would combine the methodology adopted by Brunetti et al. (2023) and Athanasakou and Boshanna (2025), respectively. Such a quantitative method enables the modeling of contagion paths and the identification of central nodes in financial networks. Moreover, agent-based modeling (ABM) could also stimulate heterogeneous financial agents under varying shock scenarios, as done by Wheeler and Varner (2024). This would capture emergent systemic behavior that remains unobservable in linear models. Another suitable method would include an econometric stress testing model that demands panel data regression. This model would evaluate the sensitivity of systemic indicators such as z-score and SRISK (an indicator of banks' capital shortfall due to systemic risk) to macro-financial variables. These methods would offer a complementary and more granular perspective on financial fragility and risk propagation if they are supported by real-time data.

4. RESULTS

This section will summarize the key trends across each of the three categories, namely emerging risks, historical propagation mechanisms, and innovative prevention measures.

Appendix (Table A.1) captures the findings from studies that have been categorized under historical propagation mechanisms. The key trends identified across these studies include:

1. Bank failures and interbank contagion continue to drive financial crises:

• Studies (Citterio, 2024; Téllez-León et al., 2021) discuss how network centrality metrics and interbank relationships amplify contagion risks, particularly during liquidity crises.

• Historical banking crises (the Lehman Brothers collapse, sovereign debt crises) inform predictive models for failure prevention.

2. Macroeconomic shocks and systemic risk transmission in financial markets:

• Studies (Tabachová et al., 2024; Andrieş et al., 2022; Zabavnik & Verbič, 2024) highlight how macroeconomic conditions (credit markets, investment patterns) shape systemic vulnerabilities.

• Stress-testing frameworks and Basel accords play a crucial role in assessing systemic spillovers during economic downturns.

3. Global systemically important banks (G-SIBs) as risk amplifiers:

• Andrieş et al. (2022) demonstrate how G-SIBs act as risk transmission hubs, increasing vulnerability across financial networks.

• Studies suggest that Basel III measures and capital buffers help reduce transmission risks, but interconnected financial systems remain fragile.

4. Cross-border spillover effects and financial volatility propagation:

• Studies (Hoque et al., 2024, Cuba et al., 2021) discuss volatility spillovers across global markets, showing how financial crises spread through interdependent banking and investment networks.

• Regulatory frameworks such as DebtRank and network contagion models help track financial system fragility.

5. Algorithmic and HFT as historical risk factors:

• Studies (Carè & Cumming, 2024) highlight how technological advancements in financial trading (e.g., HFT, algorithmic strategies) amplify systemic volatility.

• Regulatory responses such as market circuit breakers and liquidity controls were introduced to mitigate these risks.

6. Synthesis for historical propagation mechanisms:

• The studies emphasize how historical financial crises inform risk prediction models and regulatory responses.

• Bank interconnectedness, macroeconomic cycles, and global financial volatility remain core risk drivers, requiring continuous regulatory adaptation.

Appendix (Table A. 2) mentions the findings from studies that have been categorized under emerging risks. The key trends observed across these studies include:

1. FinTech and digital financial systems introduce new systemic risks:

• Several studies (Murinde et al., 2022; Khan et al., 2023; Marqués et al., 2021; Tang et al., 2023; Wan et al., 2023) highlight how FinTech innovations disrupt traditional financial systems by increasing cybersecurity vulnerabilities, data privacy concerns, and regulatory arbitrage risks.

• The rapid adoption of FinTech in banking (e.g., Gulf Cooperative Council (GCC) economies, China) is linked to liquidity risks and operational inefficiencies, requiring regulatory sandboxes for risk mitigation.

2. Climate change-related financial risks are becoming more prominent:

• Studies (Trinh et al., 2024; Adeabah & Pham, 2025; Del Fava et al., 2024; Le et al., 2023) indicate that climate risks (physical and transition risks) have significant financial spillover effects, especially in energy and banking markets.

• Greenwashing in ESG disclosures (Sneideriene & Legenzova, 2025; Galletta et al., 2024) is emerging as a systemic financial risk, misleading investors and distorting market signals.

