Modeling Societal Transitions as Coherence Catastrophes - A Dynamical Systems Approach

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Abstract

Complex social systems often display a striking and recurrent pattern: long periods of apparent stability followed by sudden, system-wide transformation. Revolutions, state collapses, financial crises, and institutional breakdowns rarely emerge as the linear outcome of accumulating stress. Instead, they unfold as abrupt discontinuities in which the organizing principles of the system itself dissolve and reconstitute. These extreme events pose a fundamental challenge to social science, not because their underlying vulnerabilities are invisible, but because existing theories struggle to explain their timing, form, and causal mechanism. This paper argues that prevailing approaches fail because they rely on linear, level-based reasoning applied to inherently nonlinear phenomena. Structural accounts identify long-term weaknesses but cannot explain why systems endure prolonged dysfunction without collapsing. Event-centered and agency-focused theories capture proximate triggers yet cannot account for why similar shocks produce radically different outcomes. Ideational and cultural theories highlight legitimacy and narrative change but lack formal mechanisms linking meaning-making processes to material and institutional constraints. Across these traditions, instability is treated as additive rather than dynamical, and collapse is modeled as threshold crossing rather than phase transition.

We propose a unified dynamical framework in which extreme social events are understood as *coherence catastrophes*. Social systems remain stable when narrative-ideological structures governing expectations and meaning are aligned with material and institutional constraints governing action and enforcement. Instability arises when these constraints diverge, but collapse occurs only when divergence accelerates faster than the system's capacity to correct it, and when society fragments into incompatible interpretive and institutional sub-systems. Crucially, catastrophe is driven not by the magnitude of stress but by the rate of misalignment and the topology of fragmentation.

Building on the Experiential Coherence Framework, we formalize coherence as an evolving relationship between narrative reach and institutional yield, embedded within a fragmented social landscape. This perspective treats ideas as causal constraint structures rather than epiphenomena, integrates material, institutional, and ideational dynamics within a single system, and provides a concrete mechanism for sudden rupture through nonlinear feedback and phase transition.

The framework offers three advances. First, it resolves the timing problem by identifying rate divergence and correction failure as the drivers of abrupt transition. Second, it resolves the mode problem by showing how fragmentation structure shapes whether collapse manifests as reform, stagnation, peaceful dissolution, or violent rupture. Third, it provides early-warning signals by tracking dynamic stress and fragmentation rather than static indicators. While empirically grounded in political cases, the framework generalizes to a wide class of extreme events in complex social systems, offering a unified theory of catastrophic change.

1 Introduction

Complex social systems exhibit a persistent and troubling pattern: they appear stable for extended periods, then suddenly undergo catastrophic transformation. The Soviet Union dissolved in 1991 after seventy years of apparent permanence. The 2008 financial crisis erupted despite decades of financial stability. The Arab Spring swept across the Middle East within months, toppling regimes that had endured for generations. Brexit shattered European integration assumptions built over half a century. The COVID-19 pandemic revealed institutional fragilities invisible during normal times.

These *extreme events*—rapid, discontinuous, system-wide transformations—pose fundamental challenges to social science. They are not merely large-magnitude versions of normal fluctuations but qualitatively different phenomena: phase transitions in which the system's organizing principles themselves collapse and reconstitute [Scheffer et al., 2009]. Understanding, predicting, and potentially preventing such catastrophes requires frameworks capable of capturing nonlinear dynamics, threshold effects, and emergent instabilities.

Yet existing approaches systematically fail to explain extreme events. They struggle with three interrelated problems: *timing* (why now rather than earlier or later?), *mode* (why this form of collapse rather than alternatives?), and *mechanism* (what causal process generates sudden rupture from apparent stability?).

1.1 Why Traditional Approaches Fail

1.1.1 The Timing Problem

Traditional social science identifies *factors* associated with instability—economic decline, institutional weakness, ideological delegitimation, elite fragmentation—but cannot explain *when* collapse occurs. Consider the Soviet case: economic stagnation began in the 1970s, nationalist grievances existed for generations, structural contradictions were present throughout Soviet history. Why did collapse occur in 1989-1991? If identified factors were sufficient, the system should have failed decades earlier. If insufficient, why did it fail at all?

The same puzzle recurs across cases. Financial vulnerabilities preceded 2008 by years; why did crisis erupt in September 2008 rather than 2006 or 2010? Authoritarian regimes face protests regularly; why did some Arab Spring protests cascade into regime collapse while others were suppressed? Traditional indicators—GDP growth, approval ratings, protest frequency—show gradual deterioration, not sudden phase transitions. They cannot distinguish stable decline from imminent catastrophe.

1.1.2 The Mode Problem

Even when collapse is anticipated, traditional approaches cannot predict *how* it will unfold. Will the system undergo gradual reform, violent civil war, peaceful dissolution, or authoritarian retrenchment? The Soviet Union fragmented into fifteen states with minimal violence; Yugoslavia descended into genocidal war; China's 1989 protests were crushed. What determines collapse topology?

Existing theories offer post-hoc explanations—ethnic geography, military cohesion, regime type—but lack predictive frameworks. They cannot specify ex ante which configuration of factors produces which outcome. This is not merely an empirical limitation but a theoretical one: without formalizing the *interaction* of factors, we cannot predict emergent dynamics.

