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Policy Pathways for Building a Resilient Supply Chain in China: A Dual Perspective From Competitiveness Enhancement and Spatial Optimization

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ABSTRACT

This study examines China's policy pathways for building a resilient supply chain from a dual perspective of competitiveness enhancement and spatial optimization. Specifically, China has implemented a multi-tiered industrial policy framework—'Fix the Weak, Reinforce the Strong, and Forge the New'—to strengthen the autonomy of vulnerable industries while enhancing the competitiveness of leading and emerging sectors. Simultaneously, China has pursued a spatial optimization strategy focused on 'market diversification' and 'globalised production', aiming to build a supply chain that balances risk mitigation and efficiency enhancement. Through policy analysis and case studies, this paper systematically examines China's approach to building a resilient supply chain, offering valuable insights for emerging economies in designing supply chain policies and promoting global supply chain reforms.

1 | Introduction

The global supply chain is currently undergoing a profound restructuring driven by intensifying geopolitical conflicts and escalating technological protectionism.[1] The Red Sea crisis serves as a stark example, where soaring shipping costs and sudden supply chain disruptions underscore the profound impact of geopolitical conflicts on supply chain. At the same time, major powers' competition in digital technologies has introduced a more covert yet potentially even more disruptive form of economic shock.[2] These non-economic factors have further exacerbated global supply chain vulnerabilities and heightened volatility risks, posing significant challenges for emerging economies in developing modern, resilient supply chain systems.

As a pivotal economy in global manufacturing and supply chain networks, China faces more complex and multidimensional challenges than other economies amid the ongoing strains on global supply chains. In response, China has implemented resilience-oriented policies and institutional frameworks to assist enterprises in mitigating risk, reducing loss, and achieving flexible adjustments and stable transitions during market fluctuations.

Resilience-oriented industrial policies generally resemble traditional industrial policies in that both rely primarily on fiscal and tax support, and pursue long-term strategic objectives such as enhancing productivity, competitiveness, and innovation. However, resilience-oriented policies also exhibit several distinctive features. First, they place a stronger emphasis on strengthening industries' capacity to withstand risks, sometimes at the expense of efficiency. Second, they are more diverse and complex, providing direct support to target industries while also indirectly strengthening resilience, for example by promoting digital technologies, global production networks, and export diversification, among many other approaches. Third, they often serve as passive responses to rising global uncertainty and external shocks, unlike traditional industrial policies, which are proactive development strategies.

This paper reviews China's resilient industrial policies and related cases, systematically summarising the strategies adopted to address supply chain shocks from the dual perspectives of competitiveness enhancement and spatial optimization.

2 | Three-Pronged Strategy for Enhancing Supply Chain Competitiveness

2.1 | Fix the Weak: Achieving Self-Sufficiency in Key Industries

Supply chain vulnerabilities in an economy often manifest as gaps in production capacity within critical industries. Each economy has its own structural weaknesses due to various factors. In China's case, these weaknesses primarily stem from two aspects. First, China exhibits a high dependency on foreign upstream suppliers in certain critical industries, such as semiconductors. According to estimates by Sun et al. (2024), in 2020, China relied on G7 countries and South Korea for 62.97% of its semiconductor industry's upstream inputs, with particularly high dependence on photoresist (90.66%) and semiconductor packaging materials (85.34%). Second, the development of these critical industries hinges on breakthroughs in materials, architectures, and manufacturing processes at the early research stages. However, China faces a structural imbalance in R&D investment, characterised by a heavy emphasis on development rather than fundamental research. While China ranks second globally in total R&D spending, trailing only the United States, its investment in basic and applied research remains insufficient. Data from 2021 indicate that basic research accounted for only 6.5% of China's total R&D expenditure, significantly lower than that of the United States (14.7%), Japan (12.7%), and South Korea (14.8%).[3] The combination of high reliance on imported inputs and insufficient early-stage innovation has made China's supply chain in these industries highly vulnerable to external shocks. This fragility became starkly evident when the U.S. imposed sanctions. A notable example is Huawei, which faced severe operational challenges after being added to the U.S. Entity List, leading to a cutoff of critical imported chips.