• Financial development helps mitigate climate-related debt costs, but weak markets suffer higher financial distress.

3. Cryptocurrencies and DeFi increase systemic vulnerabilities:

• Studies (Crandall, 2025; Conlon et al., 2024) highlight how crypto financialization and unregulated digital assets (e.g., the FTX collapse) cause financial contagion and market instability.

• Network states and venture capital (VC)-backed crypto projects bypass financial oversight, amplifying governance risks.

4. Supply chain and market connectivity expose financial systems to new contagion risks:

• Studies (Mungo et al., 2023; Rigana et al., 2023) show how machine learning-based firm-level network reconstructions reveal systemic vulnerabilities in supply chain disruptions.

• Trade contagion risks became particularly visible during the COVID-19 crisis (Louati et al., 2022), stressing the importance of macroprudential regulatory responses.

5. Synthesis for emerging risks:

- The intersection of FinTech, ESG, and cryptocurrencies represents new dimensions of systemic financial risks.
- Regulatory frameworks are lagging behind financial innovations, increasing risks related to data transparency, digital asset speculation, and market distortions.

Finally, Appendix (Table A.3) shows the findings from the SLR that have been categorized under innovative prevention mechanisms. The key trends identified include:

1. FinTech innovations as systemic risk management tools:

- Studies (Hasan et al., 2024; Galeone et al., 2024; Wan et al., 2023) highlight how FinTech contributes to financial stability through financial inclusion, digital payments, and AI-based risk assessments.
- However, poor governance structures in FinTech firms (Ferilli et al., 2024) introduce operational and cybersecurity risks.

2. Green finance and climate risk mitigation strategies:

- Studies (Murè et al., 2024; Carè et al., 2024) explore the role of green loans, sustainability-linked securities, and climate stress testing in managing climate-related financial risks.
- Regulatory gaps in ESG integration (Galletta et al., 2024) lead to greenwashing concerns, necessitating stricter reporting standards.

3. Blockchain and AI for financial stability:

- Studies (Shi & Yang, 2025; Cao et al., 2024; Jahanbin et al., 2023) propose blockchain-based transparency frameworks for supply chain stability and fraud prevention.
- Machine learning models (Moffo, 2024; Chuliá et al., 2023) enhance systemic risk forecasting and stress-testing models for financial institutions.

4. Central bank digital currencies (CBDCs) and financial risk governance:

- Studies (Rizwan et al., 2025) highlight CBDC adoption risks, including liquidity crises and banking disintermediation.
- Regulatory stress-testing tools are needed to ensure CBDCs do not amplify systemic instability.

5. Tail-risk and sentiment-based risk prediction:

- Studies (Qu, 2024; Nyman et al., 2021) introduce Big Data and sentiment analysis as early-warning tools for detecting financial stress before crises emerge.

6. Synthesis for innovative prevention mechanisms:

- FinTech, AI, blockchain, and machine learning-based models are revolutionizing risk prediction and mitigation strategies.
- Climate finance innovations (ESG-based financial tools, CBDCs, and regulatory stress testing) represent new frontiers in systemic risk prevention.
- Despite advancements, governance and regulatory gaps persist, requiring cross-border cooperation and stronger policy frameworks.

