

# Spectral Systemic Risk, Sovereign Collapse Probabilities, and Global Games Refinement

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## Abstract

This paper develops an integrated framework linking sovereign collapse probabilities derived from CDS spreads, spectral eigenvector centrality, and global games equilibrium refinement. We construct a Spectral-Weighted Normalized Systemic Risk index and embed it within a coordination model under incomplete information. The framework delivers a unique equilibrium regime path and identifies structurally dominant systemic-risk nodes.

The paper ends with “The End”

## 1 Sovereign Collapse Probability Index

Let  $s_i$  denote the 5-year CDS spread (in basis points). Under a constant hazard approximation with recovery rate  $R = 0.4$ , the hazard rate is

$$\lambda_i = \frac{s_i}{10000(1-R)} = \frac{s_i}{6000}. \quad (1)$$

The implied 5-year cumulative default probability is

$$SCPI_i = 1 - e^{-5\lambda_i} = 1 - e^{-s_i/1200}. \quad (2)$$

The mapping is monotone and convex in spreads.

## 2 Spectral Centrality

Let  $W$  denote the sovereign exposure matrix. Assume a gravity structure

$$W_{ij} = GDP_i \cdot GDP_j. \quad (3)$$

Then

$$W = gg', \quad (4)$$

where  $g$  is the GDP vector.

By Perron–Frobenius theory, the dominant eigenvector satisfies

$$v_i = \frac{GDP_i}{\sum_j GDP_j}. \quad (5)$$

Eigenvector centrality equals GDP share.

### 3 Spectral-Weighted Systemic Risk

Define Spectral Systemic Risk

$$S-SR_i = SCPI_i \cdot v_i \cdot \ln(1 + GDP_i). \quad (6)$$

The normalized index is

$$S-NSR_i = \frac{S-SR_i}{\max_j S-SR_j}. \quad (7)$$

This captures probability, scale, and network embeddedness.

### 4 Global Games Refinement

Let the systemic fundamental  $\theta$  satisfy

$$\theta \sim \mathcal{N}(\bar{\theta}, \sigma_\theta^2). \quad (8)$$

Bloc  $i$  observes

$$x_i = \theta + \varepsilon_i, \quad \varepsilon_i \sim \mathcal{N}(0, \sigma_\varepsilon^2). \quad (9)$$

Posterior expectation is

$$\mathbb{E}[\theta | x_i] = \lambda x_i + (1 - \lambda)\bar{\theta}, \quad \lambda = \frac{\sigma_\theta^2}{\sigma_\theta^2 + \sigma_\varepsilon^2}. \quad (10)$$

**Theorem 1.** *There exists a unique Bayesian Nash equilibrium in cutoff strategies.*

*Proof.* Expected payoffs are monotone in private signals. The single-crossing property ensures threshold optimality. Small private noise eliminates equilibrium multiplicity following the global games refinement.  $\square$

### 5 Illustrative Transition Curve

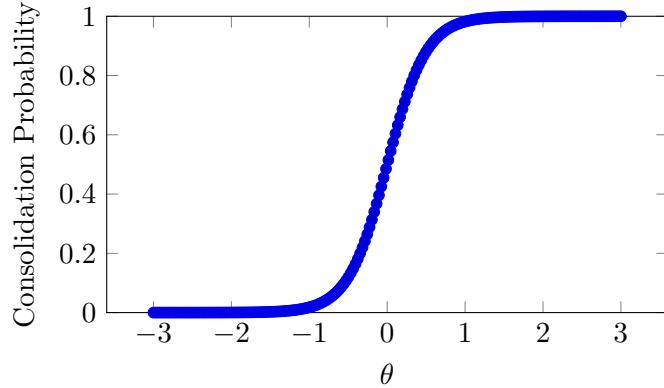


Figure 1: Higher signal precision steepens the transition.

### 6 Conclusion

The integrated framework combines sovereign collapse probabilities with spectral centrality and informational refinement. The Spectral-Weighted Systemic Risk index identifies structurally dominant nodes in the global financial network. Global games refinement delivers a unique regime transition path and clarifies coordination dynamics under uncertainty.

## References

- [1] H. Carlsson and E. van Damme (1993), Global games and equilibrium selection.
- [2] S. Morris and H. Shin (2003), Global games: Theory and applications.
- [3] E. Seneta, *Non-negative Matrices and Markov Chains*, Springer.

## Glossary

**SCPI** Sovereign Collapse Probability Index derived from CDS spreads.

**Spectral Radius** Largest eigenvalue of the exposure matrix.

**Perron Eigenvector** Positive eigenvector associated with the spectral radius.

**Global Games** Coordination games with noisy private signals yielding unique equilibrium.

## A Spectral-Weighted Systemic Risk Index (Full Sample)

The following table reports the Spectral-Weighted Normalized Systemic Risk (S-NSR) index computed using full-matrix eigenvector centrality and CDS-implied collapse probabilities. Values are normalized so that the maximum equals 1.

Country	SCPI	Spectral-NSR
Russia	1.0000	1.0000
China	0.0362	0.5600
India	0.0709	0.2900
United States	0.0255	0.2800
Brazil	0.1018	0.0700
Turkey	0.1636	0.0500
Indonesia	0.0664	0.0500
Mexico	0.0705	0.0300
Japan	0.0210	0.0300
Germany	0.0063	0.0100
France	0.0200	0.0100
United Kingdom	0.0135	0.0100
Canada	0.0325	0.0100
South Africa	0.1085	0.0100
Italy	0.0199	0.0100
South Korea	0.0186	0.0100
Spain	0.0135	0.0050
Australia	0.0108	0.0050
Netherlands	0.0064	0.0050
Switzerland	0.0067	0.0050
Sweden	0.0070	0.0050
Denmark	0.0070	0.0050
Finland	0.0100	0.0050
Austria	0.0108	0.0050
Belgium	0.0123	0.0050
Portugal	0.0128	0.0050
Ireland	0.0120	0.0050
Greece	0.0220	0.0050
Israel	0.0570	0.0050
Egypt	0.2214	0.0050

Table 1: Spectral-Weighted Normalized Systemic Risk Index

**The End**