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

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

The implied 5-year cumulative default probability is

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

The mapping is monotone and convex in spreads.

2 Spectral Centrality

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

$$W_{ij} = GDP_i \cdot GDP_j. \tag{3}$$

Then

$$W = gg', \tag{4}$$

where g is the GDP vector.

By Perron–Frobenius theory, the dominant eigenvector satisfies

$$v_i = \frac{GDP_i}{\sum_j GDP_j}. \tag{5}$$

Eigenvector centrality equals GDP share.

3 Spectral-Weighted Systemic Risk

Define Spectral Systemic Risk

$$S\text{-}SR_i = SCPI_i \cdot v_i \cdot \ln(1 + GDP_i). \tag{6}$$

The normalized index is

$$S\text{-}NSR_i = \frac{S\text{-}SR_i}{\max_j S\text{-}SR_j}. \tag{7}$$

This captures probability, scale, and network embeddedness.

4 Global Games Refinement

Let the systemic fundamental θ satisfy

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

Bloc i observes

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

Posterior expectation is

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

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. □

5 Illustrative Transition Curve

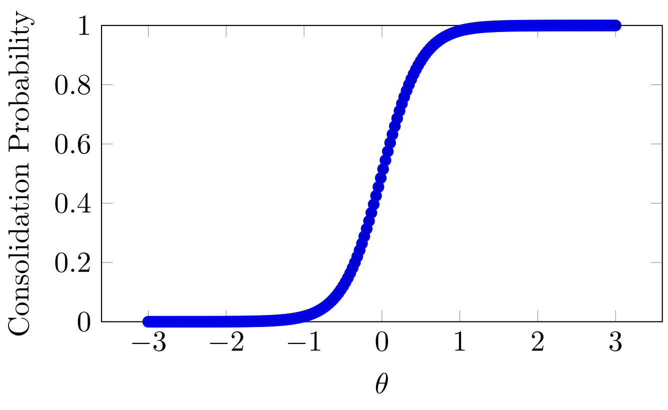

Figure 1: Higher signal precision steepens the transition.

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

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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.

The End