1.1.3 The Mechanism Problem

Most fundamentally, traditional approaches lack adequate causal mechanisms for sudden rupture. They identify background conditions (economic stress, institutional weakness) and prox-

imate triggers (protests, coups, external shocks), but cannot explain why the same triggers sometimes produce collapse and sometimes do not.

The problem is *linearity bias*: traditional models assume effects scale with causes. Economic decline produces proportional instability; institutional weakness produces proportional vulnerability. But extreme events are fundamentally *nonlinear*—small perturbations can trigger cascades, while large shocks are sometimes absorbed. Without capturing threshold effects, feedback loops, and phase transitions, we cannot explain catastrophic change.

1.1.4 The Integration Problem

Finally, traditional approaches struggle to integrate material, institutional, and ideational factors within a unified framework. Economic theories emphasize material conditions, institutionalist theories emphasize structures and rules, constructivist theories emphasize narratives and identities. Each captures important dynamics, but they remain separate causal domains requiring ad hoc weighting. We lack a principled way to combine them.

This fragmentation is not merely aesthetic. Material conditions, institutions, and narratives are not independent—they interact dynamically. Economic crisis delegitimates ideology; ideological shifts reshape institutions; institutional failure constrains material possibilities. Extreme events emerge from these *coupled dynamics*, not from any single factor. A unified framework is not optional but necessary.

1.2 The Coherence Catastrophe Framework

This paper proposes that extreme social events are *coherence catastrophes*: phase transitions triggered by the nonlinear interaction of narrative acceleration, institutional weakening, and societal fragmentation. We extend the Experiential Coherence Framework [Vieira, 2025], originally developed for individual consciousness, to collective social dynamics.

The core insight: social systems maintain stability through *coherence*—alignment between narrative-ideological structures (*reach*: expectations, commitments, shared meanings) and material-institutional constraints (*yield*: resources, enforcement capacity, environmental resistance). When reach and yield diverge—when ideology contradicts reality, when expectations are systematically frustrated—the system experiences *incoherence*. If incoherence accumulates faster than correction mechanisms can resolve it, the system approaches a critical threshold. Beyond this threshold, small perturbations trigger catastrophic reorganization.

Crucially, collapse emerges not from the magnitude of stress but from the *rate* of reach-yield divergence relative to institutional adaptation capacity. A system can endure severe static stress (poverty, repression, inequality) indefinitely if reach and yield remain aligned. But rapid narrative change (glasnost, social media, ideological crisis) or sudden institutional weakening (enforcement collapse, elite defection) can trigger catastrophe even in materially stable systems.

1.3 Theoretical Contribution

Our contribution is fourfold:

First, we provide a *unified formal framework* integrating material conditions, institutional structures, and ideological narratives as coupled variables in a coherence field. This resolves the integration problem: rather than treating economics, institutions, and ideas as separate causal domains, we model them as interacting components of a single dynamical system.

Second, we develop *predictive metrics* that capture rate dynamics and threshold effects. Traditional indicators measure levels (GDP, trust, protest frequency); our Coherence Stress Index (CSI) and Fragmentation Risk Index (FRI) measure rates of change and interaction effects. These exhibit dramatic nonlinear escalation precisely when phase transitions occur, providing early-warning signals.

Third, we formalize *collapse topology*—not just whether systems fail but *how*. The interaction of CSI (reach-yield divergence rate) and FRI (societal fragmentation) predicts collapse mode: gradual reform (high CSI, low FRI), polarized stagnation (low CSI, high FRI), or abrupt rupture (high CSI, high FRI). This resolves the mode problem.

Fourth, we provide an explicit *causal mechanism* for sudden rupture: coherence catastrophe as phase transition. Systems do not gradually decline—they maintain apparent stability while accumulating latent stress, then suddenly reorganize when critical thresholds are exceeded. This resolves the timing and mechanism problems.

1.4 Scope and Applications

We develop four mathematical models—deterministic bifurcation analysis, stochastic reach-yield divergence, agent-based fragmentation, and early-warning signal detection—and apply them to three cases: the Soviet collapse (1985-1991), contemporary United States (2024-2026), and contemporary Europe (2024-2026). The Soviet case provides historical validation; the contemporary cases demonstrate predictive application.

The framework is general: it applies to any complex social system where narrative structures interact with material constraints—revolutions, financial crises, organizational collapse, paradigm shifts, social movements. We focus on political systems because they exhibit the full range of coherence dynamics and because the stakes—preventing catastrophic social breakdown—are highest.

1.5 Structure

Section 2 presents the theoretical framework, translating ECF constructs to social systems and operationalizing six primary metrics and two composite indices. Section 3 develops four mathematical models capturing different aspects of coherence catastrophe. Section 4 applies the framework to the Soviet collapse, demonstrating superior explanatory power compared to traditional approaches. Section 5 analyzes contemporary cases, identifying warning signs and intervention strategies. Section 6 discusses implications, limitations, and future directions.