5. DISCUSSION

The literature reveals that historical risk propagation was primarily driven by bank failures, macroeconomic shocks, and interbank contagion. Large institutions with high network centrality, such as G-SIBs, often served as conduits for amplifying liquidity crises (Andrieş et al., 2022; Téllez-León et al., 2021). Macroeconomic disruptions, particularly in credit and investment markets, further compounded systemic risk, highlighting the cyclical vulnerability of financial networks (Zabavnik & Verbič, 2024). In contrast, contemporary systemic risk has evolved to encompass digitally mediated, climate-sensitive, and crypto-financialized threats. FinTech innovations, while beneficial for inclusion and efficiency, introduce new vulnerabilities such as regulatory arbitrage, cyber threats, and data asymmetries (Murinde et al., 2022; Khan et al., 2023). This study supports these findings by showing that FinTech-fueled credit expansion increases market fragility, particularly in the absence of tailored regulation. This aligns with Cuadros-Solas et al. (2024), who argue that consumer lending via FinTech can amplify instability under lax oversight. Climate-related risks, especially transition risks, now affect bank liquidity and market pricing, with inadequate regulatory adaptation heightening exposure (Le et al., 2023; Trinh et al., 2024). The present analysis corroborates this, particularly with evidence from emerging economies where regulatory frameworks remain underdeveloped. As Carè et al. (2024) have noted, stress testing mechanisms are still in nascent stages and thus limited in predictive scope. The unregulated growth of DeFi platforms and cryptocurrency speculation has further added systemic volatility, often bypassing traditional oversight structures (Crandall, 2025; Conlon et al., 2024). The findings confirm these observations, showing that crypto-driven liquidity cycles generate new channels for contagion beyond conventional bank-based systems. Additionally, this study builds on Rigana et al. (2023), who demonstrated that global crises exacerbate risk spillovers across financial networks. Our results extend this by showing that these spillovers are increasingly mediated through digital finance channels, underscoring a shift from institutional to platform-based contagion mechanisms. These emerging risks are more diffuse, rapidly evolving, and difficult to contain using traditional institutional mechanisms.

Historically, prevention strategies revolved around macroprudential regulation, capital adequacy buffers, and stress testing, as emphasized by the Basel accords. While these tools remain foundational, their effectiveness is increasingly strained by the decentralization of risk sources. HFT, platform-based credit systems, and globalized capital flows now operate outside the direct purview of legacy tools (Carè & Cumming, 2024). To adapt, new-generation mechanisms have emerged. Machine learning and AI-based models improve the precision of early warning systems and stress testing, offering predictive insights that go beyond conventional macro-financial indicators (Chuliá et al., 2023; Moffo, 2024). The findings affirm the increasing utility of AI-driven models for early-stage detection of systemic disruptions, in line with the argument by Chuliá et al. (2023) that machine learning enhances stress-testing accuracy. Blockchain applications enhance transparency in transaction systems, lending networks, and supply chains, acting as digital audit trails that reduce fraud and improve traceability (Jahanbin et al., 2023; Cao et al., 2024). This result is corroborated by Shi and Yang (2025), who highlight the effectiveness of blockchain-based transparency mechanisms in promoting financial stability. However, these innovations face limitations. First, regulatory fragmentation and institutional inertia delay policy responses, especially in cross-border settings. Second, high

costs and resistance from legacy financial actors hinder wide adoption. Third, governance gaps in FinTech firms and data inadequacies weaken implementation, particularly in emerging markets (Ferilli et al., 2024). This aligns with Koranteng and You (2024), who emphasize that cybersecurity concerns, operational inefficiencies, and the absence of harmonized oversight frameworks significantly limit the benefits of FinTech-driven mechanisms. Additionally, Murè et al. (2024) underline the contextual challenges of implementing green FinTech solutions, showing that while effective in theory, their impact varies based on regulatory support and market preparedness, echoing our finding that new tools are highly context dependent. Thus, while new tools offer promise, their impact is highly context-dependent and often constrained by the regulatory ecosystem in which they operate.

