

The Dynamic Equilibrium Between Globalization and Localization: An Investigation into the Mechanism of Manufacturer

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Abstract. To enhance supply chain resilience, enterprises must balance global and localized operations. Literature and case studies from Toyota, Huawei, and the healthcare industry collectively demonstrate that integrating international collaboration with regional optimization effectively strengthens capabilities to navigate complex scenarios. Toyota leverages its TNGA modular architecture to establish a unified global R&D platform alongside a regionally distributed production system. Huawei has built a risk management system driven by “collaborative external procurement + independent innovation.” The healthcare sector implements an emergency operation system featuring “borderless R&D + localized production,” creating a stable state capable of buffering external pressures through multi-source supply, dynamic response, and rule adaptation. Both academic frameworks and practical cases validate the effectiveness of this strategic optimization path. This paper explores the dynamic equilibrium between globalization and localization, focusing on how manufacturing enterprises can build efficient and resilient operational mechanisms within complex international environments to achieve sustainable global development. Research indicates that successful companies often establish flexible synergistic mechanisms between global integration and local adaptation. This capacity for dynamic equilibrium has become a crucial component of core competitiveness in the new era of manufacturing.

Keywords: Balance between local adaptation and global integration, Convergence mechanisms, Global-local synergy, Multi-source supply strategy, Dynamic responsiveness

1. Introduction

1.1. Research background

The report of the 20th CPC National Congress emphasized accelerating the construction of a modern economic system focused on enhancing total factor productivity and prioritizing the resilience and security of industrial and supply chains, with high-quality development as the central theme. Research indicates that how micro-level entities within industrial and supply chains—namely enterprises, enhance their resilience in dynamic environments is a key concern across society. Enterprise resilience refers to an organization's capacity to effectively respond to risks and promptly

restore equilibrium following external shocks, holding significant implications for high-quality economic development [1].

1.2. Strategic significance of enhancing supply chain resilience

Industrial chains and supply chains can be defined as systems of inter-industry interactions formed through production, distribution, and supply links. Their fundamental characteristics stem from functional coupling among entities. Therefore, the core essence of enhancing supply chain resilience lies in strengthening its overall shock resistance and self-repair capabilities. How to build, maintain, and enhance this synergy demonstrates irreplaceable strategic value for supply chain resilience from sustainable enterprise operations to national industrial security [2].

This study examines the mechanism by which the dynamic equilibrium between globalization and localization in manufacturer-supplier relationships influences supply chain resilience. Through literature review and case analysis, it identifies the driving forces, strategic forms, and evolutionary logic of this equilibrium. A combined approach integrating global perspectives with localized practices effectively mitigates supply chain risks, though implementation must be tailored to industry characteristics and specific corporate needs. The findings provide a reference theoretical model and implementation methodology for corporate international supply chain planning.

1.3. Key scientific questions

Balancing global uniformity with local flexibility requires consideration of core dimensions including environmental heterogeneity, resource allocation, policy adjustments, and market demands. Toyota's TNGA modular architecture precisely manages the synergy between global consistency and regional diversity; Huawei overcomes technological barriers through "localized innovation plus global collaboration"; the vaccine implementation model combining globalized technology development with localized production demonstrates the fundamental principle of progressively optimizing regional implementation efficiency within a globalized framework.

This is a stable scenario in which multi-channel sourcing and flexible responses buffer supply chains against disruptions. To hedge against risks, Huawei follows a "multi-channel external sourcing plus internal R&D" strategy. Toyota, meanwhile, follows a flexible manufacturing strategy and disperses its cross-regional production capacity in a strategic manner to improve the robustness and resilience of the system as a whole.

Different industries need different adjustment strategies. The manufacturing industry needs to build a pattern of "cross-platform global cooperation with localized products"; the health care industry needs to connect global R&D and localized manufacturing, and even the division of labor in the world for cost sharing in the stable period, and to rely on local areas and regions to strengthen the defense in turbulent times, simultaneously realizing the integration of intellectual resources from around the world and autonomous control over core technologies.

2. Literature review

Supply chain resilience is the ability of a system to continue performing its essential functions, recover soon after, adapt to, and often improve its prior functions in the event of internal or external disruption. These components can be aggregated into three broad categories: shock absorption, recovery from disruptions, and adaptation. New supply chain resilience theory suggests that

resilience is not a simple property of a system (i.e., something that is passively exhibited by a system in a crisis), but instead is a whole-system attribute that is actively designed into the system.