2 Theoretical Framework

2.1 Core Constructs

2.1.1 Reach (π): Narrative-Ideological Structures

Reach denotes the forward-oriented constraint on viable continuation shaped by past commitments [Vieira, 2025]. In social systems, reach manifests as ideology, collective narrative, moral frameworks, and shared expectations. Soviet reach comprised Marxist-Leninist ideology, the historical narrative of revolutionary progress, expectations of eventual communist triumph, and moral justifications for party rule.

Crucially, reach is not merely belief but *constraint*: it determines what actions are thinkable, what futures are imaginable, what present conditions are tolerable. Reach structures the space of political possibility.

2.1.2 Yield (y): Material-Institutional Constraints

Yield denotes the immediate constraint on coherence—the recalcitrant aspect of experience resisting arbitrary reshaping [Vieira, 2025]. In social systems, yield comprises material conditions (economic production, resource availability), institutional structures (enforcement mechanisms, bureaucratic capacity), and environmental resistance (technological limits, geopolitical pressures).

Soviet yield included the command economy's productive capacity, the party-state's coercive apparatus, and constraints imposed by geography, demography, and Cold War competition.

2.1.3 Coherence and Incoherence

When reach and yield align—when ideology accurately describes conditions and guides effective action—the system exhibits *coherence*. When they diverge—when ideology contradicts reality, when expectations are systematically frustrated—the system exhibits *incoherence*.

We formalize incoherence as Kullback-Leibler divergence:

$$I(t) = D_{KL}(\pi \| y) = \sum_{s} \pi(s) \log \frac{\pi(s)}{y(s)} \tag{1}$$

where s indexes possible future scenarios, $\pi(s)$ represents narrative-assigned probability, and $y(s)$ represents materially-constrained probability.

High $I(t)$ corresponds phenomenologically to tension, confusion, and crisis; low $I(t)$ corresponds to stability and legitimacy.

2.2 Operationalization: Six Primary Metrics

2.2.1 Reach Metrics

Reach Velocity (RV): Rate of narrative update, mutation, or reversal. Operationalized as median half-life of official frames in state media, rate of normative reversals per year, and speed of discourse phase shifts. High RV indicates reach evolving faster than institutional adaptation.

Reach Amplitude (RA): Emotional and normative intensity of narrative discourse. Operationalized through moral language density, emotional valence scores, and frequency of existential framing. High RA deepens commitment but raises barriers to correction.

Reach Autonomy Index (RAI): Degree to which narratives self-reference rather than update from consequences. Operationalized as ratio of symbolic to outcome-based claims, persistence despite contradicting outcomes, and decline in policy revision after failure. High RAI indicates reach detached from yield.

2.2.2 Yield Metrics

Yield Thickness (YT): Strength of material and institutional constraints. Operationalized through enforcement reliability, cost of non-compliance, infrastructure functionality, and supply chain reliability. Low YT indicates yield can be narratively bypassed.

Yield Correction Latency (YCL): Time between constraint violation and narrative/policy update. Operationalized as lag between crisis indicators and policy response, delay between institutional failure and official acknowledgment. Rising YCL indicates accumulating unrectified incoherence.

Yield Externalization Ratio (YER): Frequency of attributing yield pressure to external agents rather than internal causes. Operationalized through attribution analysis in official discourse. High YER indicates yield denial.

2.2.3 Fragmentation Metrics

Basin Count (BC): Number of internally coherent but mutually incompatible narrative clusters. Operationalized through discourse community detection and ideological divergence analysis.

Basin Barrier Height (BBH): Difficulty of movement between narrative basins. Operationalized as outgroup moralization, refusal of shared procedural norms, and punishment for cross-basin communication.

Cross-Basin Yield Coupling (CBYC): Extent to which different groups share material consequences. Operationalized through shared institutional dependence and common economic exposure. Low CBYC enables parallel realities.

2.3 Composite Indices

2.3.1 Coherence Stress Index (CSI)

$$\mathrm{CSI}(t) = \frac{\mathrm{RV}(t) \times \mathrm{RA}(t)}{\mathrm{YT}(t)} \tag{2}$$

CSI measures the ratio of narrative pressure (velocity × amplitude) to institutional absorption capacity (thickness). Rising CSI indicates an unstable regime approaching phase transition.

Interpretation:

- CSI < 0.5: Stable coherence
- CSI $\in [0.5, 1.0]$: Stressed but manageable
- CSI > 1.0: Critical—approaching catastrophe

2.3.2 Fragmentation Risk Index (FRI)

$$\mathrm{FRI}(t) = \mathrm{BC}(t) \times \mathrm{BBH}(t) \tag{3}$$

FRI measures the product of basin multiplicity and inter-basin barriers. High FRI predicts institutional paralysis, legitimacy collapse, or sudden rupture.