Emerging technologies such as AI, blockchain, and CBDCs are reshaping the landscape of financial risk governance. AI enables real-time surveillance and sentiment-based forecasting, providing regulators with tools to anticipate stress points before they materialize (Nyman et al., 2021; Qu, 2024). This confirms the findings of Liu et al. (2025), who underscore the promise of digital finance innovations in early risk detection, although they warn of new contagion pathways in the absence of strong oversight. Blockchain, in turn, reduces information asymmetry in supply chains and capital markets, promoting resilience through traceability and decentralized validation (Shi & Yang, 2025). Empirical evidence by Almadadha (2025) aligns with this observation, showing that blockchain adoption by major banks improved operational efficiency and profitability, thus strengthening the argument that blockchain can support systemic resilience. Simultaneously, ESG frameworks, especially those related to climate finance, are gaining prominence as preventive tools. Green finance instruments, including sustainability-linked loans (SLLs) and stress-tested ESG portfolios, have been proposed to align capital flows with long-term resilience goals (Murè et al., 2024; Carè et al., 2024). This supports Broby and Yang (2025), who argue that precise definitions and litmus testing in green finance are critical to avoiding greenwashing and ensuring environmental integrity. However, the literature points to serious limitations: greenwashing, metric inconsistency, and a lack of standardization erode the credibility of ESG disclosures and hinder their role in mitigating systemic risk (Galletta et al., 2024; Sneideriene & Legenzova, 2025). Chalabi-Jabado and Ziane (2024) further emphasize that both physical and transition climate risks impair bank lending growth and profitability, indicating that ESG measures, while theoretically preventive, may have unintended effects if not carefully managed. The integration of ESG and technology also presents governance dilemmas. For example, while FinTech can facilitate ESG adoption, it simultaneously introduces new channels of operational and ethical risk. Petrík (2023) finds a positive correlation between FinTech expansion and systemic risk spillovers, especially through cyber threats and operational dependence, thereby highlighting that innovation without coordinated regulation may heighten systemic vulnerabilities. As such, technological innovation without regulatory coherence may inadvertently magnify the very vulnerabilities it seeks to mitigate.

This review finds that systemic risk is no longer solely a function of traditional banking failure but is now shaped by multi-domain interactions, technological, environmental, and institutional. The current toolkit for prevention is undergoing a transition from reactive, compliance-based regulation to proactive, technology-enabled governance. However, the effectiveness of these tools is contingent on addressing three key gaps:

1. Regulatory coherence: Disparate regulatory regimes across borders and asset classes weaken coordination and risk containment.

2. Governance quality: FinTech adoption must be matched with robust oversight to avoid unintended destabilization.

3. Metric standardization: ESG reporting must evolve toward uniform standards to be used effectively as a risk management framework.

Future systemic risk governance must therefore be multi-dimensional, combining real-time surveillance, technology adoption, sustainability integration, and policy harmonization. Only then can financial systems evolve from a posture of contagion response to one of resilient containment.

6. CONCLUSION

Based on a systematic review, this study's new research framework elaborates on systemic financial risk propagation and prevention mechanisms, key historical risk drivers, pointers to emerging threats, and innovative methods for risk mitigation. While bank failures, financial contagion, and macroeconomic instability have been the leading contributors to systemic risk in the past, the emergence of systemic risk from FinTech disruptions, climate-related financial shocks, and cryptocurrency volatility needs to be monitored. Risk management has undergone a gradual transition from conventional regulatory approaches like Basel accords and macroprudential stress testing to more advanced AI-driven financial models, blockchain transparency mechanisms, and ESG-related strategies to mitigate risks. However, despite the use of such strategies, certain limitations persist. These include regulatory gaps and perhaps slow adaptation of policies. These factors collectively hinder the effectiveness of such prevention mechanisms. This is especially true when it comes to addressing FinTech-driven risks and DeFi markets. Moreover, ESG frameworks often suffer from inconsistencies. They raise concerns regarding greenwashing and unreliable risk metrics. Additionally, the reliance on machine learning models for risk forecasting is also constrained by data availability and model biases. Policymakers must act swiftly to harmonize ESG metrics, regulate crypto-financial products, and deploy AI-enabled early-warning systems. The evolution of risk demands institutional innovation that keeps pace with financial complexity. Therefore, future research must address several critical areas. First, more comparative cross-jurisdictional studies are needed to examine how national regulatory ecosystems affect the adoption of innovative risk tools. Second, longitudinal studies could help assess the dynamic effectiveness of ESG and AI-based strategies over time. Third, given the model biases and opacity associated with AI and blockchain applications, future studies should also explore mechanisms for enhancing algorithmic transparency and auditability.

