

Emerging Technologies in the Context of Geoeconomic Fragmentation: A Bibliometric Analysis

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Abstract

This study maps the emerging body of scientific literature at the intersection of international trade, supply chain resilience, and emerging technologies, in the specific context of post-2022 geopolitical crises (the Russia-Ukraine war, Red Sea disruptions, Iran sanctions) and geoeconomic fragmentation (US-China tariff escalation, friend-shoring, technological decoupling). A bibliometric analysis was conducted on 790 articles indexed in the Web of Science Core Collection (SSCI, SCIE, AHCI) between 2022 and April 2026, retrieved through a three-block Boolean query combining geopolitical-risk, emerging-technology, and international-trade terms. Data were processed with the bibliometrix R package using performance metrics, science mapping, co-occurrence and collaboration networks, thematic maps, and Lotka's law analysis. Findings. Scientific production grew at an annual rate of 28.88%, from 58 publications in 2022 to 298 in 2025, with 160 additional articles in the first four months of 2026. Three country clusters were identified, which appear to be broadly consistent with current geoeconomic alignments. Supply chain resilience appears to occupy a central position within the intellectual structure of the field, with COVID-19 functioning as a bridging theme between disruption-related and technology-response narratives. To the best of our knowledge, this study is among the first bibliometric syntheses to explicitly examine the link between emerging technologies and the post-2022 geoeconomic fragmentation context. The findings may offer a useful knowledge base for policymakers considering technology-oriented industrial policies aimed at strengthening trade resilience and strategic autonomy. They also provide researchers with a structured map of thematic gaps for future research.

Keywords

Supply chain resilience; Emerging technologies; Geoeconomic fragmentation; Bibliometric analysis; Artificial intelligence; Digital transformation; International trade.

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Introduction

The decade that opened with the COVID-19 pandemic has been punctuated by an uninterrupted sequence of geopolitical and geoeconomic shocks. The Russian invasion of Ukraine in February 2022 reshaped European energy and grain supply chains overnight; the intensification of the US-China strategic rivalry translated into successive rounds of tariffs, export controls on advanced semiconductors, and restrictions on critical-minerals trade; attacks on commercial shipping in the Red Sea from late 2023 onwards forced a structural rerouting of east-west container flows; and renewed sanctions on Iran added further volatility to global energy markets (IMF, 2023; UNCTAD, 2024). Against this backdrop, firms and governments have turned increasingly to emerging digital and physical technologies — artificial intelligence (AI), blockchain,

digital twins, additive manufacturing, and the Industry 4.0/5.0 paradigm — as strategic instruments for rebuilding trade resilience and partial operational autonomy (Belhadi et al., 2024; Ivanov, 2023). Yet, despite the growing body of empirical and conceptual work, this specific intersection — namely the role of emerging technologies in the context of post-2022 geoeconomic fragmentation — appears to remain insufficiently mapped from a bibliometric perspective.

This paper addresses that gap by formulating three research questions:

RQ1. How has scientific production at the intersection of trade resilience, emerging technologies, and geoeconomic fragmentation evolved between 2022 and 2026?

RQ2. What are the main geographic and intellectual structures of this research field, and to what extent do they appear consistent with current patterns of geoeconomic alignment?

RQ3. Which themes are motor, basic, niche, and emerging within the field, and which gaps remain underexplored?

The intended contribution of this research is structured along three main dimensions. First, it offers one of the earliest post-2022 bibliometric maps of this fast-growing research domain. Second, it relates bibliometric structural indicators (clusters, Multiple-Country Publications - MCP ratios, thematic quadrants) to the ongoing debate on geoeconomic fragmentation and explores possible points of correspondence between them. Third, based on the identified thematic gaps, the paper outlines a tentative research agenda to guide future scholarly inquiries in this field. The remainder of the paper is organized as follows: Section 1 reviews the relevant literature; Section 2 presents the methodology; Section 3 reports and discusses the results; the final section concludes.

