CausalEntropy and Fracture Index: Measuring Global Systemic Fragility in Sovereign Risk

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Abstract

This paper introduces two systemic risk indices for the global sovereign landscape: the Fracture Index, which measures aggregate global fragility as a GDP-weighted average of country-level Collapse Index scores, and the CausalEntropy Index, which applies Shannon entropy to the distribution of sovereign risk states to quantify the unpredictability of the global risk environment. Using data from 80 countries monitored by the CAUSENTIA platform, we demonstrate that the CausalEntropy Index provides a complementary signal to traditional aggregate measures: high entropy indicates a diffuse, volatile risk landscape, while low entropy suggests concentrated or uniform risk states. As of February 2026, the Fracture Index stands at 29.6 (NORMAL) while CausalEntropy reads 36.1 (FLUX), indicating a stable but increasingly unpredictable global sovereign environment.

Keywords: systemic risk, Shannon entropy, sovereign fragility, global risk measurement, information theory, macroeconomic stability

1. Introduction

Individual sovereign risk metrics, however accurate, fail to capture the systemic dimension of global financial stability. A world where one country has CI 80 and 79 have CI 5 is fundamentally different from a world where 20 countries have CI 40, even if both produce similar aggregate averages. This paper addresses this gap with two complementary indices.

The Fracture Index measures the *level* of global risk, while the CausalEntropy Index measures its *distribution*. Together, they provide a two-dimensional map of global sovereign fragility that cannot be captured by any single metric.

2. The Fracture Index

2.1 Definition

The Fracture Index (FI) computes global systemic fragility as a GDP-weighted average of Collapse Index scores:

$$FI = \Sigma(CI_i \times GDP_i) \; / \; \Sigma(GDP_i)$$

where CI_i is the Collapse Index of country i and GDP_i is its GDP in current US dollars. The GDP weighting ensures that crises in larger economies contribute proportionally more to systemic risk.

2.2 Classification

FI Range	Classification	Interpretation
0 - 20	STABLE	Low global systemic risk, well-distributed buffers
20 - 40	NORMAL	Moderate risk, isolated stress points manageable

FI Range	Classification	Interpretation
40 - 60	ELEVATED	Multiple stress points, contagion risk increasing
60 - 80	CRITICAL	Systemic stress, coordinated response required
80 - 100	FRACTURE	Global systemic breakdown in progress

Table 1: Fracture Index classification thresholds.

3. The CausalEntropy Index

3.1 Theoretical Foundation

Shannon entropy, originally formulated in information theory (Shannon, 1948), measures the uncertainty or disorder in a probability distribution. Applied to sovereign risk, it quantifies how predictable or chaotic the global risk landscape is.

3.2 Computation

Countries are classified into five risk states (SAFE, CAUTION, DANGER, CRITICAL, COLLAPSE) based on their CI scores. The proportion of countries in each state defines a probability distribution $p = (p_1, p_2, ..., p_5)$. The CausalEntropy Index is:

$$CE = -\Sigma(p_k \times \log_2(p_k)) / \log_2(5) \times 100$$

The normalization by $\log_2(5)$ scales the index to 0-100, where 0 indicates all countries in a single risk state (perfectly predictable) and 100 indicates uniform distribution across all five states (maximum unpredictability).

3.3 Interpretation

CE Range	Classification	Interpretation
0 - 20	UNIFORM	All countries clustered in 1-2 states; predictable
20 - 40	FLUX	Moderate spread; transitions occurring
40 - 60	VOLATILE	Wide distribution; many countries near thresholds
60 - 80	CHAOTIC	Highly dispersed; prediction extremely difficult
80 - 100	MAXIMUM ENTROPY	Uniform distribution; complete unpredictability

Table 2: CausalEntropy Index classification.

4. Current Global Assessment

As of February 2026, the CAUSENTIA platform reports:

- **Fracture Index: 29.6 (NORMAL)** — Global systemic risk is moderate, with stress concentrated in a small number of countries (primarily Sudan at CI 77.9).
- **CausalEntropy Index: 36.1 (FLUX)** — The risk landscape is in transition, with countries moving between risk categories. This suggests increasing unpredictability despite the low aggregate risk level.

The combination of low Fracture Index and moderate CausalEntropy creates a "calm surface, shifting currents" scenario: aggregate risk appears manageable, but the underlying distribution is becoming less predictable.

5. Two-Dimensional Risk Map

The Fracture Index and CausalEntropy Index define a 2D space for classifying global states:

	Low CE (Predictable)	High CE (Chaotic)
Low FI (Stable)	Golden Era: stable and predictable	Brewing Storm: stable but shifting
High FI (Stressed)	Concentrated Crisis: high but localized	Systemic Chaos: high and dispersed

Table 3: Two-dimensional global risk classification matrix.

February 2026 places the world in the **"Brewing Storm"** quadrant: aggregate risk is moderate (FI 29.6), but entropy is rising (CE 36.1), suggesting that current stability may be more fragile than aggregate numbers indicate.

6. Limitations and Future Work

- GDP weighting in the Fracture Index may underrepresent small economies with acute crises that have regional contagion effects.
- Shannon entropy treats all risk transitions equally; future work will explore weighted entropy where transitions toward CRITICAL carry higher information content.
- Historical time series of both indices will enable trend analysis and regime-change detection.

7. Conclusion

The Fracture Index and CausalEntropy Index provide a two-dimensional framework for assessing global sovereign fragility that no single metric can capture. The current "Brewing Storm" assessment highlights the importance of monitoring not just the level of global risk but its distribution and predictability.

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