In response to the cutoff of imported chips, the Chinese government implemented a series of supportive industrial policies, with the R&D funding serving as the primary policy instrument. Figure 1 presents the R&D subsidies allocated to A-share listed companies in China for chip-related products from 2017 to 2022. The data reveals a sharp increase in R&D subsidies from 2020 onward, reaching 1.345 billion RMB in 2022—3.4 times the amount in 2019, the year when the United States added Chinese companies to the Entity List in October. With policy support, China's semiconductor industry has made significant strides towards technological self-reliance. By 2023, China accounted for 29% of global production capacity in mature-process chips (28 nm and above), ranking first in the world. More importantly, significant breakthroughs have been made in the field of advanced-process chips (below 28 nm). For example, companies such as SMIC and Hua Hong Semiconductor Ltd have achieved mass production at the 14 nm process, with chip yield rates reaching 95%. Moreover, R&D efforts for more advanced process, including 7 nm, 5 nm, and 3 nm, are steadily advancing. As China continues to improve its self-sufficiency and manufacturing capabilities, the risk of supply chain chokepoints in the semiconductor sector is gradually being alleviated.

It should be noted that China's 'self-sufficiency' strategy in the semiconductor industry is a defencive response to the external chip technology restrictions and represents a measure of necessity rather than choice. Under normal circumstances, 'self-sufficiency' may increase domestic risk exposure—such as to epidemics or natural disasters—which could undermine rather than strengthen resilience.

2.2 | Reinforce the Strong: Solidifying the Advantages of Digitalisation

Existing research identifies digitalisation as a key pathway to enhancing supply chain resilience. Dilyard et al. (2021) argue that digitalisation contributes to resilience through two primary channels: cost reduction and efficiency improvement, that is, establishing connections with upstream and downstream industries at lower costs and in shorter time. Additionally, studies indicate that during major external shocks, such as the COVID-19 pandemic, firms with higher levels of digitalisation exhibit greater adaptability to crises. Specifically, service enterprises leverage remote work to achieve agile restructuring of operational systems (Bécue et al. 2020), while manufacturing firms rely on smart factories to maintain the stability and resilience of production systems (Romero and Stahre 2021).

As a global manufacturing powerhouse, China possesses a strong foundation in industrial digitalisation and has consistently regarded it as a long-term development strategy. Prior to 2020, China's industrial digitalisation efforts were primarily centred on automation. In terms of industrial robot adoption,[4] China had an industrial robot stock of only 52,000 units in 2010. However, from 2013 onward, this number increased rapidly, surpassing other major economies within a few years and reaching 783,000 units by 2019 (see Figure 2). During this period, the rapid automation of China's manufacturing sector also contributed to greater resilience. Studies have shown that the industry experienced temporary labour shortages during the COVID-19 outbreak. In this context, firms with higher utilization of industrial robots faced significantly fewer disruptions (Xu et al. 2024). This highlights the advantages of automation modes that are remotely controlled and require low human intervention, which help maintain production continuity and stability when labour mobility is restricted, thereby reducing the adverse effects of external shocks.

After 2020, breakthroughs in AI technology created new opportunities for industrial digital transformation, prompting China to prioritise AI development as a core component of its next phase of digital industrialisation. Notably, as early as July 2017, the Chinese government proactively introduced the New

