

# Contagion Network Analysis: Trade-Linked Sovereign Risk Transmission in 80 Countries

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February 2026 | DOI: 10.5281/zenodo.18584024

## Abstract

This paper presents a network-based analysis of sovereign crisis contagion using trade and geographic proximity links between 80 countries. Using data from the CAUSENTIA platform, we construct a weighted directed graph with 85+ edges representing bilateral trade relationships and geographic adjacency. Node attributes include the Collapse Index (CI), and edge weights capture trade volume intensity. We compute contagion exposure scores for each country as the weighted sum of neighboring CI values, identifying countries with high indirect risk from trade partner instability. The analysis reveals that trade-connected neighbors of high-CI countries face measurably elevated risk transmission, with Ethiopia and Egypt showing the highest exposure to Sudan's CRITICAL status. Regional clustering analysis identifies MENA and East Africa as the highest contagion-risk zones.

**Keywords:** contagion, sovereign risk, network analysis, trade links, crisis transmission, systemic risk

## 1. Introduction

Sovereign crises rarely remain contained within national borders. Trade disruptions, capital flight, refugee flows, and investor sentiment propagation create transmission channels that can transform a localized crisis into a regional or global event. The 1997 Asian financial crisis, the 2010 European debt contagion, and the 2023 Sudan-Ethiopia regional destabilization demonstrate that understanding these transmission pathways is essential for crisis anticipation.

This paper constructs a network model of sovereign risk contagion based on bilateral trade relationships and geographic proximity, using the CAUSENTIA platform's real-time country risk data to quantify exposure and identify vulnerable transmission corridors.

## 2. Network Construction

### 2.1 Nodes

Each of the 80 CAUSENTIA-monitored countries constitutes a node with attributes: Collapse Index (CI), risk classification (SAFE/CAUTION/DANGER/CRITICAL), region, and key economic indicators.

### 2.2 Edges

Edges represent two types of bilateral connections:

- **Trade links:** Bilateral trade relationships weighted by trade volume intensity (1-3 scale). 70+ trade edges are defined based on major bilateral trade flows.
- **Geographic proximity:** Shared borders or close geographic proximity, particularly relevant for refugee flows, cross-border conflict, and regional sentiment contagion. 15+ geographic edges with dashed representation.

### 3. Contagion Exposure Model

The contagion exposure score for country  $i$  is defined as:

$$E_i = \sum_{j \in N(i)} (CI_j \times w_{ij})$$

where  $N(i)$  is the set of countries connected to  $i$ ,  $CI_j$  is the Collapse Index of neighbor  $j$ , and  $w_{ij}$  is the edge weight (1-3) representing trade intensity. Higher exposure scores indicate greater indirect risk from trade partner instability.

## 4. Results

### 4.1 Highest Exposure Countries

Country	Own CI	Connections	Exposure Score	Highest-Risk Neighbor
Ethiopia	13.0	4	248	Sudan (CI 77.9)
Egypt	17.9	7	231	Sudan (CI 77.9)
Turkey	18.2	9	198	Lebanon (CI 38.5)
Syria	N/A	4	187	Lebanon (CI 38.5)
Jordan	8.1	5	172	Iraq (CI 17.9)
South Africa	7.4	5	156	Zimbabwe (CI 23.7)
Brazil	5.2	4	142	Argentina (CI 31.0)
Germany	3.8	7	128	Turkey (CI 18.2)
United States	4.1	9	118	Mexico (CI 6.2)
China	7.3	8	112	Pakistan (CI 6.8)

Table 1: Top 10 countries by contagion exposure score.

### 4.2 Regional Analysis

Regional clustering reveals three high-contagion zones:

- **East Africa (Sudan-Ethiopia-Egypt corridor):** Sudan's CRITICAL status (CI 77.9) creates the highest contagion pressure globally. Ethiopia's exposure score of 248 is the highest in the network, driven by geographic proximity, refugee flows, and trade disruption.
- **MENA (Lebanon-Syria-Turkey-Iraq cluster):** Lebanon's CAUTION status (CI 38.5) propagates through dense trade links to Syria, Turkey, and Jordan. Turkey's high connectivity (9 edges) makes it both a receiver and transmitter of risk.
- **South America (Argentina-Brazil corridor):** Argentina's CAUTION status (CI 31) and 219.9% inflation create trade disruption risk for Brazil, Chile, and Bolivia through Mercosur linkages.

## 5. Implications

The contagion network analysis reveals that countries with low own-CI can face significant indirect risk through trade connections. Ethiopia (own CI 13.0, SAFE) has an exposure score of 248 due to Sudan's crisis, suggesting that purely domestic-focused risk assessment underestimates actual vulnerability. This finding supports the integration of network-based contagion metrics into sovereign risk frameworks.

## 6. Limitations

- Trade weights are approximated on a 1-3 scale rather than using precise bilateral trade flow data (future integration planned).
- The model assumes symmetric contagion; in practice, risk transmission is often asymmetric (large economies affect small partners more).
- Capital flow channels, remittance dependencies, and shared currency exposure are not yet modeled.

## 7. Conclusion

Network-based contagion analysis provides a critical complement to individual country risk assessment. The identification of high-exposure corridors (Sudan-Ethiopia-Egypt, Lebanon-Turkey-Syria, Argentina-Brazil) enables proactive monitoring of crisis transmission before it manifests in domestic indicators. The contagion network is accessible interactively at causentia.org.

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