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Review

An Integrated Risk Management Algorithm for Economic Catastrophes: From Exogenous Shocks to Endogenous Vulnerabilities

Vladimir Ristanović

Institute of European Studies, Sq. Nikola Pašić 11, Belgrade, 11000; vladimir.ristanovic@ies.rs

Correspondence: vladimir.ristanovic@ies.rs; Tel.: +381-64-645-4415

Abstract

Modern economic catastrophes are increasingly driven by the endogenous accumulation of risk rather than by isolated exogenous shocks. Although natural disasters, financial crises, and trade disruptions continue to act as triggers, their economic impact is largely determined by structural conditions that evolve gradually and rupture under stress. This paper develops an integrated risk management algorithm that conceptualizes catastrophe risk as a dynamic and systemic process rather than a discrete event. Building on a four-layer framework – hazards, exposure, vulnerability, and resilience – the study synthesizes insights from disaster economics, systemic risk theory, and the literature on global trade fragmentation to propose a transferable analytical architecture applicable across economic domains. Time dynamics and governance quality are introduced as cross-cutting dimensions that shape the transmission, amplification, and mitigation of shocks. Instead of aiming at deterministic crisis prediction, the algorithm enables continuous monitoring of slow-forming structural fault lines, interaction effects, and potential threshold points. The paper is designed as a conceptual review and methodological synthesis that demonstrates how integrated risk assessment can support proactive economic governance. Adaptive policy instruments, technological upgrading, diversification, and institutional coordination are interpreted as protective layers that deepen systemic resilience and reduce the probability of catastrophic outcomes. By shifting the analytical focus from ex post crisis response toward structured foresight and resilience-oriented policy design, the framework contributes to contemporary debates on stability in an increasingly fragmented global economy. The proposed algorithm provides a flexible foundation for future empirical modeling and cross-sectoral applications.

Keywords

Integrated risk management; economic catastrophes; systemic risk; resilience; global fragmentation

7. Introduction

Economic catastrophes are increasingly the result of risks that accumulate endogenously within economic systems rather than the direct consequence of isolated exogenous shocks. Global financial crises, pandemic-induced supply disruptions, energy price volatility, and climate-related disturbances demonstrate a common pattern: similar external pressures generate profoundly different economic outcomes across countries and regions. This asymmetry suggests that the magnitude of disruption is determined less by the shock itself than by the structural depth of the system it encounters. In this perspective, catastrophe represents the visible rupture of slow-forming systemic fault lines.

The dominant economic and policy literature has long conceptualized crises as discrete, rare, and largely external events that temporarily displace otherwise stable systems. From early analyses of macroeconomic volatility to influential historical studies of financial crises, the analytical focus has been placed on identifying the origin of disturbance and estimating its impact on output, employment, and financial stability (Lucas, 1987; Reinhart & Rogoff, 2009). Within this framework, risk appears as an exogenous force acting upon a fundamentally equilibrating economy.

In parallel, the risk management tradition – particularly in finance and corporate governance – has developed sophisticated instruments for measuring exposure, pricing uncertainty, building buffers against volatility, and finance resilience (Knight, 1921; Taleb, 2007; OECD, 2008; OECD, 2021). This direction of risk management is accompanied by a growing number of initiatives that have been developed to invest in disaster and climate change preparedness and prevention (Simpson et al., 2021; Mechler et al., 2016; Kreimer & Arnold, 2000; Mahefasoa et al., 2022). Yet these approaches remain predominantly static and outcome-oriented. They are designed to minimize losses once volatility materializes rather than to trace the dynamic processes through which vulnerability is produced, deepened, and transmitted across sectors and over time.

A different analytical shift emerges in the resilience and complex systems literature, where economies are understood as adaptive, path-dependent structures characterized by non-linearity, multiple equilibria, and institutional co-evolution (Arthur, 1994; Rodrik, 2011). The focus moves from shocks to system architecture – toward diversification, technological capability, governance quality, and policy coordination as determinants of how disturbances propagate (Williams, 2011). Similarly, global risk assessments emphasize cascading and interconnected crises rather than isolated events (WEF, 2023).