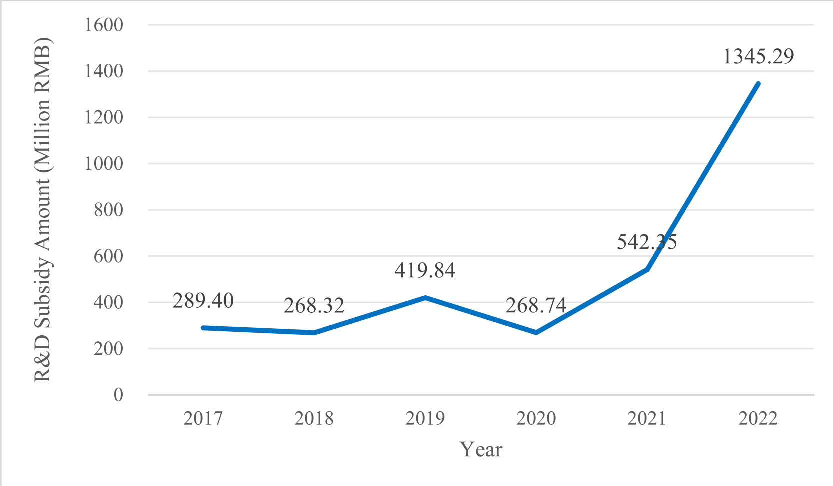

FIGURE 1 | R&D subsidies for chip-related products received by A-share listed companies in China (2017–2022). Data sourced from CSMAR database. Calculations and visualizations were performed by the authors. The data was extracted from financial statements by aggregating government subsidies for projects containing the keywords 'chip,' 'wafer,' or 'integrated circuit' in the profit and loss statements.

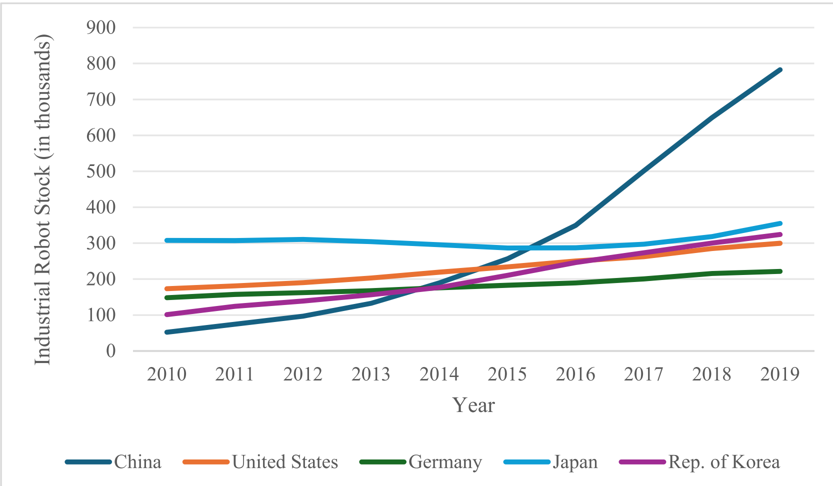

FIGURE 2 | Industrial robot stock in major economies (2010–2019). Data sourced from the international federation of robotics (IFR) database.

Generation Artificial Intelligence Development Plan, outlining strategic objectives, key tasks, and policy measures for AI industry development.[5] In November 2022, the emergence of ChatGPT catalysed a global AI revolution. During this period, China adopted a synergistic approach, fostering a collaborative development model in which enterprises spearhead AI-related research, commercialisation, and industry-academia cooperation, while the government oversees digital infrastructure, talent cultivation, and industry regulation. Under this model, China's AI industry has achieved remarkable progress in both research and commercialisation. In research, according to a World Intellectual Property Organisation (WIPO) report, by 2023, China had surpassed the U.S. in generative AI (GenAI) patent filings, maintaining a competitive lead over India, Japan, and South Korea. In commercialisation, in January 2025, a Chinese company launched the DeepSeek-R1 large language model, which rivals OpenAI-o1 in computational power and has garnered global recognition. Additionally, China has also achieved notable breakthroughs in AI applications in image recognition and audio processing. Relevant studies have shown that the application of AI technologies in areas such as supply chain management and maritime risk detection can effectively enhance supply chain resilience (Baryannis et al. 2019). To be specific, firms can leverage AI in processes such as order scheduling, production planning, and warehouse management to enable real-time information sharing across upstream and downstream partners, thereby enhancing their ability to flexibly adjust production activities in response to unexpected disruptions. In addition, risk-predictive AI models trained on historical data can combine real-time intelligence to estimate the probability of major port incidents, such as the Red Sea crisis, providing companies with early warnings and alternative transport routes.