1. Literature review

1.1. Supply chain resilience

Supply chain resilience (SCR) has been defined as the adaptive capability of a supply chain to prepare for unexpected events, respond to disruptions, and recover from them by maintaining operational continuity at the desired level of connectedness and control over structure and function (Christopher & Peck, 2004; Ponomarev & Holcomb, 2009). The concept is theoretically anchored in the dynamic capabilities view (Teece et al., 1997), which emphasizes the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments. More recent work has extended SCR into the intertwined supply network framework, highlighting the interdependencies between physical, informational, and financial flows (Dubey et al., 2021; Ivanov & Dolgui, 2021).

1.2. Emerging technologies in supply chains

The post-pandemic literature has examined a wide portfolio of emerging technologies as enablers of resilience and visibility. Blockchain has been proposed as a mechanism for traceability and trust in multi-tier networks (Queiroz, Telles, et al., 2019); artificial intelligence and machine-learning models are used for demand forecasting, disruption detection, and inventory optimization under uncertainty (Belhadi et al., 2024; Dubey et al., 2022); digital twins enable real-time simulation of supply-chain scenarios (Ivanov, 2024); additive manufacturing supports distributed, on-demand production that can partially substitute long-distance imports (Bednarski et al., 2025). The convergence of these technologies under the Industry 4.0/5.0 umbrella has been conceptualized as a socio-technical shift that redefines the competitive boundaries of firms (Leng et al., 2024).

1.3. Geoeconomic fragmentation and trade

The term geoeconomic fragmentation, popularized by IMF (2023), designates the policy-driven reversal of global economic integration, manifested through reshoring, friend-shoring, selective decoupling, export controls, and the weaponization of interdependence (Farrell & Newman, 2019). Empirical work documents a measurable decline in cross-bloc trade intensity after 2022, particularly in technology-intensive goods (Aiyar et al., 2023). The literature on the firm-level response has emphasized strategies such as supplier diversification, nearshoring, and investment in digital visibility tools (Kazancoglu et al., 2023; Qader et al., 2022).

1.4. Research gap

Prior bibliometric studies have analyzed SCR (Kamalahmadi & Parast, 2016), Industry 4.0 in supply chains (Queiroz, Fosso Wamba, et al., 2020), or COVID-19 and resilience (Moosavi et al., 2022) as separate streams. While several studies have explored these themes individually, there is still limited bibliometric

research addressing their triple intersection in the immediate post-2022 period. This paper aims to fill that gap by synthesizing the links between (i) emerging technologies, (ii) international trade, and (iii) the specific context of geoeconomic fragmentation.

2. Research methodology

2.1. Database and search strategy

The study follows the PRISMA-inspired bibliometric workflow proposed by Aria & Cuccurullo (2017) and Donthu et al. (2021). Data were retrieved from the Web of Science Core Collection (subsets SSCI, SCIE and AHCI), widely regarded as the most rigorous citation database for science mapping. The query was structured into three thematic blocks combined with Boolean AND operators:

- Block 1 (Geopolitical risk and fragmentation): TS=((geopolitic* OR "geo-economic*" OR geoeconomic*) NEAR/3 (risk* OR crisis* OR tension* OR fragmentation* OR conflict*)) OR TS=("trade war*" OR decoupling OR "friend-shoring" OR "reshoring" OR "supply chain disrupt*") — 23,684 records;
- Block 2 (Emerging technologies): TS=("artificial intelligence" OR "machine learning" OR blockchain OR "digital twin*" OR "additive manufacturing" OR "Industry 4.0" OR "Industry 5.0" OR IoT OR "big data") — 2,141,867 records;
- Block 3 (International trade and supply chains): TS=("supply chain*" OR "international trade" OR "global value chain*" OR "trade flow*" OR logistics) — 313,400 records.