However, even within this dynamic tradition a critical gap remains. The literature provides powerful diagnostic concepts – fragility, tipping points, black swans, resilience – but offers limited operational methodologies for observing how structural weaknesses and external pressures co-evolve in real time. We have rich descriptions of systemic fault lines, but no analytical workflow for mapping their formation, depth, and interaction (Chernov & Sornette, 2020).

This paper positions economic disasters not as shocks but as the visible rupture of long-forming systemic fault lines. What is missing in the existing body of work is a methodological architecture capable of capturing this slow-moving process – linking endogenous policy depth with the changing topology of external pressures.

The central objective of the paper is to develop an integrated analytical algorithm for economic catastrophes that conceptualizes catastrophe risk as a dynamic and multi-layered process. Building on the interaction between hazards, exposure, vulnerability, and resilience, and embedding these dimensions within a temporal and governance-oriented framework, the paper proposes a transferable methodological architecture for continuous monitoring and proactive management of systemic risk. The dynamic function $C_t=F(H_t,E_t,V_t,R_t \| G)$ does not aim at deterministic prediction. Instead, it operationalizes continuous monitoring, enabling the identification of slow-building pressures, interaction effects, and potential threshold points.

In this framework, the economy is conceptualized as a developmental path whose depth reflects institutional capacity, technological upgrading, and policy responsibility, while external disturbances constitute shifting lateral pressures. Catastrophe occurs where accumulated structural shallowness meets intensified external stress.

The objective of the paper is therefore to develop an integrated methodological workflow for systemic economic resilience that transforms risk management from a reactive stabilization tool into a continuous governance function. By synthesizing insights from disaster economics, systemic risk theory, and the literature on global economic fragmentation, the paper contributes a unified conceptual language linking previously disconnected strands of research; also, a dynamic and operational definition of economic catastrophe as a process rather than an event; and finally, a transferable analytical framework for proactive and resilience-oriented economic policy. In doing so, the study responds to the growing need for analytical models capable of supporting economic stability in an era of deep interdependence, structural transformation, and cascading global risks.

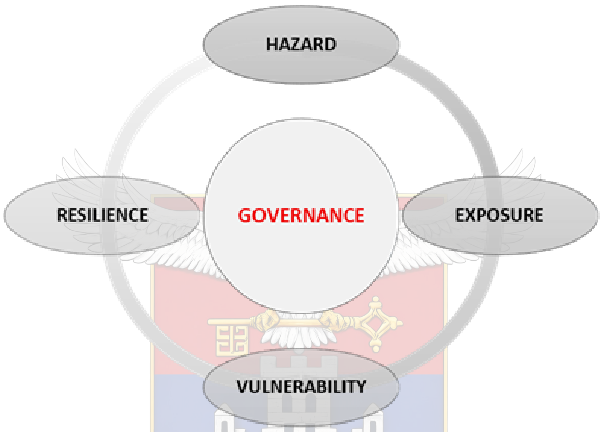
The remainder of the paper is structured as follows. Section 2 presents the methodological foundations of the integrated algorithm. Section 3 develops the conceptual interpretation of the model through the interaction of its five components. Section 4 illustrates the functional dynamics of the framework through a comparative analytical mapping. Section 5 discusses policy implications and the broader cross-disciplinary applicability of the proposed approach. The final section is conclusion.

8. Methods

This study adopts a conceptual-analytical research design with an operational methodological framework, combining qualitative synthesis with a structured comparative data architecture. The aim is not to estimate a single empirical model but to develop a reproducible workflow for continuous monitoring of systemic economic catastrophe risk through the dynamic function. Similar to Slotsvik et al. (2025), where they use a 'min-max concept formation strategy' for good disaster risk management practice. In methodological terms, the research follows a theory-building and model-operationalization strategy, where conceptual integration is supported by transparent indicator selection and a replicable analytical sequence (Creswell & Creswell, 2018; Kothari, 2004).

The study is designed as a mixed-methods conceptual review with a structured comparative analytical component. The qualitative dimension synthesizes the literature on disaster economics, systemic risk, resilience, and global economic fragmentation in order to define the functional relationships between hazards, exposure, vulnerability, resilience, and governance. The quantitative-analytical dimension translates these theoretical constructs into measurable proxy indicators, enabling their use in a continuous monitoring framework rather than in a single ex-post evaluation. This approach corresponds to model-based analytical research in which theoretical constructs are operationalized through observable variables to allow replication and future empirical testing (Jaccard & Jacoby, 2020). Rather than predicting crises, the paper develops a reproducible analytical workflow that enables their continuous monitoring and governance, transforming economic catastrophe from an unexpected event into a structurally observable process (see Scheme 1).