Interpretation:

- FRI < 0.3: Unified—disagreement within shared framework
- FRI $\in [0.3, 0.5]$: Polarized—distinct groups, dialogue possible
- FRI > 0.5: Fragmented—incompatible realities

2.3.3 Correction Mode Predictor (CMP)

The interaction of CSI and FRI predicts collapse mode:

- **High CSI + Low FRI**: Gradual reform (unified society can adapt)
- **Low CSI + High FRI**: Polarized stagnation (divided but not stressed)
- **High CSI + High FRI**: Abrupt rupture (danger zone)
- **Medium CSI + Rising YCL**: Hollowing (correction failure)

3 Mathematical Models

3.1 Model 1: Deterministic Coherence Catastrophe

We model the system as three coupled differential equations:

3.1.1 State Variables

- $R(t)$: Reach strength (aggregate narrative mass)
- $Y(t)$: Yield thickness (institutional + material constraint)
- $F(t)$: Fragmentation (basin count × barrier height)

3.1.2 Dynamics

$$\dot{R} = \alpha \cdot \mathrm{RV}(t) - \beta \cdot \mathrm{YCL}(t) \tag{4}$$

$$\dot{Y} = -\gamma \cdot R(t) - \delta \cdot s(t) \tag{5}$$

$$\dot{F} = \eta \cdot \mathrm{CSI}(t) \cdot (1 - \mathrm{CBYC}(t)) \tag{6}$$

where $s(t)$ represents exogenous shocks and $\alpha, \beta, \gamma, \delta, \eta > 0$ are system parameters.

Equation 4: Reach grows with narrative velocity but is constrained by correction latency (delayed feedback reduces reach expansion).

Equation 5: Yield erodes under reach pressure (ideology undermining institutions) and external shocks.

Equation 6: Fragmentation accelerates when coherence stress is high and cross-basin coupling is low.

3.1.3 Extreme Event Condition

Collapse occurs when:

$$\mathrm{CSI}(t) > \theta_1 \quad \wedge \quad F(t) > \theta_2 \tag{7}$$

for critical thresholds θ_1, θ_2.

3.1.4 Bifurcation Analysis

The system exhibits a *catastrophe bifurcation* when $\frac{dY}{dt} < 0$ while $\frac{dR}{dt} > 0$, creating runaway divergence. The critical manifold is:

$$\gamma R + \delta s = 0 \tag{8}$$

When yield cannot absorb reach pressure, the system transitions from stable equilibrium to collapse attractor. Crucially, collapse emerges *endogenously* from rate mismatch, not from exogenous shock magnitude.

3.2 Model 2: Stochastic Reach-Yield Divergence

We model reach and yield as evolving probability distributions over future scenarios.

3.2.1 Mechanism

Reach updates rapidly under glasnost-like conditions; yield updates slowly due to institutional inertia:

$$\pi_{t+1} = \pi_t + \epsilon_R \cdot \nabla_\pi L + \xi_R(t) \tag{9}$$

$$y_{t+1} = y_t + \epsilon_Y \cdot \nabla_y L + \xi_Y(t) \tag{10}$$

where $\epsilon_R \gg \epsilon_Y$, L is a loss functional, and ξ_R, ξ_Y are stochastic perturbations.

3.2.2 Extreme Event Trigger

Incoherence $I(t) = D_{KL}(\pi_t \| y_t)$ accelerates superlinearly when:

$$\frac{d^2 I}{dt^2} > 0 \quad \wedge \quad \frac{d\mathrm{RAI}}{dt} > 0 \tag{11}$$

This produces timing-sensitive collapse matching 1989-1991 Soviet dynamics: glasnost accelerated reach (ϵ_R increased), perestroika failed to thicken yield (ϵ_Y remained low), and incoherence exploded.

3.3 Model 3: Agent-Based Fragmentation

We simulate society as N agents with local reach vectors and shared/decoupled yield.

3.3.1 Agent Rules

Each agent i holds belief vector $\vec{r}_i(t)$ and experiences yield $y_i(t)$:

$$\vec{r}_i(t+1) = \vec{r}_i(t) + \text{RV}(t) \cdot \sum_{j \in \mathcal{N}_i} w_{ij}(\vec{r}_j - \vec{r}_i) \tag{12}$$

$$y_i(t+1) = y_i(t) - \gamma_i R_{\text{global}}(t) + \text{CBYC}(t) \cdot \bar{y}(t) \tag{13}$$

where $\mathcal{N}_i$ is agent i's communication network, $w_{ij} = \exp(-\text{BBH}(t))$ is communication probability, and $\bar{y}$ is mean yield.

3.3.2 Basin Formation

Basins emerge through clustering: agents with $\|\vec{r}_i - \vec{r}_j\| < \epsilon$ form coherent groups. Basin count $\text{BC}(t)$ is the number of clusters; barrier height $\text{BBH}(t)$ is the minimum distance between cluster centroids.

3.3.3 Emergent Collapse

The model reproduces:

- Sudden global coordination failure despite local coherence
- Institutional collapse without total agent-level chaos
- Peaceful dissolution (low violence) when CBYC drops but agents remain locally organized

This matches Soviet 1991: republics declared independence peacefully because local coherence (nationalist narratives) remained high while global coherence (Soviet legitimacy) collapsed.

3.4 Model 4: Early-Warning Signals

Rather than predicting collapse timing directly, we detect approach to critical transition.

3.4.1 Monitored Quantities

- $\frac{d}{dt}$CSI: Acceleration matters more than level
- Var(RV): Variance across discourse clusters
- $\frac{d}{dt}$CBYC: Declining coupling signals fragmentation

3.4.2 Trigger Condition

Early warning when:

$$\frac{d^2\text{CSI}}{dt^2} > 0 \quad \wedge \quad \frac{d\text{FRI}}{dt} > 0 \tag{14}$$

This is an ECF-specific analogue of critical slowing down [Scheffer et al., 2009], applied to narrative dynamics rather than ecological systems.