The conjunction Block 1 AND Block 2 AND Block 3 returned 1,423 documents. Successive filters were applied: publication years 2022–2026, document types article, review, and early access (conference proceedings were excluded for rigor), and the three WoS Core Collection indexes listed above. The final dataset consists of 790 documents, exported as plain-text Full Record and Cited References files on 15 April 2026.

2.2. Analytical tools

Data were processed using the bibliometrix R package v4.x (Aria & Cuccurullo, 2017), a comprehensive open-source tool for quantitative research in scientometrics. The analysis combined three complementary layers: (i) performance analysis — annual production, most-productive sources, authors, and countries, most-cited documents, Lotka's and Bradford's laws; (ii) science mapping — thematic maps based on author keywords, co-occurrence networks, and country-collaboration networks; (iii) clustering — Louvain community detection applied to collaboration and co-occurrence matrices. Prior to the conceptual-structure analyses, the Author Keywords field (DE) was harmonized through singular/plural merging, orthographic normalization, unification of semantic duplicates, and removal of a residual null token; stemming was not applied. Figures were produced at 300 DPI for publication quality. The corresponding R script is available upon request.

3. Results and discussion

3.1. Descriptive overview of the corpus

The final corpus of 790 documents spans 248 sources, 2,321 authors, and 44,214 cited references. The average age of a document is 1.51 years and the average citations per document is 19.5, indicating a highly recent and already-influential body of knowledge. Single-authored documents represent only 7% of the corpus (55 of 790), while international co-authorships account for 39.24%, confirming the transnational nature of the field.

Figure no. 1 reveals an exponential growth trajectory: from 58 publications in 2022, output rose to 112 (2023), 162 (2024), and 298 (2025), representing a 414% increase over four years and a compound annual growth rate (CAGR) of 28.88%. The 160 articles published in the first four months of 2026 may indicate that the field is continuing to expand rapidly, although this projection should be interpreted with caution given the partial-year coverage.

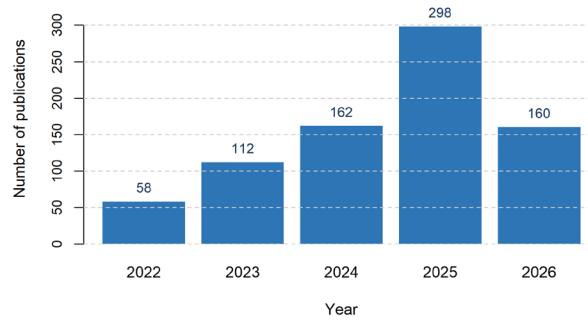


Figure no. 1. Annual scientific production (2022-2026)

Source: authors' analysis using bibliometrix R package (Aria & Cuccurullo, 2017) on Web of Science data.

The source distribution (Table no. 1) shows a classic Bradford's-law pattern: a small core of operations-management and sustainability journals concentrates most of the output. The International Journal of Production Research, the International Journal of Production Economics, and the Annals of Operations Research collectively host nearly 11% of the corpus. The prominence of Sustainability (64 articles) reflects the strong cross-cutting interest in environmentally responsible resilient supply chains.

Table no. 1. Top 10 most productive sources (journals)

Rank	Source (Journal)	Articles
1	Sustainability	64
2	International Journal of Production Research	40
3	Annals of Operations Research	23
4	Computers & Industrial Engineering	21
5	International Journal of Production Economics	21
6	IEEE Transactions on Engineering Management	20
7	Journal of Enterprise Information Management	18
8	Supply Chain Management-An International Journal	16
9	Systems	16
10	Operations Management Research	15

Source: authors' analysis based on 790 WoS records (2022-2026).

Table no. 2 documents a striking asymmetry. China leads the corpus with 283 articles (36% of the total), yet its MCP ratio (0.28) indicates that most of its output is domestic. The pattern is reversed for France (MCP ratio = 0.87) and the United Kingdom (0.69), whose researchers publish overwhelmingly in international collaborations. The very low MCP ratio of Saudi Arabia (0.07) confirms the domestic orientation of its contribution. This asymmetry may be read as a tentative pattern consistent with the broader discussion on geoeconomic fragmentation, in the sense that scientific internationalization appears uneven across country groupings.