2.3 | Forge the New: Pioneering Emerging Industries

Early entrants in emerging industries often gain a certain first-mover advantage within the supply chain system. On one hand, they are more likely to secure and develop critical resources and core technologies ahead of competitors, thereby mitigating risks associated with technological blockades or external supply chain disruptions (Xiao et al. 2019). On the other hand, they have the potential to establish market dominance and shape industry standards, leveraging this position to exert control over the market and effectively hedge against market volatility (Ma et al. 2023).

China's pioneering efforts in the electric vehicle (EV) industry exemplify a successful strategy for gaining a first-mover advantage in emerging sectors. As early as the late 20th century, when the domestic traditional automotive industry was still in its infancy, China had already formulated development plans for EV industry, aiming to achieve a 'leapfrog' advancement over the global automotive industry. The government primarily supported the EV industry through establishing R&D funding programs, which were typically carried out by universities and enterprises in collaboration. After nearly a decade of technological development, Chinese automotive firm BYD launched its first plug-in hybrid vehicle, the F3DM, in 2008, marking the inception of the EV market. In the early stage of the commercialised EV market, the focus of industry policies shifted from R&D support to fiscal subsidies and tax incentives, designed to help this 'infant industry' expand its initial market presence. By 2016, the proportion of EVs in China's total vehicle ownership reached 0.34%. Although the market penetration rate remained relatively low, technological advancements and declining production costs laid the foundation for further growth. Subsequently, the government gradually reduced direct policy support, allowing market forces to take the lead, and introduced foreign investment at the right time (e.g., the establishment of Tesla's Gigafactory in 2023) to stimulate competition through the 'catfish effect'. At this stage, China's vast domestic market provided a solid consumer base for the expansion of the industry, with rapid adoption of EVs observed in first-tier cities. It can be argued that strong domestic demand has been a key factor in enabling the industry's successful transition from policy-driven growth to market-driven development. Meanwhile, the government shifted its policy focus towards supporting power infrastructure and related services, creating a conducive environment for the growth of the EV industry.

From a policy trajectory perspective, China's EV industry policy has progressed through three key phases: R&D support, fiscal and tax incentives, and infrastructure development. The strategic timing of policy intervention and withdrawal aligns with the infant industry development model (Chang 2003). This policy framework has yielded remarkable outcomes. Domestically, within an open and competitive market environment, EV ownership increased more than tenfold from 2016 to 2022, reaching 4.11% (see Figure 3). Globally, since 2019, China has emerged as the world's largest exporter of EVs, with EVs becoming one of the country's three major new export pillars, securing strong market positions in Latin America and Europe.[6]

2.4 | Summary

The cases above illustrate that China tailors its strategies based on the development stage of each industry when constructing a resilient supply chain. Broadly, its multi-tiered industrial policy can be summarised as follows: In vulnerable sectors, China prioritises R&D support to achieve self-sufficiency in critical technologies; in leading sectors, it minimises direct market intervention while actively investing in infrastructure development, talent cultivation, and industry regulation; in emerging sectors, it adopts a flexible policy approach, adjusting policy tools dynamically and fostering a competitive market environment as industries mature. It should be noted that the successful cases of China's industrial policies have depended on certain conditions, such as a well-developed domestic supply chain system and a large market scale. Therefore, such experiences may not be directly applicable to smaller economies.