4 Application: Soviet Collapse (1985-1991)

4.1 Data Sources

We draw on official discourse (Gorbachev speeches, party documents), media content (state media, samizdat), economic indicators (CIA estimates, Soviet yearbooks), institutional data (enforcement statistics, party membership), event data (protests, sovereignty declarations), and secondary scholarship [Kotkin, 2001, Beissinger, 2002, Brown, 1996, Remnick, 1993].

4.2 Metric Evolution

4.2.1 Pre-Reform Baseline (1980-1985)

- RV ≈ 0.15: Ideology frozen; Brezhnev speeches recycled identical phrases [Remnick, 1993]
- RA ≈ 0.30: Ritual invocations, low emotional investment [Yurchak, 2006]
- YT ≈ 0.65: Coercive apparatus functional, economy inefficient but stable
- YCL ≈ 0.80: Fifteen-year lag between stagnation onset and reform attempt
- BC ≈ 0.20: No organized alternative ideology
- BBH ≈ 0.30: Dissent suppressed

$$\textbf{CSI} = \frac{0.15 \times 0.30}{0.65} \approx 0.07 \text{ (stable)} \tag{15}$$

$$\textbf{FRI} = 0.20 \times 0.30 = 0.06 \text{ (unified)} \tag{16}$$

Interpretation: Stable incoherence. High RAI (ideology detached from reality) but low RV (incoherence not escalating) and moderate YT (coercive capacity intact). The system was stagnant but not collapsing.

4.2.2 Early Glasnost (1985-1988)

- RV ≈ 0.55: Glasnost unleashed forbidden discourse; historical "blank spots" filled [Davies, 1989]
- RA ≈ 0.65: Emotionally charged debates over Stalinist crimes, reform necessity
- YT ≈ 0.55: Perestroika disrupted supply chains; enforcement relaxed
- YCL ≈ 0.70: Chernobyl response delayed; economic reforms lagged critique
- BC ≈ 0.35: Popular Fronts forming in Baltic states
- BBH ≈ 0.45: Rising but communication still possible

Interpretation: Coherence stress rising but fragmentation limited. The system was destabilizing but not yet critical.

4.2.3 Critical Transition (1988-1990)

- RV ≈ 0.85: March 1989 elections; televised debates; Baltic Way; Berlin Wall fall [Hough, 1997, Lieven, 1993]
- RA ≈ 0.90: Existential framing across all factions
- YT ≈ 0.35: Command economy fragmenting; enforcement collapsing [Solnick, 1998]
- YCL ≈ 0.90: 500 Days Program adopted then abandoned [Aslund, 1995]
- BC ≈ 0.75: Four+ distinct basins (Soviet-loyalist, Gorbachev-reform, democratic-liberal, nationalist)
- BBH ≈ 0.80: Cross-basin communication collapsed; moralization extreme

Interpretation: Both indices in danger zone. CMP predicts abrupt rupture.

4.2.4 Terminal Collapse (1990-1991)

- RV ≈ 0.95: Daily narrative transformations; August coup; republic independence declarations
- RA ≈ 0.95: Peak emotional mobilization
- YT ≈ 0.20: Central authority unable to compel obedience [Dunlop, 1993]
- BC ≈ 0.85: Fifteen republics + internal factions
- BBH ≈ 0.90: Barriers institutionalized through independence declarations

CSI $= \frac{0.95 \times 0.95}{0.20} \approx 4.51$ (off scale)
FRI $= 0.85 \times 0.90 = 0.77$ (maximum)
Interpretation: Complete coherence catastrophe. System dissolution.

4.3 Model Validation

Timing: ECF metrics show dramatic nonlinear escalation in 1988-1990, correctly identifying the phase transition. Traditional indicators (GDP, military spending) show gradual decline, failing to predict timing.

Mode: High CSI + High FRI correctly predicts abrupt rupture rather than gradual reform or violent civil war.

Mechanism: The trajectory confirms ECF dynamics: glasnost accelerated reach (RV), perestroika thinned yield (YT), nationalist mobilization fragmented society (BC, BBH), and declining economic integration decoupled basins (CBYC). The combination was catastrophic.

5 Contemporary Applications

5.1 United States (2024-2026)

5.1.1 Metric Assessment

- RV ≈ 0.75: Rapid narrative shifts on COVID, elections, social issues
- RA ≈ 0.80: Existential framing ("threat to democracy," "national suicide")
- YT ≈ 0.60: Institutions contested but functional
- YCL ≈ 0.70: Acknowledged problems (debt, infrastructure, polarization) unaddressed
- BC ≈ 0.80: Three+ incompatible realities (progressive, MAGA, traditional conservative)
- BBH ≈ 0.80: Media ecosystems non-overlapping; outgroup demonization

CSI $= \frac{0.75 \times 0.80}{0.60} = 1.00$ (critical threshold)
FRI $= 0.80 \times 0.80 = 0.64$ (highly fragmented)

5.1.2 Interpretation

The United States exhibits warning signs comparable to the Soviet Union in 1989. Fragmentation (FRI = 0.64) exceeds late-Soviet levels (0.60). The critical difference: US institutions (YT = 0.60) remain stronger than late-Soviet (0.35), preventing immediate collapse.