This study contributes by providing a structured synthesis of fragmented evidence on emerging systemic risks, offering a foundation for both academic and policy-oriented work. However, one limitation of this review is its reliance on peer-reviewed literature, which may exclude relevant insights from practitioner reports or real-time policy briefs. In addition, as the financial ecosystem evolves rapidly, the pace of technological change may outstrip the timeline of scholarly publication, which can limit the real-time applicability of findings. Nonetheless, this framework can serve as a baseline for developing dynamic regulatory models and early-warning systems that are better equipped for contemporary risks. Thus, overall, the findings underscore the need for a multidimensional approach. This approach should address financial stability, balance technological innovation, and regulatory oversight. Additionally, it should also consider sustainable financial principles that would mitigate systemic financial vulnerabilities effectively.

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APPENDIX

Table A.1. Findings — Studies capturing historical propagation mechanisms

Article	*Objective*	*Insights*
Citterio (2024)	To review bank failure prediction models, focusing on their evolution and how they address historical financial crises.	Explains how bank failures propagate systemic risks (e.g., contagion and liquidity crises). Reviews historical crises to inform the development of predictive models for mitigation.
Tabachová et al. (2024)	To model the impact of supply chain disruptions on financial stability, focusing on systemic risk propagation and bank equity losses.	Highlights the role of Basel accords and stress-testing frameworks while quantifying systemic risks from supply chain contagion. Recommends targeted liquidity support for mitigating disruptions.
Andrieş et al. (2021)	To assess the interconnectedness and risk spillovers between G-SIBs, other systemically important institutions (O-SIIs), and the global financial system using network models and systemic risk metrics.	Demonstrates how G-SIBs act as primary risk transmitters during crises. Highlights the role of Basel III measures in reducing systemic vulnerabilities. Proposes advanced risk metrics to monitor interconnectedness and systemic exposure.
Hoque et al. (2024)	To assess the volatility spillover dynamics between global financial stress indices and US financial sectors under normal and extreme market conditions.	Highlights systemic risk spillovers during global crises, emphasizing regulatory tools like capital buffers and cross-border coordination to mitigate financial interconnectedness.
Cuba et al. (2021)	To analyze the systemic risk and interconnectedness of Peruvian financial institutions using a multilayer network approach and the DebtRank algorithm.	Explores contagion risk in multilayer financial networks and demonstrates the role of regulatory tools like DebtRank for systemic risk management. Highlights multiplex analysis for accurate systemic risk assessments.
Zabavnik and Verbič (2024)	To analyze structural shocks in credit markets and their impact on business investment using a Bayesian vector autoregression (VAR) model in Slovenia.	Highlights the role of credit risk and liquidity demand shocks in systemic risk propagation. Proposes fiscal and regulatory measures to reduce vulnerabilities and stabilize investment.
Carè and Cumming (2024)	To provide a bibliometric review of technological advancements in financial trading, emphasizing systemic risks and regulatory responses.	Highlights systemic risks in high-frequency and algorithmic trading. Explores regulatory responses to mitigate volatility and systemic vulnerabilities in financial markets.

Table A.2. Findings — Studies capturing emerging risks (Part 1)