Table no. 2. Top 10 countries by publication output and international collaboration

Rank	Country	Articles	% Freq.	SCP	MCP	MCP Ratio
1	China	283	35.96	205	78	0.276
2	USA	69	8.77	43	26	0.377
3	United Kingdom	61	7.75	19	42	0.689
4	India	55	6.99	30	25	0.455
5	Germany	28	3.56	22	6	0.214
6	Italy	24	3.05	13	11	0.458
7	France	23	2.92	3	20	0.870
8	South Korea	23	2.92	11	12	0.522
9	Australia	20	2.54	8	12	0.600
10	Saudi Arabia	15	1.91	14	1	0.067

Source: authors' computations. SCP = Single-Country Publications; MCP = Multiple-Country Publications.

3.2. Geography of collaboration

The country collaboration network (Figure no. 2) identifies three distinct clusters that appear broadly consistent with the current geoeconomic landscape: (i) a China-USA-European industrial axis (red cluster) including Germany, the Netherlands, Sweden, Poland, Pakistan, Malaysia, and Korea, which may indicate that advanced-manufacturing collaborations continue to connect the two largest economies despite rising political tensions; (ii) a Commonwealth-Francophone bloc (blue cluster) led by the United Kingdom, India,

France, Italy, Ireland, Canada, Vietnam, Bangladesh, Morocco, Finland, and Egypt, which may reflect persistent post-colonial and EU-UK research networks; (iii) a middle-powers cluster (green cluster) encompassing Australia, Brazil, Turkey, Jordan, the UAE, Spain, and Portugal, which may be associated with countries pursuing more diversified or multi-aligned international strategies. This tripolar structure appears broadly compatible with recent international-relations literature on selective decoupling (Farrell & Newman, 2019) and may suggest that scientific collaboration networks are evolving in ways that partially resemble shifts observed in trade relations, although such parallels should be interpreted cautiously.

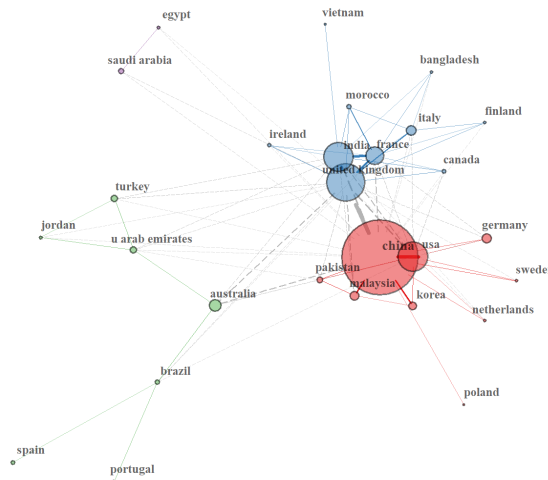


Figure no. 2. Country collaboration network (Louvain clustering)
Source: authors' analysis using bibliometrix networkPlot function; $n = 30$ top countries.

3.3. Intellectual and conceptual structure

The thematic map (Figure no. 3) positions keyword clusters along two axes: relevance (centrality, horizontal) and development (density, vertical). Four conceptual zones emerge. In the upper-right motor-themes quadrant, supply chain resilience, digital transformation, and dynamic capabilities appear to function as major driving themes within the field — mature themes with strong external links. The lower-right basic-themes quadrant hosts resilience, supply chain and COVID-19, acting as the empirical backbone that connects more specialized clusters. Artificial intelligence, supply chains, and sustainable development appear as niche themes (upper-left), highly developed internally but less central; this may suggest the emergence of a growing but still partly isolated AI-sustainability subfield. Machine learning, supply chain disruptions, and deep learning occupy the lower-left emerging/declining quadrant, suggesting fast-moving technical frontiers that do not yet appear fully integrated with the core resilience discourse. Additive manufacturing, digital twin, blockchain and supply chain management lie near the center of the map, in a transitional position.