Scheme 1. Integrated Economic Catastrophe Algorithm as a Recursive Risk-Governance Cycle



Source: Author's Loop

Note: The figure presents the functional flow of the proposed model in which hazards enter the system through existing exposure channels, interact with structural vulnerabilities, and are mediated by resilience capacity, while governance operates as a cross-cutting coordination and adaptation mechanism. The recursive feedback loop transforms realised disturbances into policy learning and structural adjustment, reconfiguring the system for subsequent periods.

While economic catastrophes cannot be fully predicted or prevented, an integrated risk management algorithm enables early identification of systemic vulnerabilities, continuous monitoring of exposure, and the design of adaptive policy layers that significantly reduce the likelihood and severity of catastrophic outcomes. Put another way, the algorithm does not predict catastrophes, it identifies where and how they may emerge.

The empirical architecture relies exclusively on secondary data from internationally harmonized and publicly available macro-structural databases. These include global datasets covering macroeconomic stability, trade integration, sectoral structure, institutional quality, financial development, energy dependence, and technological capacity. The use of internationally standardized sources ensures cross-country comparability and longitudinal consistency, which are essential for systemic risk analysis (WB, 2022; IMF, 2023; WEF, 2023).

Each component of the function $Ct = F(Ht, Et, Vt, Rt \parallel G)$ is represented through a set of proxy variables:

- Hazard (H) – indicators of external volatility and shock intensity
- Exposure (E) – measures of trade openness, import concentration, financial integration, and energy dependence
- Vulnerability (V) – structural and institutional fragility indicators
- Resilience (R) – fiscal space, policy flexibility, technological capability, and social adaptive capacity
- Governance (G) – coordination quality, regulatory effectiveness, and institutional depth

The analytical framework is designed for cross-country and cross-sectoral application. For demonstrative purposes, the sampling logic follows a comparative purposive strategy, selecting economic systems that differ in structural depth, institutional capacity, and integration into global production networks. This allows the model to capture variation in the interaction between endogenous structural characteristics and exogenous pressures, which is the core mechanism of the proposed algorithm (Flyvbjerg, 2006).

The unit of analysis is the national economic system observed over time, while the time dimension enables the identification of slow-forming structural pressures and threshold effects.

The study relies exclusively on aggregated secondary data from publicly accessible international databases, which contain no personal or confidential information. Consequently, it does not require formal ethical approval. The research follows international standards of data transparency, reproducibility, and proper source attribution in accordance with open science principles (OECD, 2007).

The analytical procedure follows a dashboard-based and process-tracing approach. First, proxy indicators are assigned to each functional component of the model. Second, their evolution over time is examined to identify structural trends and interaction effects. Third, the analysis maps the co-movement between increasing external pressure and changes in structural depth.

The objective is not to aggregate variables into a composite index, but to interpret their dynamic relationships within the functional logic of the model. This corresponds to a systemic risk mapping strategy, where emphasis is placed on transmission channels, feedback loops, and potential threshold zones rather than on point prediction (Acemoglu et al., 2015; Battiston et al., 2016).

The framework is fully compatible with future econometric implementation. The operational workflow can be implemented in standard statistical environments such as Stata allowing panel-data estimation, network analysis, or early-warning signal detection in subsequent empirical research.

9. Results

9.1. The Changing Nature of Economic Disasters: From Exogenous Shocks to Systemic Fault Lines

Traditional economic crisis analysis has largely been built on the assumption that catastrophic outcomes are triggered by identifiable exogenous shocks – financial crashes, commodity price spikes, natural disasters, or abrupt geopolitical disruptions. In this view, the shock is treated as the primary analytical object, while the structure of the affected economy is considered a passive transmission mechanism. Such an approach proved analytically useful in a world of relatively contained interdependence, where disturbances were episodic and recovery paths were broadly aligned with cyclical adjustment. However, the increasing density of global production networks, financial integration, technological dependence, and energy interconnections has fundamentally altered the anatomy of economic disasters. Contemporary crises rarely emerge as isolated events; instead, they unfold as cascading processes in which multiple disturbances interact with pre-existing structural conditions.