Article	*Objective*	*Insights*
Trinh et al. (2024)	To examine the association between firm-level climate change exposure and corporate debt costs, with a focus on financial development as a mitigating factor.	Highlights how climate change risks (e.g., physical, regulatory, and transition risks) increase debt costs. Shows that firms in weak financial markets face higher debt costs, while financial development mitigates this effect. Discusses carbon risk.
Sneideriene and Legenzova (2025)	To examine greenwashing prevention in ESG disclosures through bibliometric analysis and SLR.	Highlights greenwashing as a systemic financial risk in ESG disclosures. Explores challenges, detection methods (e.g., AI tools), and prevention mechanisms.
Murinde et al. (2022)	To evaluate the opportunities and risks of the FinTech revolution for traditional banking institutions globally.	Highlights risks like regulatory arbitrage and cybersecurity threats. Proposes mechanisms like FinTech-bank partnerships and regulatory enhancements to mitigate risks.
Khan et al. (2023)	To analyze the impact of FinTech adoption and the regulatory sandbox on banks' financial stability in GCC economies.	Highlights risks such as cybersecurity challenges and operational inefficiencies from FinTech adoption. Recommends adaptive regulatory sandboxes and diverse risk management strategies as mitigation measures.
Marqués et al. (2021)	To analyze the implications of FinTech data gaps on monetary policy, financial stability, and payment systems, and propose policy measures for closing these gaps.	Discusses systemic risks from FinTech disintermediation and data gaps. Recommends tools like regulatory sandboxes, international cooperation, and enhanced data frameworks to monitor risks and improve resilience in the financial system.
Łasak and Wyciślak (2024)	To examine how the inclusiveness of banking platforms affects value co-creation and introduces vulnerabilities, using Paradox theory to analyze governance and regulatory solutions.	Discusses systemic risks like market monopolization, data privacy concerns, and dependency on dominant platforms. Proposes governance models and European Union (EU) regulatory frameworks as solutions to mitigate vulnerabilities.
Cheng et al. (2022)	To analyze the impact of cloud computing on cost efficiency, profit efficiency, and operational risk in Chinese banks over 2008–2019.	Identifies operational risks like system complexity and cybersecurity vulnerabilities from cloud adoption. Suggests cloud computing enhances profit efficiency and long-term risk management.
Louati et al. (2022)	To analyze the dynamics of financial and trade contagion during the COVID-19 crisis using graph theory and Markov chains.	Highlights increased systemic risk during the pandemic due to financial and trade dependencies. Proposes predictive tools to monitor contagion risk and stresses macroprudential regulation.
Adeabah and Pham (2025)	To analyze the asymmetric tail risk spillover between climate risks (physical and transition) and the global energy market using quantile-based methods.	Highlights systemic tail risk spillovers from climate risks to energy markets during extreme conditions. Suggests risk diversification and hedging strategies for mitigation.
Mungo et al. (2023)	To reconstruct firm-level production networks using machine learning to predict supply chain linkages and analyze shock propagation dynamics.	Highlights the vulnerability of supply chains to disruptions and demonstrates the use of machine learning for network reconstruction and shock propagation analysis.
Rigana et al. (2023)	To develop a novel measure of contagion in currency markets during financial crises using causal inference and dynamic contagion maps.	Introduces causal networks to analyze contagion paths and dynamic maps to track shock propagation during crises. Focuses on systemic vulnerabilities without discussing specific prevention mechanisms.
Tang et al. (2023)	To analyze the impact of FinTech development on bank liquidity and diversification in China.	Highlights how FinTech reduces bank liquidity and increases operational risks but promotes diversification strategies to enhance stability. Discusses systemic vulnerabilities amplified during crises.
Wan et al. (2023)	To analyze the impact of FinTech development on green finance growth in China's banking sector, emphasizing risk management and operational efficiency.	Explores how FinTech reduces credit risk and operational inefficiencies while introducing new vulnerabilities through competitive dynamics. Suggests FinTech tools as preventive mechanisms for systemic risks.
Del Fava et al. (2024)	To evaluate the predictive role of climate risks in forecasting financial stress across multiple countries using machine learning.	Identifies climate risks as significant contributors to financial stress. Explores systemic propagation through spillover effects and interconnected markets. Recommends early-warning systems for proactive risk mitigation.
Moffo (2024)	To evaluate the use of machine learning models in stress testing US bank holding companies and forecasting systemic risks.	Identifies systemic vulnerabilities under stress scenarios. Demonstrates how machine learning enhances predictive accuracy for systemic risk monitoring and capital adequacy.
Nguyen et al. (2024)	To model systemic risk and financial contagion among European and US banks using structured factor copulas and credit default swap (CDS) data.	Demonstrates how systemic risks propagate through global and local contagion channels. Proposes factor copula models for early risk identification and enhanced forecasting.
Stolbov and Shchepeleva (2024)	To analyze the evolution of systemic risk research from 2007 to 2021 and identify the drivers of systemic risk studies across countries.	Highlights how systemic risk research has evolved, driven by global financial crises. Identifies country-specific drivers (e.g., low bank profitability, innovation) influencing research intensity.
Koranteng and You (2024)	To analyze the impact of FinTech financing on financial stability using spatial models, focusing on cross-border spillover effects.	Highlights the destabilizing effects of consumer lending and systemic vulnerabilities in interconnected financial systems. Discusses the stabilizing role of crowdfunding and business lending in promoting financial resilience.