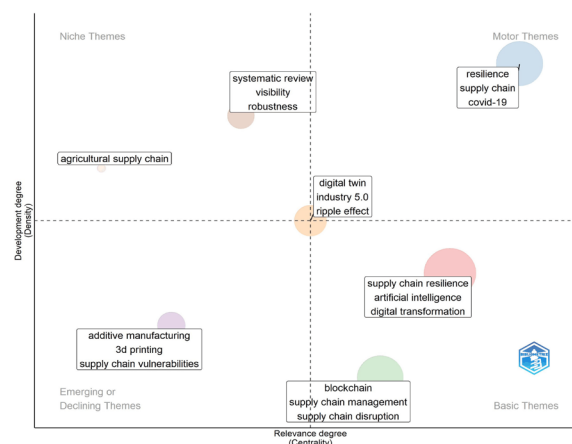


Figure no. 3. Thematic map of author keywords (density vs. centrality)
Source: authors' analysis using bibliometrix thematicMap on top 250 keywords, min frequency = 5.

The keyword co-occurrence network (Figure no. 4) further supports and refines this interpretation. Three interlocking clusters emerge. The red cluster is organized around supply chain resilience, which appears as a major hub, densely connected with artificial intelligence, digital transformation, Industry 4.0/5.0, machine learning, big data analytics, deep learning, dynamic capabilities, supply chain risk management, supply chain agility, and the ripple-effect concept. The blue cluster, organized around resilience and supply chains, groups COVID-19, supply chain disruption, uncertainty, risk management, blockchain, and additive manufacturing; within it, COVID-19 appears to function as a bridging node between the shock narrative (blue) and the technological-response narrative (red). The green cluster links supply chain management, sustainability, blockchain technology, digital twin, and circular economy, suggesting that emerging technologies are increasingly discussed not only as resilience tools, but also as enablers of more sustainable supply-chain configurations.