Some studies have critically discussed China's industrial policies for failing to effectively improve productivity and innovation capacity (Barwick et al. 2025; Li and Branstetter 2024). While these studies face limitations in indicator construction and sample selection that affect the generalisability of their findings, they nevertheless serve as a reminder that industrial policies are not always effective. This underscores the need to explore and implement more appropriate institutional designs. Additionally, other studies have raised concerns about China's industrial policies in the context of international trade law (Bown 2024; Bown and Hillman 2019). Regarding this issue, there is currently no evidence suggesting that China's resilience-oriented industrial policies violate WTO rules. In fact, academic discussions in Geneva have not primarily focused on whether China's industrial policies might violate WTO rules; rather, they have emphasised their positive spillover effects. For example, China's electric vehicle policies have improved the availability and accessibility of environmentally friendly products in global markets, generating positive environmental externalities.[7] Moreover, even if violations were to occur, economies have the full right to seek remedies through the WTO.

3 | Dual-Focused Strategy for Optimising Supply Chain Spatial Layout

3.1 | Market Diversification: Mitigating Dependence on a Single Market

Over-reliance on a single market is akin to 'putting all eggs in one basket', posing significant supply chain risks. First, a dominant buyer often wields substantial bargaining power, which may heavily suppress import prices; Second, geopolitical disruptions and trade realignments (e.g., trade diversions) may lead to market contraction or the loss of key export destinations. Recognising these risks, China has prioritised export market diversification and implemented a series of targeted policies to promote it.[8] These policies primarily focus on three key areas: First, strengthening foundational support—enhancing export credit financing, foreign exchange risk management, and smart customs systems to improve firms' international trade capacity. Second, enhancing institutional safeguards—proactively negotiating and signing Free Trade Agreements (FTAs) to establish a stable regulatory framework that facilitates exports to diverse global markets. Third, expanding global market access—

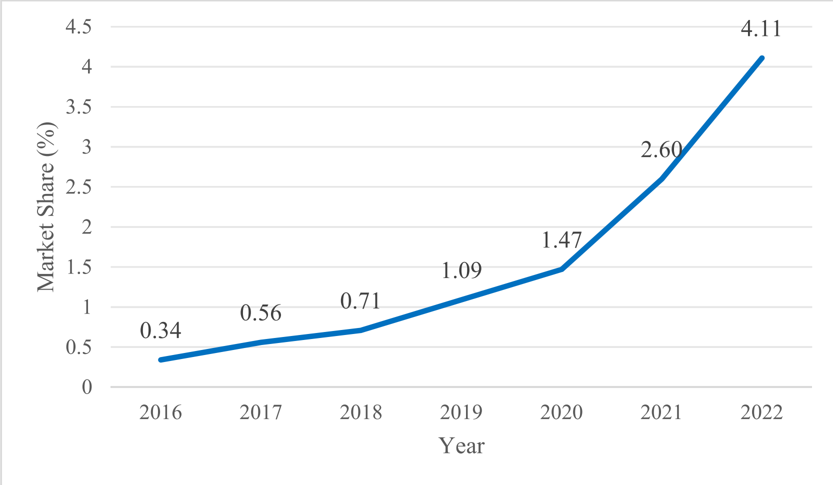

FIGURE 3 | Trend of electric vehicle ownership share in China (2016–2022). Data sourced from EV volumes and the China association of automobile manufacturers. calculations and visualizations were performed by the authors.

developing export demonstration zones and comprehensive cross-border e-commerce pilot zones to accelerate firms' integration into international markets.

Supported by a series of policy measures, China's major export markets have become increasingly diversified. First, the exports of two of China's 'New Three' strategic emerging products—solar cells, and lithium batteries—show a clear trend towards diversification across overseas markets.[9] Figure 4 presents the Herfindahl-Hirschman Index (HHI) and the share of the largest oversea market for these two products from 2012 to 2023 (with solar cell data available only up to 2021). Both indicators measure export market concentration, where higher values indicate a more concentrated and less diversified market. The trends reveal a decline in the HHI for solar cells and lithium batteries from 0.11 to 0.17 to 0.07 and 0.09, respectively, while the share of the largest market decreased by 6.4 and 16.3% points. These shifts suggest a notable increase in market diversification. A more detailed examination of solar cell exports shows that Brazil's market share rose from 0.01% to 9.3%, positioning it as the third-largest export destination, following the Netherlands and India. In lithium battery exports, South Korea (+5.4% points) and the Netherlands (+4.4% points) saw significant increases in their market shares, ranking as the third- and fourth-largest destinations after the United States and Germany.