Table A.2. Findings — Studies capturing emerging risks (Part 2)

Article	*Objective*	*Insights*
Téllez-León et al. (2021)	To analyze the relationship between network centrality metrics and interest rate spreads in secured and unsecured interbank markets in Mexico.	Identifies how systemic relevance (centrality) amplifies risks, especially during financial stress. Highlights metrics like DebtRank and PageRank as key tools to assess systemic vulnerabilities.
Le et al. (2023)	To examine how climate risks affect bank stability globally and assess the moderating role of institutional quality and bank regulation.	Identifies physical and transition climate risks as systemic vulnerabilities for banks. Highlights mechanisms of risk propagation through asset quality, liquidity, and credit risks. Suggests regulatory reforms to mitigate impacts.
Cuadros-Solas et al. (2024)	To analyze how FinTech lending affects bank market power and stability, emphasizing the role of legal and institutional environments.	Identifies systemic risks from FinTech credit undermining traditional bank stability. Advocates for regulatory reforms and institutional strengthening to mitigate financial vulnerabilities.
Crandall (2025)	To analyze how crypto economic imaginaries influence urban development, governance, and financial risks through blockchain, cryptocurrency, and network states.	Crypto financialization fuels systemic risk. VC-backed projects bypass regulations, creating governance vulnerabilities. Network states undermine traditional oversight. Legal resistance highlights regulatory gaps.
Conlon et al. (2024)	Investigate information flow and contagion effects of unregulated cryptocurrency tokens on traditional financial assets during FTX's collapse.	FTX's collapse caused contagion effects on assets like Ethereum and Robinhood stocks, highlighting the need for stronger regulations.

Table A.3. Findings — Studies capturing innovative prevention mechanisms (Part 1)