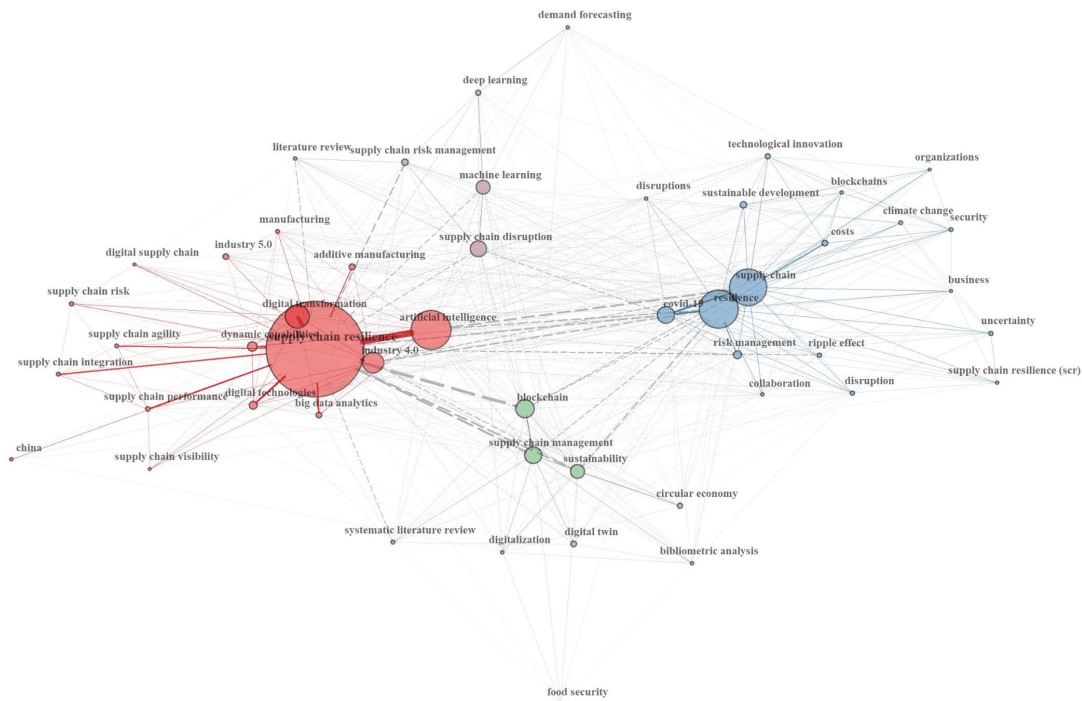


Figure no. 4. Author keywords co-occurrence network

Source: authors' analysis using bibliometrix biblioNetwork (Fruchterman-Reingold layout).

3.4. Author productivity and Lotka's law

The application of Lotka's law to the 2,321 authors yields $\beta = 3.059$, $C = 0.602$, $R^2 = 0.925$, with a Kolmogorov-Smirnov p-value of 0.055. The coefficient β is markedly higher than the classical value of 2.0, indicating a strongly skewed distribution of productivity: approximately 60% of authors contributed a single publication, while a small core of prolific researchers anchors the field — most notably Ivanov D. (17 articles), Mangla S.K. (10), Singh R.K. (9), Gupta S. and Kumar A. (8 each). The p-value, marginally above the conventional 0.05 threshold, indicates that authorship distribution approximately but not rigidly follows Lotka's inverse square law — a pattern often observed in young and rapidly expanding research domains, where output tends to be concentrated among a relatively small core of prolific contributors.

Conclusions

To the best of our knowledge, this study presents one of the first post-2022 bibliometric syntheses of research at the intersection of international trade, supply chain resilience, and emerging technologies, analyzed against the backdrop of geoeconomic fragmentation. The analysis highlights four main findings. First, the data suggest that the field is undergoing rapid expansion ($CAGR = 28.88\%$), plausibly associated with successive geopolitical shocks. Second, the collaboration network displays a tripolar structure that appears broadly consistent with interpretations associated with geoeconomic fragmentation. Third, supply chain resilience appears to function as a central integrative theme within the field, with COVID-19 bridging the shock narrative and the technological-response narrative; artificial intelligence, digital transformation, and dynamic capabilities appear among the main motor themes identified in the dataset, while machine

learning and digital twin remain in the emerging zone. Fourth, authorship is strongly skewed (Lotka $\beta = 3.059$), which is consistent with the concentration of output often observed in emerging research domains.

From a theoretical standpoint, the paper contributes to discussions around the dynamic-capabilities framework by examining it in the context of geoeconomic fragmentation. The findings are compatible with a dynamic-capabilities reading in which technology-related absorptive capabilities appear increasingly relevant to resilience discussions. From a practical standpoint, policymakers may use these findings as an input into discussions on technology-oriented industrial strategies aimed at strengthening trade resilience and strategic autonomy. Managers may use the identified thematic structure as a broad reference point when reflecting on digital-transformation priorities. The study offers researchers a structured map of under-researched niches — particularly at the AI-sustainability and digital-twin-circular-economy junctions. These patterns also suggest that emerging technologies are increasingly being framed not only as resilience tools, but also as enablers of more sustainable supply-chain configurations.

Several limitations should be acknowledged. First, the analysis relies on a single database (Web of Science Core Collection), which may lead to a partial representation of regional or non-English publications. Second, the 2026 data is preliminary, covering only the first four months of the year. Third, the Boolean query, although carefully constructed, cannot fully capture all conceptual borders of an emerging field. Future research could (i) extend the corpus through complementary sources such as Scopus or Dimensions, (ii) conduct systematic reviews of the motor-theme cluster, and (iii) test causal links between specific geoeconomic events and the diffusion patterns of individual technologies.

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