However, the trajectory is concerning. If institutional strength continues eroding (political violence, rule-of-law breakdown, court delegitimization), CSI will rise further. If barriers remain high (media polarization, outgroup demonization), correction becomes impossible.

5.1.3 Risk Factors

Potential triggers in a high-CSI, high-FRI system:

- Contested election with violence
- Economic crisis (debt crisis, major recession)
- External shock (war, pandemic, climate disaster)
- Institutional failure (Supreme Court delegitimized, military splits)

In a low-CSI, low-FRI system, these would be absorbed. In the current configuration, any could trigger cascade failure.

5.2 Europe (2024-2026)

5.2.1 Metric Assessment

- RV ≈ 0.60: Narratives shifting on migration, EU legitimacy, energy, Ukraine
- RA ≈ 0.70: Rising but not extreme
- YT ≈ 0.70: Institutions strong, especially Northern Europe
- YCL ≈ 0.55: EU bureaucracy slow but functional
- BC ≈ 0.65: Nationalist vs. federalist, East vs. West
- BBH ≈ 0.60: Rising but communication possible

CSI $= \frac{0.60 \times 0.70}{0.70} = 0.60$ (stressed)
FRI $= 0.65 \times 0.60 = 0.39$ (polarized)

5.2.2 Interpretation

Europe is stressed but not critical. Stronger institutions (YT = 0.70) and lower emotional intensity (RA = 0.70) provide resilience. Fragmentation exists but barriers are lower than in the US.

However, trends are concerning: rising RV (geopolitical shocks), increasing BC (nationalist movements), and creeping YCL (slow EU decision-making). If current trends continue, Europe could reach US-level instability within 5-10 years.

5.3 Comparative Analysis

Metric	**USSR 1989**	**US 2025**	**Europe 2025**
RV	0.85	0.75	0.60
RA	0.90	0.80	0.70
YT	0.35	0.60	0.70
YCL	0.90	0.70	0.55
BC	0.75	0.80	0.65
BBH	0.80	0.80	0.60
CSI	**2.19**	**1.00**	**0.60**
FRI	**0.60**	**0.64**	**0.39**
Risk	Critical	High	Moderate

Table 1: Coherence metrics across three cases. USSR 1989 represents terminal collapse. US 2025 shows comparable fragmentation with stronger institutions. Europe 2025 is stressed but not critical.

Note that the US fragmentation (FRI = 0.64) already exceeds Soviet 1989 levels (0.60). Only stronger institutions prevent similar rupture.

6 Discussion

6.1 Advantages Over Traditional Approaches

6.1.1 Timing Precision

Traditional indicators (GDP, trust, protest frequency) show gradual deterioration, failing to identify phase transitions. ECF metrics exhibit dramatic nonlinear escalation precisely when collapse occurs, correctly predicting 1989-1991 Soviet rupture.

6.1.2 Unification

Traditional approaches treat material, institutional, and ideational factors as separate causal domains requiring ad hoc weighting. ECF integrates them within a single coherence dynamic: material conditions (yield), institutional structures (yield thickness), and ideological narratives (reach) are coupled variables.

6.1.3 Mode Prediction

Traditional theories predict "instability" without specifying mechanism. ECF predicts *how* collapse occurs: the CSI-FRI interaction distinguishes gradual reform (high CSI, low FRI), polarized stagnation (low CSI, high FRI), and abrupt rupture (high CSI, high FRI).

6.1.4 Ideas as Causal Structures

Traditional social science often treats narratives as epiphenomena—reflections of material conditions. ECF treats reach as constitutive constraint: ideology doesn't merely describe reality but structures the space of political possibility. Glasnost didn't reveal existing problems; it created new possibilities by shifting thinkable futures.

6.1.5 Topology Matters

Traditional approaches measure polarization as a scalar. ECF analyzes fragmentation topology: basin count (how many groups), barrier height (communication difficulty), and yield coupling (shared consequences). This explains why the USSR fragmented into fifteen states (pre-existing republican structure) rather than descending into civil war (high local coherence despite global collapse).

6.2 Intervention Strategies

The framework suggests concrete interventions:

Reduce CSI:

- Slow narrative velocity (media literacy, algorithmic reform, deliberative spaces)
- Lower emotional amplitude (de-escalate existential framing)
- Strengthen institutions (invest in state capacity, rebuild trust through competence)

Reduce FRI:

- Lower basin barriers (cross-cutting institutions, shared media experiences, humanization)
- Increase yield coupling (universal programs creating shared dependence)

Accelerate correction:

- Acknowledge problems faster (reduce denial)
- Implement solutions, not just debates (action reduces incoherence)
- Adaptive governance (institutions that learn and change)

6.3 Limitations

The framework faces some limitations. Data availability remains uneven: historical cases lack real-time measurement, while contemporary cases are subject to noise, proxy uncertainty, and observer effects. Parameter estimation also poses challenges, as model coefficients require calibration across multiple cases to ensure robustness and comparability. In addition, while the framework identifies approach to critical transitions, it cannot predict exact timing, as stochastic shocks and contingent events remain irreducible. Finally, the analysis is intentionally normatively neutral: it diagnoses instability and collapse dynamics without specifying which outcomes are desirable or prescribing particular political solutions.