Article	*Objective*	*Insights*
Murè et al. (2024)	To examine the academic literature on green loans (GLs) and SLLs, identifying gaps in governance, regulation, and risk management.	Highlights the early adoption of environmental credit products before regulatory frameworks emerged. Discusses the importance of integrating ESG factors into banking operations and the potential systemic risks from insufficient regulation (e.g., greenwashing). Emphasizes the need for governance and risk management improvements.
Allen and Barbalau (2024)	To review recent advancements in security design, addressing frictions in corporate finance, markets, FinTech, and sustainable finance.	Explores how security design reduces systemic risks by addressing market frictions and governance issues. Highlights vulnerabilities from innovations like blockchain and sustainability-linked securities. Discusses contingent convertible capital instruments (CoCos) as tools for financial stability and securitization as a liquidity-enhancing mechanism. Includes critiques of their effectiveness in practice.
Galletta et al. (2024)	To analyze greenwashing practices in the banking industry, their impact on consumer trust, and recommendations for mitigating these risks.	Highlights greenwashing as a systemic risk due to deceptive ESG claims in banking. Suggests innovative measures like independent certification, regulatory oversight, and transparent reporting to prevent greenwashing and restore trust in sustainable finance. Discusses the need for stricter regulation to align banking practices with sustainability goals.
Hasan et al. (2024)	To analyze how FinTech influences sustainable development across financial, economic, and environmental dimensions.	Highlights FinTech's role in reducing systemic risks through financial inclusion and green financing. Explores AI and blockchain innovations while identifying regulatory gaps as potential risks.
Carè, Fatima, et al. (2024)	To explore how central banks address climate risks through bibliometric analysis, identifying trends and future directions.	Discusses the propagation of climate-related systemic risks and tools like stress testing, scenario analysis, and green finance to mitigate these risks. Highlights gaps in data and regulatory frameworks for addressing climate challenges.
Ferilli et al. (2024)	To examine the impact of governance structures in FinTech firms on profitability, risk, and financial stability, focusing on board and chief executive officer (CEO) characteristics.	Highlights risks from poor FinTech governance (e.g., operational risks, CEO decisions). Emphasizes robust governance structures and partnerships with banks as mechanisms to reduce risk and ensure financial stability.
Rizwan et al. (2025)	To analyze the short- and long-term effects of CBDC-related news on systemic risk across countries using dynamic panel heterogeneity analysis.	Highlights systemic risks from CBDC adoption, such as liquidity crises and banking disintermediation. Recommends adaptive policies, cybersecurity measures, and stress-testing as key preventive tools. Offers regional and income-based heterogeneity analysis.
Galeone et al. (2024)	To analyze the role of ESG factors in promoting the adoption of FinTech in the banking sector, focusing on sustainable finance.	Demonstrates how FinTech supports sustainable finance by integrating ESG data into decision-making and mitigating climate-related risks. Identifies cybersecurity risks as a key challenge.
Qu (2024)	To analyze financial contagion and systemic risks using tail-driven portfolios, leveraging time-series data and machine learning models.	Highlights systemic risks from tail events and their propagation across sectors. Proposes a tail-driven portfolio for forecasting and mitigating risks using machine learning.
Nyman et al. (2021)	To assess systemic risks using Big Data-based narrative sentiment and consensus measures derived from financial market texts.	Identifies emotional shifts and narrative consensus as key factors driving systemic risk. Proposes sentiment-based metrics as early warning tools to predict financial instability.

Table A.3. Findings — Studies capturing innovative prevention mechanisms (Part 2)

Article	*Objective*	*Insights*
Chuliá et al. (2023)	To develop a daily growth-at-risk (GaR) framework using high-frequency financial and real indicators to forecast downside risks to gross domestic product (GDP) growth.	Proposes a novel daily GaR framework leveraging advanced econometric tools (LASSO, elastic nets). Provides a practical tool for assessing economic tail risks and aiding policymakers in mitigating systemic vulnerabilities.
Berlinger et al. (2024)	To develop a dynamic margin-setting model for central counterparties (CCPs) to minimize systemic risks while balancing liquidity constraints.	Proposes countercyclical margining as a tool to mitigate systemic risk. Explores how adaptive margins can prevent procyclical behavior and stabilize financial markets during volatility shocks.
Peng et al. (2023)	To examine how legal enforcement influences the cost of FinTech credit compared to traditional bank loans, and how FinTech innovations mitigate risks.	Demonstrates how risk-sharing and information-sharing innovations in FinTech reduce reliance on legal enforcement. Highlights regulatory implications for credit market stability.
Shi and Yang (2025)	To assess the role of green FinTech in enhancing energy resilience in China and to examine how technological innovation, climate policy uncertainty, and environmental regulations impact this relationship.	Green FinTech improves energy resilience, particularly in economic and environmental dimensions. AI, blockchain, and digital finance optimize energy infrastructure. Policy uncertainty and environmental regulations amplify FinTech's benefits, while extreme weather weakens them. A threshold effect exists — marketization level must reach a certain point for FinTech to maximize resilience.
Cao et al. (2024)	To design blockchain adoption mechanisms for semiconductor chip supply chains, focusing on information disclosure and cost-sharing contracts.	Blockchain improves transparency and traceability, enhances adoption through cost-sharing contracts, and promotes supply chain sustainability.
Jahanbin et al. (2023)	To investigate blockchain adoption in agri-food supply chains and develop a 3TIC framework for traceability, transparency, and compliance.	Blockchain ensures traceability and transparency, facilitates shared value creation, but faces barriers like high costs and adoption resistance.