NetSciX2026: International School and Conference on Network Science
February 17^{th}-20^{th}, 2026 - Auckland, New Zealand

Global Supply Chain Resilience and Geopolitical Uncertainty

Keywords: Global supply chains, network resilience, geopolitical uncertainty, network motifs, higher-order interactions

Extended Abstract

The election of President Trump, and ongoing tensions in the Middle East, have generated unprecedented uncertainty and introduced new challenges to the resilience of global supply chains. We study the evolution of a global network of firm-level supplier-customer relationships between July 2024 and July 2025. In particular, we systematically examine the structural properties of the network and measures of its resilience under intensifying geopolitical uncertainty. A novel aspect of our analysis is the introduction of "network motifs" – recurring and statistically significant sub-graphs within networks – to economics in understanding how localized interaction rules underpin the resilience of networks (Figure 1 illustrates possible 4-node undirected motifs in the global supply chain network.). Rather than focusing exclusively on global network characteristics, the concentration of network motifs measures the local robustness of a network and provides a basis to assess how long a network can preserve its geometry to different types of disruptions, proxies for geopolitical uncertainties [1, 2].

Our comparison of two snapshots of the global supply chain network shows that global supply chains appear to have become more sparse and fragmented, evidenced by reductions in average degree and centrality, as well as the increasing network distances between specific regions and industries. We construct a new measure of network reliability by modeling the exponential survival of motifs and provide a formal statistical method for the analysis of differences in the robustness properties of supply chain networks by applying a log-logistic model based on the degradation rate of motifs. The faster decay of motifs, as well as the greater volatility in the degradation rate of motifs in the network of July 2025, indicates that the global supply chain network has become significantly less robust to a variety of disruptions, especially under disruptions that target the firms with the highest connectivity or intermediation effects (see Table 1). Comparing the various performances of different motif patterns by applying the partial-motif-test, we demonstrate that the "Circular Economy" motif plays a critical role in determining the differences in reliability between the two networks than other motif structures.

By integrating network theory with economic analysis, our study presents an alternative and competitive pathway for understanding the resilience of global supply chains. Moving beyond traditional approaches that focus only on binary relationships, the introduction of network motifs highlights the importance of higher-order interactions in economics. Our results also provide valuable insights for policymakers seeking to mitigate instabilities and build a more resilient economy.

Our study adheres to ethical research standards. No personally identifiable information is used, and all data is publicly available. All methods and analyses are conducted for academic research, with no potential for misuse affecting individuals or groups.

References

[1] Yuzhou Chen et al. “Understanding power grid network vulnerability through the stochastic lens of network motif evolution”. In: *Journal of the Royal Statistical Society Series C: Applied Statistics* (2024), qlae071.

[2] Asim K Dey, Yulia R Gel, and H Vincent Poor. “What network motifs tell us about resilience and reliability of complex networks”. In: *Proceedings of the National Academy of Sciences* 116.39 (2019), pp. 19368–19373.

Table 1: **Average Degradation Rates of Networks ($\bar{\mathscr{A}_i}$).** The estimated results are from the log-logistic model. α_i represents the scale parameter for each network i, and the $\beta_{i,k}$ represents the shape parameter for each motif M_k in different network i. Motif M_5 and M_6 are excluded due to their irregular fluctuation patterns, infrequent occurrence, and limited explanatory power.

		Random Disruptions				**Connectivity Disruptions**				**Intermediation Disruptions**			
		Cross-national		*Cross-industrial*		*Cross-national*		*Cross-industrial*		*Cross-national*		*Cross-industrial*	
		2024	2025	2024	2025	2024	2025	2024	2025	2024	2025	2024	2025
α_i		0.819	0.806	0.847	0.794	2.103	2.709	2.574	2.481	2.056	2.709	1.554	1.435
$\beta_{i,k}$	M_1	2.807	2.946	2.800	3.001	5.379	6.548	6.455	7.029	5.822	6.548	4.162	3.675
	M_2	2.926	2.957	3.057	2.927	6.472	7.078	7.160	7.685	5.626	7.078	5.309	3.881
	M_3	2.953	3.512	3.549	3.514	6.110	5.008	6.812	8.071	1.846	5.008	2.487	2.552
	M_4	2.646	3.050	3.954	2.789	6.048	5.179	7.168	9.255	4.616	4.179	4.764	4.806
$\bar{\mathscr{A}_i}$		1.034	1.042	1.182	1.047	1.912	2.807	2.555	2.563	2.168	2.207	1.881	1.897

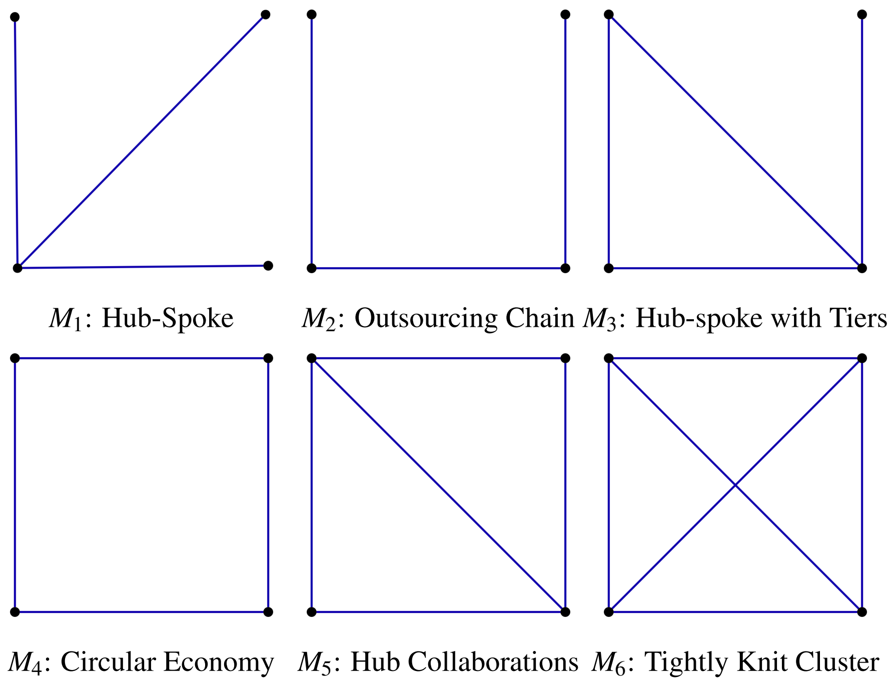

Figure 1: All Connected 4-Node Motifs in Networks

Notes. We examine undirected 4-node network motifs, where nodes represent firms and edges indicate business relationships between pairs of firms. These motifs help to capture collaboration structures among firms within broader global supply chains.