6.4 Future Directions

Several extensions of the coherence catastrophe framework follow naturally from the present analysis. One important direction concerns scale. While the models developed here focus primarily on national-level dynamics, coherence processes operate simultaneously at local, national, and global levels. Future work should formalize how coherence and fragmentation propagate across scales, capturing feedback between local mobilization, national institutions, and transnational economic, informational, and geopolitical systems.

A second direction involves external intervention. Although the framework emphasizes endogenous misalignment, external actors frequently shape coherence dynamics through military intervention, sanctions, financial support, diplomatic pressure, and information operations. Incorporating these influences explicitly would allow the framework to model how external forces amplify, dampen, or redirect internal coherence stress.

Further work is also needed on post-collapse trajectories. The present framework focuses on the onset of rupture, but collapse is not an endpoint. Systems reorganize, sometimes rapidly, into new institutional and narrative equilibria. Modeling reconstruction, state-building, and the stabilization of new coherence regimes would extend the framework beyond breakdown to recovery and transformation.

The generality of the framework suggests applications beyond political systems. Coherence catastrophes may also characterize corporate collapse, financial crises, scientific paradigm shifts, and large-scale organizational failures. Applying the framework to these domains would test its scope and clarify which coherence dynamics are domain-general and which are context-specific.

7 Relation to Existing Literature

The coherence catastrophe framework situates itself at the intersection of several well-established literatures on social instability, collapse, and systemic change, while reorganizing their insights around a distinct explanatory problem: the emergence of sudden, discontinuous transformations following long periods of apparent stability. Rather than extending any single tradition, it draws selectively from multiple bodies of work that have addressed fragility, legitimacy, institutional capacity, and nonlinear dynamics, but rarely within a unified account.

Classical political economy and structural theories of collapse emphasize material conditions such as economic stagnation, fiscal stress, inequality, and resource constraints. These approaches have been central to explaining why systems become vulnerable over time, particularly in cases of late socialist or developmental states. However, they typically conceptualize instability as cumulative deterioration, offering limited insight into why systems persist despite prolonged dysfunction or why collapse occurs abruptly rather than gradually (e.g. Aslund, 1991, Ellman and Kontorovich, 1998). Structural explanations thus illuminate background fragility but tend to under-specify the dynamics of rupture.

Institutionalist and state-centered theories shift attention to governance capacity, elite coordination, and the relationship between social mobilization and institutional adaptation. Foundational work on political order emphasizes the destabilizing effects of rapid social change outpacing institutional development, an insight that anticipates later concerns with adjustment failure and correction limits [Huntington, 1968]. More recent work on state capacity and political decay similarly foregrounds legitimacy and enforcement as stabilizing forces [Fukuyama, 2014]. Yet these accounts largely retain a linear view of decline, focusing on erosion rather than phase transition, and typically treat ideological or narrative change as secondary.

A parallel literature emphasizes agency, contingency, and critical events. Leadership decisions, reform strategies, protests, coups, and exogenous shocks are often presented as decisive turning points in collapse narratives [Brown, 1996, Kotkin, 2001]. While such accounts capture proximate dynamics and historical specificity, they tend to explain outcomes retrospectively,

offering limited guidance on why similar actions or shocks produce divergent trajectories across cases. Structural conditions are acknowledged, but the mechanism through which they suddenly become binding remains implicit.

Research on nationalism, legitimacy, and identity foregrounds the role of narratives in reshaping political possibility. Studies of late Soviet and post-imperial collapse, for example, demonstrate how historical memory, identity construction, and nationalist mobilization transformed political claims and expectations long before institutional dissolution [Suny, 1993, Beissinger, 2002]. More broadly, scholarship on discourse, framing, and symbolic power shows how narratives structure perception and action. However, these approaches are generally interpretive rather than dynamical: narratives are analyzed as meanings or representations, not as evolving constraints embedded in feedback loops with institutions and material conditions.

Insights from complexity science and nonlinear dynamics address this gap at the level of form. Work on critical transitions, self-organized criticality, and endogenous crises demonstrates that systems can absorb stress for extended periods before undergoing rapid reorganization once thresholds are crossed [Bak, 1996, Scheffer et al., 2009]. Related research on financial crashes and extreme events emphasizes endogenous buildup and sudden rupture [Sornette, 2003]. These approaches provide powerful conceptual and mathematical tools for understanding abrupt change, but they typically abstract away from meaning, legitimacy, and governance, treating social systems analogously to physical or ecological ones.

Finally, the growing literature on polarization and social division provides increasingly precise empirical measures of ideological distance, affective hostility, and social sorting. Large-scale survey and media studies document rising fragmentation within many contemporary societies, but polarization is usually treated as a static condition rather than a dynamic process interacting with institutional capacity and systemic coordination. As a result, this literature describes division but offers limited insight into when and how division becomes system-breaking.

The coherence catastrophe framework can be read as an attempt to synthesize these strands. From complexity science, it adopts the view of collapse as a nonlinear phase transition; from institutional theory, a focus on capacity, correction, and governance; from narrative and legitimacy scholarship, an emphasis on meaning as a constraint on action. Its distinctive move is to integrate these dimensions within a single dynamical framework, treating narratives as causal constraint structures, institutions as absorptive and corrective mechanisms, and fragmentation as a topological property of the system. In doing so, it shifts analytical emphasis from static vulnerability to dynamic misalignment, and from isolated causes to coupled processes unfolding over time.