The export diversification of the 'New Three' products is only a microcosm reflecting a broader trend. From a wider perspective, this pattern is also clear. In 2023, China's three largest export sectors were electronics, machinery, and textiles, accounting for 25.96%, 20.15%, and 13.94% of total exports, respectively. Figure 5 compares the distribution of China's export markets in 2012 and 2023, covering both all products and these three sectors specifically, by examining the cumulative share of the top 1, 3, and 5 export markets. It can be observed that, whether in overall exports or in sectoral exports, the share of exports to major destination countries has declined, demonstrating a clear trend towards export diversification.

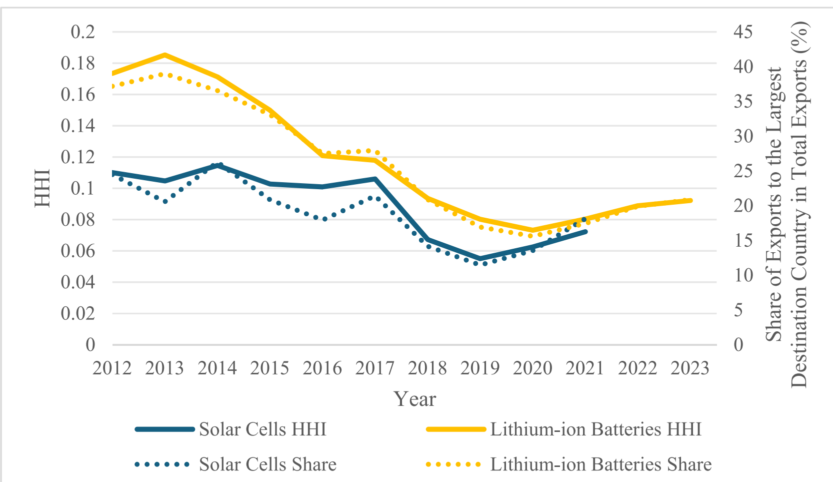

FIGURE 4 | HHI and share of exports to the largest destination country in total exports for China's solar cells and lithium-ion batteries exports (2012–2023). Data sourced from UN comtrade database. Calculations and visualizations were performed by the authors.