In this new environment, catastrophic outcomes are less the result of the magnitude of a single shock and more the consequence of accumulated systemic stress. Slow-moving processes – such as declining diversification, institutional erosion, persistent external imbalances, technological dependence, demographic pressures, or rising inequality – create latent fault lines within the economic system. These structural weaknesses remain largely invisible during periods of stability but become decisive under conditions of stress, when even moderate external disturbances can trigger disproportionate and non-linear effects. Economic disasters therefore increasingly resemble phase transitions: the visible rupture occurs at a specific moment, but its causes are embedded in long-term structural configurations.

At the same time, the boundary between exogenous and endogenous risk has become progressively blurred. External shocks propagate through trade, financial, energy, and technological networks whose architecture is itself the outcome of domestic development strategies and policy choices. Exposure is therefore not an exogenous condition but a co-produced structural feature, while vulnerability reflects the depth, quality, and adaptability of the national economic system. This implies that crisis intensity is determined not only by the nature of the disturbance but by the interaction between network position, internal resilience, and governance capacity. As a result, two economies facing the same external shock may experience entirely different trajectories, ranging from rapid adaptation to systemic breakdown.

These transformations reveal the limitations of analytical frameworks that focus exclusively on shock identification or on the ex post measurement of losses. What is required is an integrated perspective capable of capturing the dynamic interaction between hazards, transmission channels, structural sensitivity, and adaptive capacity. The integrated algorithm proposed in this paper responds to this need by shifting the analytical focus from event-based crisis detection to the continuous mapping of systemic risk. By formalising the recursive relationship between hazard, exposure, vulnerability, resilience, and governance, the framework makes it possible to interpret economic disasters not as isolated disruptions but as the realisation of stresses accumulated along structural fault lines. In doing so, it provides a coherent analytical bridge between crisis theory, resilience economics, and risk governance, and establishes the basis for a process-oriented approach to prevention, absorption, and transformation.

9.1.1. Sub-subsections

Use further subdivisions if needed to clarify complex findings.

- **Bullet points** can be used for highlighting specific observations.
- **Numbered lists** are useful for stepwise descriptions.

Numbered lists can be added as follows:

1. First item
2. Second item
3. Third item

9.2. Figures, Tables, and Schemes

Figure 1, Table 1, etc.

Figure 1. This is a figure. Captions/titles should be placed **below the figure** (not above).

Table 1. This is a table. Tables should be placed in the main text near the first time they are cited.

Title 1	Title 2	Title 3
entry 1	data	data
entry 2	data	data [1]

[1] Tables may have a footer.

10. Discussion

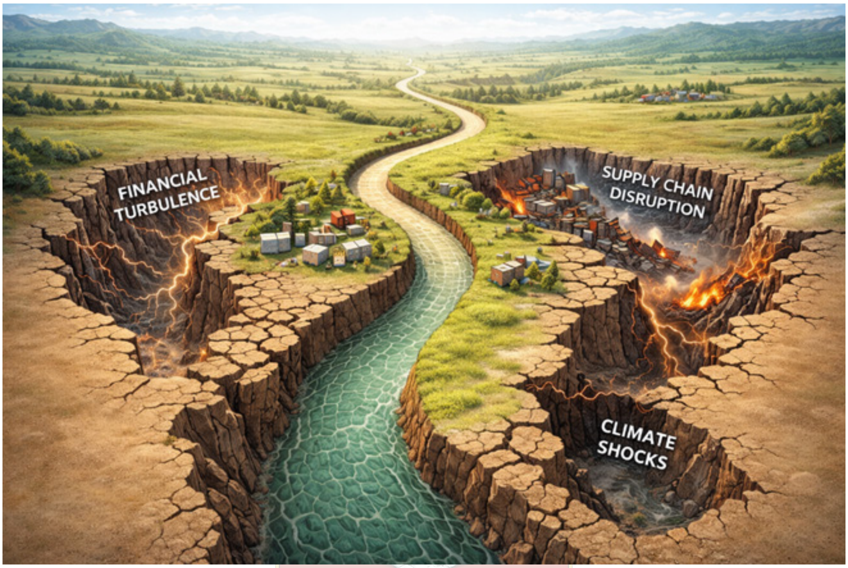
10.1. Conceptual Interpretation: Economic Catastrophes as Dynamic System Failures Along Structural Fault Lines