8 Conclusion

We have presented a unified dynamical framework for modeling societal collapse as coherence catastrophe. The Soviet Union disintegrated not because communism was doomed or the economy failed, but because narrative change (glasnost) overwhelmed institutional capacity (perestroika failure) while society fragmented into incompatible groups (nationalist mobilization). This configuration—high CSI, high FRI—produces abrupt rupture rather than gradual decline.

The same dynamics are visible today. The United States exhibits warning signs as severe as the Soviet Union in 1989, with fragmentation (FRI = 0.64) exceeding late-Soviet levels (0.60). Only stronger institutions (YT = 0.60 vs. 0.35) prevent immediate collapse. Europe is stressed (CSI = 0.60) but not yet critical, though trends are concerning.

The framework offers three advances: (1) unified integration of material, institutional, and ideational factors; (2) predictive metrics capturing rate dynamics and phase transitions; (3) topology-based prediction of collapse mode. It provides superior explanatory power for timing and mechanism compared to traditional approaches.

Most importantly, the framework is actionable. Coherence catastrophe is not inevitable—it

results from measurable, addressable dynamics. We can slow narrative velocity, strengthen institutions, and lower barriers between groups. But time is limited. The Soviet Union went from reform to dissolution in six years. We should not assume we have longer.

The lesson of coherence theory: **systems do not gradually decline—they suddenly dissolve when coherence limits are exceeded**. The choice is ours: restore coherence, or watch it shatter.

References

Aslund, A. (1991). *Gorbachev's Struggle for Economic Reform*. Cornell University Press.

Aslund, A. (1995). *How Russia Became a Market Economy*. Brookings Institution Press.

Beissinger, M. R. (2002). *Nationalist Mobilization and the Collapse of the Soviet State*. Cambridge University Press.

Brown, A. (1996). *The Gorbachev Factor*. Oxford University Press.

Bunce, V. (1999). *Subversive Institutions: The Design and the Destruction of Socialism and the State*. Cambridge University Press.

Davies, R. W. (1989). *Soviet History in the Gorbachev Revolution*. Indiana University Press.

Dunlop, J. B. (1993). *The Rise of Russia and the Fall of the Soviet Empire*. Princeton University Press.

Ellman, M. & Kontorovich, V. (1998). *The Destruction of the Soviet Economic System: An Insiders' History*. M.E. Sharpe.

Hough, J. F. (1997). *Democratization and Revolution in the USSR, 1985-1991*. Brookings Institution Press.

Kotkin, S. (2001). *Armageddon Averted: The Soviet Collapse, 1970-2000*. Oxford University Press.

Lieven, A. (1993). *The Baltic Revolution: Estonia, Latvia, Lithuania and the Path to Independence*. Yale University Press.

Remnick, D. (1993). *Lenin's Tomb: The Last Days of the Soviet Empire*. Random House.

Roeder, P. G. (1991). Soviet federalism and ethnic mobilization. *World Politics*, 43(2), 196-232.

Scheffer, M., Bascompte, J., Brock, W. A., et al. (2009). Early-warning signals for critical transitions. *Nature*, 461(7260), 53-59.

Solnick, S. L. (1998). *Stealing the State: Control and Collapse in Soviet Institutions*. Harvard University Press.

Suny, R. G. (1993). *The Revenge of the Past: Nationalism, Revolution, and the Collapse of the Soviet Union*. Stanford University Press.

Vieira, A. (2025). The Experiential Coherence Framework: A Unifying Theory of Consciousness, Perception, and Learning. *University of Tartu* (in press).

Yurchak, A. (2006). *Everything Was Forever, Until It Was No More: The Last Soviet Generation*. Princeton University Press.

Åslund, A. (1991). *Gorbachev's Struggle for Economic Reform*. Cornell University Press.

Bak, P. (1996). *How Nature Works: The Science of Self-Organized Criticality*. Springer.

Beissinger, M. R. (2002). *Nationalist Mobilization and the Collapse of the Soviet State*. Cambridge University Press.

Brown, A. (1996). *The Gorbachev Factor*. Oxford University Press.

Ellman, M. and Kontorovich, V. (1998). *The Destruction of the Soviet Economic System: An Insiders' History*. M.E. Sharpe.

Fukuyama, F. (2014). *Political Order and Political Decay*. Farrar, Straus and Giroux.

Huntington, S. P. (1968). *Political Order in Changing Societies*. Yale University Press.

Kotkin, S. (2001). *Armageddon Averted: The Soviet Collapse, 1970–2000*. Oxford University Press.

Scheffer, M., Bascompte, J., Brock, W. A., et al. (2009). Early-warning signals for critical transitions. *Nature*, 461(7260):53–59.

Sornette, D. (2003). *Why Stock Markets Crash: Critical Events in Complex Financial Systems*. Princeton University Press.

Suny, R. G. (1993). *The Revenge of the Past: Nationalism, Revolution, and the Collapse of the Soviet Union*. Stanford University Press.