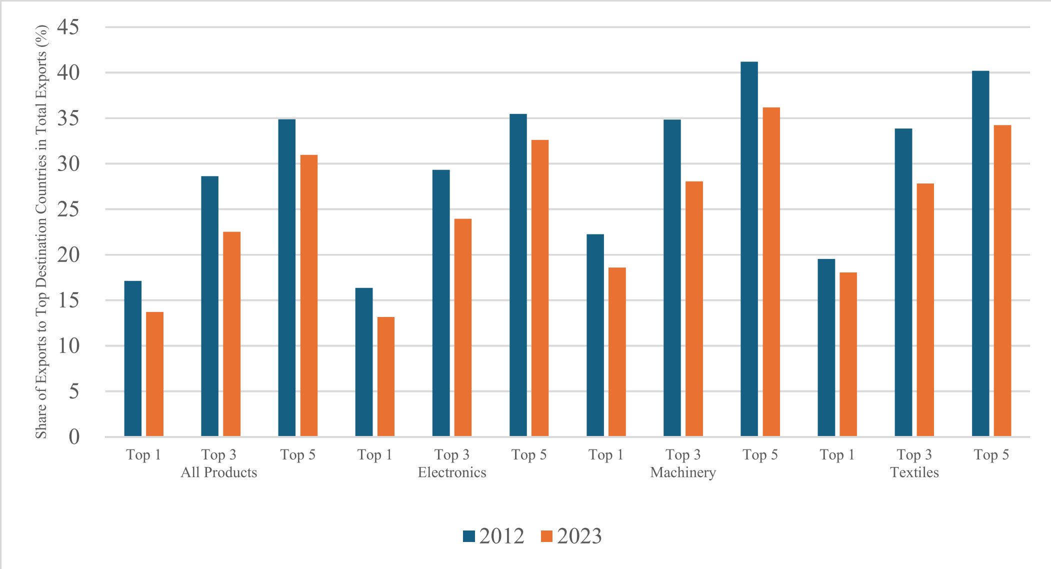

FIGURE 5 | Share of exports to top destination countries in total exports of all products and the three major export industries in China (2012 vs. 2023). Data sourced from UN comtrade database. Calculations and visualizations were performed by the authors.

3.2 | Globalised Production: Optimising Supply-Side Spatial Distribution

Globalised production typically refers to overseas investment activities driven by firms' motivations for market- or resource-seeking. However, existing research indicates that globalised production can also serves as an effective risk mitigation strategy amid supply chain disruptions. In the current environment of frequent geopolitical conflicts, 'risk avoidance' has become an increasingly important driver for firms' overseas investment. Kamalahmadi and Parast (2017) argue that multisourcing strategies not only enhance the security and resilience of supply chains but also facilitate the efficient allocation and rapid redeployment of resources across a broader scope. An empirical study by Wang et al. (2025) based on data from Chinese industrial firms finds that outward foreign direct investment (OFDI) by China's manufacturing enterprises contributes to the diversification of supply chains and sources of intermediate goods, thereby enabling firms to build self-centred global supply networks to better cope with supply chain risks. In practice, there are also numerous cases in which firms have used OFDI as a means to withstand the impacts of sanctions. For instance, BYD has already established a significant market presence in Southeast Asia (Thailand, Indonesia), Latin America (Brazil, Mexico), and Europe (the UK, Spain, Ireland). Since 2024, the company has actively expanded its global production network by launching overseas factory projects in Thailand, Indonesia, Hungary, and Mexico, etc. Amid rising tariff sanctions on Chinese EV exports by the US and EU, BYD could leverage overseas factories to produce and export its products to these economies, thereby circumventing trade barriers.

To support enterprises in overcoming challenges associated with overseas investment, the Chinese government has implemented a series of targeted policy measures. At the international level, China has actively promoted the Belt and Road Initiative (BRI) to facilitate infrastructure development and provide financial support for enterprises. Additionally, the government has participated in regional trade agreements such as the Regional Comprehensive Economic Partnership (RCEP) and has sought alignment with high-standard trade frameworks like the Comprehensive and Progressive Agreement for *Trans*-Pacific Partnership (CPTPP), to offer institutional safeguards for firms' overseas investments. Domestically, the government has introduced fiscal and tax incentives to assist enterprises in mitigating financial constraints associated with cross-border operations. With these policy measures in place, Chinese enterprises have accelerated the establishment of global production networks, thereby enhancing their international competitiveness and resilience against supply chain risks.

3.3 | Summary

China's approach to optimising the spatial layout of its supply chain adopts a balanced strategy that addresses both demand- and supply-side considerations. On the demand side, the government promotes market diversification to mitigate dependence on any single overseas market. On the supply side, it facilitates globalised production by encouraging enterprises to expand their overseas investments. From a policy implementation perspective, China has developed a comprehensive strategy that integrates domestic and international measures. Domestically, it provides fiscal and tax incentives to support firms' global expansion. Internationally, it establishes cooperative mechanisms to strengthen cross-border economic partnerships. Collectively, these policies have effectively enhanced supply chain resilience, reinforcing the stability and competitiveness of Chinese enterprises within the global industrial network.

It is worth noting that building a resilient supply chain is inherently a defencive strategy that often comes at the expense of efficiency. Diversified production and market layouts may not represent the optimal allocation of resources in the short term, but they tend to perform better in the face of risks. Against the backdrop of heightened global uncertainty, China's industrial policy choices have increasingly prioritised resilience over efficiency—an approach considered by China to be appropriate for its current stage of development.