The proposed framework interprets the economy as a moving developmental path carved into a landscape of interacting pressures, where the depth, coherence, and direction of the path reflect the quality of structural transformation and governance (Image 1). Economic catastrophes do not appear as sudden breaks on a flat surface; they occur where this path becomes shallow, fragmented, or poorly coordinated, and where surrounding external pressures – represented as fault channels – intensify. In this sense, crises are not isolated events but moments when accumulated tensions exceed the structural depth of the system. This interpretation draws on systems thinking (Meadows, 2008) and the adaptive-cycle logic (Gunderson & Holling, 2002), where visible disruption is the outcome of long-term interactions between internal structure and external disturbance.

10.1.1. Hazard: The Pressure Flowing Through the Fault Channels

In the visual metaphor, hazards are not the cracks themselves but the forces flowing through the surrounding channels – financial volatility, geopolitical tensions, supply-chain disruptions, technological shifts, climate events. Their depth and width vary over time, reflecting the intensity of global turbulence. However, their destructive potential is relational: strong external pressure only becomes catastrophic where the economic path is shallow. This reflects the Minskian insight that instability is endogenously generated and revealed by shocks (Minsky, 1986), as well as the broader risk-society argument that modern hazards are systemic rather than exceptional (Beck, 1992). The same external wave may pass almost unnoticed along a deep and coherent path, yet overflow and collapse a shallow one.

Figures 1. Economic journey through turbulent challenges



Source: Author's illustration

10.1.2. Exposure: The Points Where the Path Meets the Channel

Exposure corresponds to the points of contact between the central economic path and the surrounding fault channels. These are the trade corridors, financial linkages, energy dependencies, and technological interfaces through which external pressures enter the system. In network terms, they represent the economy's positionality within global production and financial structures. Highly connected economies are not necessarily fragile; fragility arises when strong exposure is combined with insufficient structural depth. This is consistent with the global value chain perspective (Gereffi, 2018) and the new geography of production described in Baldwin's The Great Convergence (2016), where integration increases both opportunity and transmission speed of shocks. In the image 1, the wider the channels and the more directly they intersect the path, the stronger the transmission mechanism.

10.1.3. Vulnerability: The Structural Depth of the Economic Path

Vulnerability is the depth and compactness of the path itself. A deep path represents diversified production, institutional coherence, technological capability, social inclusion, and credible macroeconomic policy. A shallow path reflects structural dualism, weak institutions, narrow fiscal space, and low productive complexity. This interpretation is closely aligned with the capability-based development approach in Development as Freedom (Sen, 1999) and with the economic complexity literature (Hidalgo & Hausmann, 2009), where development is understood as the accumulation of productive knowledge that increases adaptive capacity. Metaphorically, shallow segments are the zones where even modest external pressure causes erosion and fragmentation. These are the latent fault lines of the economy – long periods of apparently stable growth that conceal declining transformative capacity.

10.1.4. Conceptual Interpretation: Economic Catastrophes as Dynamic System Failures Along Structural Fault Lines

Resilience is not simply the ability to repair a damaged segment of the path; it is the capacity to deepen, redirect, and reinforce it while pressure is still present. This corresponds to the distinction between recovery and transformation in Resilience Thinking (Walker & Salt, 2006). A resilient economy uses disturbance to upgrade its productive structure, diversify its linkages, and reduce future exposure. Visually, resilient systems are those that progressively carve a deeper and more stable trajectory even where external channels remain active. By contrast, systems that repeatedly rebuild the same shallow segments remain locked into cycles of disruption, echoing the historical patterns of crisis and recovery described in Aliber & Kindleberger (2011) and Reinhart and Rogoff (2009).

10.1.5. Governance: The Engineering Intelligence That Shapes the Entire Landscape

Governance is the meta-layer that determines how the path is constructed and how the surrounding channels are managed. It decides where to deepen the trajectory, where to build protective buffers, how to redirect flows, and how to transform exposure into strategic integration rather than dependency. In evolutionary political economy, policy is not a corrective intervention but a continuous process of coordination and learning (Rodrik, 2007; Acemoglu & Robinson, 2012). Metaphorically, governance is the invisible but decisive force that shapes the terrain itself: without it, the path follows the easiest short-term route and remains shallow; with it, the path becomes a long-term developmental corridor capable of withstanding external pressure.

10.2. Cross-Sector Applicability of the Systemic Resilience Workflow

The systemic resilience workflow proposed in this paper is not confined to a single policy domain; rather, it provides a transferable analytical architecture for tracing how hazards interact with exposure, vulnerability, and resilience across structurally different but functionally interconnected sectors. By translating the dynamic function of catastrophe formation into sector-specific configurations, the framework enables a comparative reading of risk accumulation and buffering capacity within trade, finance, energy, and security systems. This cross-sector perspective reflects the growing recognition in complex systems and global risk literature that contemporary crises propagate through tightly coupled networks rather than within isolated institutional silos (Helbing, 2013; WEF, 2023). In this context, resilience becomes a relational and governance-dependent property: the same external disturbance produces divergent outcomes depending on the depth of institutional capacity, the diversification of structures, and the degree of strategic coordination, as emphasized in recent European Union approaches to open strategic autonomy and integrated risk management (European Commission, 2021a, 2022). The table that follows operationalizes this logic by mapping the four-layer model across the selected sectors, demonstrating how the common workflow can support continuous monitoring, policy prioritization, and anticipatory economic governance.

Table 1. Applicability Across Domains

Sector	Hazard	Exposure	Vulnerability	Resilience
Trade	Supply-chain disruptions, protectionist shocks, logistics breakdowns, maritime chokepoints	High trade openness, import dependency in strategic goods, concentration of partners and routes	Low diversification, weak domestic value chains, limited storage and buffering capacity	Supplier diversification, nearshoring/friendshoring, strategic reserves, adaptive trade policy
Finance	Sudden capital outflows, liquidity freezes, asset price volatility, banking contagion	Financial openness, external debt, foreign currency lending, cross-border banking linkages	Shallow domestic capital markets, currency mismatch, regulatory gaps, high leverage	Macroprudential frameworks, capital buffers, lender-of-last-resort capacity, financial supervision integration

Energy	Price spikes, physical supply disruption, infrastructure attacks, technology lock-in	Import dependence, centralized generation, fossil fuel reliance, grid interconnection asymmetry	Lack of diversification in energy mix, aging infrastructure, slow permitting, limited storage	Renewable diversification, smart grids, storage capacity, demand-side flexibility, regional interconnectors
Security	Hybrid threats, cyber-attacks, disinformation, critical infrastructure sabotage, geopolitical spillovers	Digitalized governance systems, external technology dependence, open data and infrastructure networks	Institutional fragmentation, interoperability gaps, legacy ICT systems, cyber skills shortages	System redundancy, coordinated crisis response, secure digital architecture, strategic technological autonomy

Source: Author's elaboration

References: Systemic risk & complex adaptive systems – Arthur (1994), Helbing (2013), WEF (2023); Financial exposure & resilience – Brunermeier & Oehmke (2013), Tooze (2019); Trade & strategic autonomy – Baldwin & Evenett (2020), Rodrik (2011), European Commission (2021a); Energy transition & security – IEA (2021) European Commission (2022); Security & cyber resilience – European Commission (2021c), European Council (2022); Conceptual shift from risk → resilience governance – Knight (1921), Taleb (2007), Mazzucato (2021)

The table operationalizes the paper's central proposition that economic catastrophes are not single events but systemic failures emerging from the interaction between structural exposure and institutional capacity.

Across all four sectors, hazards represent external or endogenous triggers, but they do not by themselves produce systemic breakdowns. Their transformative impact depends on the configuration of exposure – the structural openness, interdependence, and concentration patterns embedded in the system.

Vulnerability is interpreted as a governance and development variable, not merely a risk condition. It reflects coordination failures, technological asymmetries, and regulatory fragmentation. In this way, vulnerability becomes the key transmission channel through which shocks evolve into economic disasters.