4 | Conclusion and Policy Recommendation

This paper examines China's policy pathways for building a resilient supply chain from the perspective of competitiveness enhancement and spatial optimization. China's industrial policy design provides valuable insights for other emerging economies, leading to the following policy recommendations.

First, governments should formulate targeted policies based on the development stage of different industries. In vulnerable sectors, strong policy support should be provided to encourage enterprises to increase R&D investment and enhance self-sufficiency in critical areas. In leading industries, policy interventions should focus on complementary support, such as infrastructure development, talent cultivation, and industry regulation. For emerging industries, flexible fiscal and tax incentives should be introduced and withdrawn at appropriate stages to foster a competitive market environment conducive to sustainable industrial growth.

Second, governments should support enterprises in optimising their global supply chain layout. To promote market diversification, policymakers should enhance trade facilitation services, including trade financing, credit insurance, and smart customs systems, etc. Additionally, active participation in free trade agreements (FTAs) can provide institutional safeguards for exports, while the establishment of pilot zones can facilitate firms' overseas market expansion. To strengthen globalised production, governments should advance international investment agreements to improve institutional support for overseas operations and implement fiscal and tax incentives to assist firms in securing financial resources for global expansion.

Since China's resilience-oriented industrial policies still rely heavily on fiscal support, the issue of subsidy competition remains a concern—both among provinces and between countries. Such competition often distorts market mechanisms by reducing the efficiency of resource allocation and causing waste of public funds. This has led to aggressive subsidy races, the proliferation of homogeneous projects, mounting fiscal pressure, and increased risks of overcapacity. To address these challenges, a central-level review and guidance mechanism should be established at the outset of policy design to clearly define the scope, limits, and duration of subsidies, ensuring that local subsidy practices are regulated and rational. During policy implementation, subsidy programs should be subject to regular evaluation, with support promptly withdrawn from firms that fail to meet performance targets or encounter major operational difficulties, thereby promoting the efficient reallocation of resources. Another feasible approach is to develop cross-regional coordination mechanisms. Interprovincial subsidy coordination platforms could be established in key industries to harmonise the pace and scale of subsidies and prevent disorderly competition among regions. These measures may also offer valuable insights for mitigating industrial policy competition at the international level.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

Endnotes

[1] The Association for Supply Chain Management (ASCM) forecasts that 'artificial intelligence' and 'global trade dynamics and geopolitical policies' will be the two primary drivers shaping the future landscape of supply chains. For more details, see https://www.ascm.org/making-an-impact/research/top-10-supply-chain-trends-in-2025/.

[2] For instance, the inclusion of Chinese firms on the U.S. Entity List not only prompted the relocation of semiconductor manufacturers such as TSMC and Samsung for non-economic reasons but also accelerated China's domestic semiconductor substitution. This trend is increasingly driving the global semiconductor supply chain toward fragmentation and regionalization (Xiong et al. 2024).

[3] The data is sourced from the OECD Research and Development Statistics, with amounts calculated in current U.S. dollars based on purchasing power parity. The data was retrieved on February 22, 2025.

[4] Existing research often assesses the degree of automation based on the adoption of industrial robots, as demonstrated by Acemoglu and Restrepo (2022).

[5] For more details, see https://www.gov.cn/gongbao/content/2017/content_5216427.htm.

[6] https://www.usitc.gov/publications/332/executive_briefings/ebot_china_ev_exports.pdf.

[7] For example, the March 2025 workshop held in Geneva, Academic Perspectives on Industrial Policy. Available at: https://www.econ.uzh.ch/en/eventsandseminars/workshopsandconferences/Industrial-Policy.html.

[8] For example, multiple measures outlined in *Report on the Work of the Government (2024)* to support enterprises in expanding diversified markets. For more details, see https://english.www.gov.cn/news/202403/13/content_WS65f0dfccc6d0868f4e8e5079.html.

[9] Detailed export data for the third product–electric vehicles—were not available due to data limitations.

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