Resilience, in the proposed workflow, is not limited to recovery capacity. It captures redundancy, diversification, adaptive policy capability, and institutional learning. This confirms the shift from traditional risk management toward continuous systemic monitoring and resilience governance, which is the core analytical contribution of the model.

Most importantly, the unified structure demonstrates that the same algorithmic logic can be applied across sectors, making the framework: scalable, comparable, and operational for policymaking without reducing complexity to a single composite indicator.

In the context of the European Union, the four-dimensional structure closely corresponds to the policy logic embedded in the European Commission frameworks on resilience, particularly the Recovery and Resilience Facility (European Commission, 2021b), the Strategic Compass (European Council, 2022)., and the REPowerEU agenda (European Commission, 2022). Hazard aligns with the EU concept of shocks and stressors; exposure corresponds to open strategic autonomy and interdependence mapping; vulnerability reflects structural reform needs; while resilience mirrors the EU understanding of adaptive capacity, diversification, and coordinated crisis response. This semantic convergence strengthens the framework's direct applicability within EU resilience governance and cohesion-policy programming.

10.3. Synthesis: Catastrophes as Ruptures of Shallow Developmental Trajectories

When the five components are observed together, the visual landscape becomes a dynamic representation of modern capitalism. External pressures are constant and often intensifying, but catastrophic rupture occurs only where they intersect with insufficient structural depth and weak adaptive coordination. The analytical focus therefore shifts from predicting the arrival of shocks to mapping the topology of the path – its depth, continuity, and capacity to evolve. This interpretation transforms crisis analysis into the study of how economic systems carve their long-term trajectories within an environment of permanent turbulence, consistent with the complexity view of the economy as an evolving system (Arthur, 2015) and with the uneven-development tradition (Smith, 2008).

In this sense, the integrated algorithm provides more than a functional model: it offers a spatial and dynamic language for understanding economic disasters as the outcome of interactions between structural quality, network position, and governance effectiveness. The central research implication is clear and directly aligned with the visual metaphor: modern economic catastrophes do not originate in the shock itself, but in the shallow segments of the developmental path where accumulated structural weaknesses meet intensified external pressure.

11. Conclusions

This paper has argued that modern economic catastrophes can no longer be adequately understood as the consequence of isolated exogenous shocks. Rather, they emerge as systemic ruptures along slow-forming structural fault lines produced by the interaction of endogenous policy depth, institutional capacity, and evolving external pressures. The central contribution of the paper is therefore not a predictive model in the conventional sense, but a process-oriented algorithmic framework that enables the continuous monitoring, interpretation, and management of these dynamics.

By conceptualizing the economy as a winding developmental path whose depth reflects the quality of governance and structural resilience, and by representing external disturbances as lateral pressures that penetrate the system only where this depth is insufficient, the paper offers a new operational language for integrated risk management. Economic catastrophe appears not as an unexpected event, but as the visible moment in which accumulated vulnerabilities intersect with intensified external stress. In this sense, resilience is not a buffer applied after the shock, but a structural property built through the long-term deepening of the path itself.

The proposed formulation Ct=F(Ht,Et,Vt,Rt∥G) repositions risk analysis from outcome measurement to dynamic governance architecture. It enables simultaneous observation of hazards, exposure, vulnerability, and resilience as co-evolving layers and transforms crisis management into a continuous policy function rather than an episodic response. Such an approach is consistent with insights from complexity economics, systemic risk theory, and resilience thinking (Walker, & Salt, 2006), yet it advances the literature by providing a clear methodological flow for their integration.

Beyond its economic application, the framework has potential relevance for other domains characterized by cascading risks and structural fragilities – including environmental governance, energy transitions, regional development, and public health systems – thereby opening space for a broader interdisciplinary research agenda.

For policy, the implications are direct: the primary task is not to eliminate shocks, but to increase the structural depth of the economic path so that external pressures remain lateral rather than disruptive. Economies that invest in institutional quality, diversification, technological upgrading, and adaptive governance reduce the probability that stress will translate into rupture.

Future research will operationalize the algorithm through empirical indicators, comparative regional applications, and simulation modeling, allowing the transition from conceptual architecture to measurable systemic diagnostics. In doing so, the framework presented here can evolve from a conference model into a scalable analytical tool for understanding and managing the economic catastrophes of the twenty-first century.

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