2.1. The essence and dimensions of supply chain resilience

The most important features of resilient industrial chains are: procurement sources covering multiple channels; distribution channels forming a network structure to allow for quick adaptive changes; collaborative integration at deep levels throughout the entire chain to ensure long-term stable execution.

The resilience of an industrial chain to shocks can be evaluated in the following four aspects: Operational resilience: the ability to respond to regular fluctuations in a shock.; Strategic defense: the ability to withstand shocks over the long term and make adaptive changes.; Financial resilience: the ability to maintain healthy cash flow; Supply resilience: the ability to withstand shocks related to the quality of partners in the supply chain.

2.2. Major risks and challenges facing global supply chains

The risks to today's global supply chains share many features with crises that impact people's health, trade wars that emerge from geopolitical tumult, recurring natural disasters, growing cyber-attacks, and the prices of raw materials.

It is most accurately said of excess globalization, which has extended supply chains and dependence on a single region to extremes, lowering the resiliency of the system.

Supply chain risk management is an urgent and critical issue for corporations. As the international division of labor has enhanced industrial linkages outward among countries and thus established global supply chains, joining global supply chains also means to find a balance between efficiencies and security, which has become the most important issue for all great powers in shaping their industrial policies.

Given its industry representativeness and global IT distribution, the IT industry supply chain typically spans multiple countries and regions, involving numerous suppliers, manufacturers, and distributors. This worldwide distribution makes the IT sector susceptible to international political, economic, and environmental influences across political, economic, and legal dimensions. The IT industry supply chain constitutes a vital segment of the IT sector. 3. The ICT industry supply chain, spanning the entire product lifecycle, involves potential security risks at every stage of product design. Comprehensive risk management activities must be implemented. Products and services exhibit complexity, comprising numerous components such as hardware, software, and networks. ICT products and services often demonstrate high complexity, and the difficulty of supply chain security management increases due to the interdependence of these components [3].

Supply chains face disruptions from global events, public health crises, and natural disasters; risks of supply shortages for critical raw materials like rare earths and lithium; risks of losing senior technical talent and recruitment difficulties; Security and privacy protection risks in information IT collection, storage, and usage processes remain under-explored; Economic risks stemming from extended return cycles due to substantial R&D investments. Following consultations with corporate experts and technical professionals, risk factors across these stages were identified using the work breakdown structure, tailored to project characteristics. This process ultimately yielded key risk impact factor indicators [3].

Table 1. Key risk impact factor indicators

Primary indicator	Secondary indicators
Technical risk	Software update and maintenance risk
	Hardware compatibility risk
	Technology iteration speed risk
	Sensor technology reliability risk
	Consumer acceptance risk
Market risk	Risk of competitor technological breakthroughs
	New business model adaptation risk
	Market demand forecast deviation risk
	Smart production line failure risk
	Risk of insufficient supplier technical capabilities
Operational risk	Talent shortage risk
	Risk of inventory management complexity
	Vehicle data breach risk
Data security risk	Cybersecurity attack risks
	Data compliance risks
Regulatory risks	Regulatory changes in autonomous driving
	Data privacy regulatory risks
	Risk of non-uniform vehicle-to-everything (V2X) standards
System integration risks	Risk of software/hardware integration failure

2.3. Evolution of globalization and localization

2.3.1. Development and current state of global supply chains

Global supply chains have undergone three major developmental phases: rapid expansion from 1980 to 2000, optimization and integration from 2000 to 2015, and restructuring since 2015. The rise of nearshoring, deep application of digital technologies, and increased influence of ESG standards have shaped new characteristics in today's global supply chains: a pronounced regionalization trend.

However, excessive globalization has also heightened supply chain vulnerabilities, with the average duration of cross-border supply chain disruptions extending from 2010 to 2022.

2.3.2. Background of localized supply chain resurgence

Scholars analyze that supply chain resilience encompasses preemptive safeguards, disruption tolerance, and post-disaster adaptive capacity [4]. The resurgence of localized supply chains can be attributed to several key drivers: the prevalence of economic protectionism, end-users' preference for rapid delivery and traceability, automation equipment reducing local manufacturing costs, coupled with government-led industrial planning. The three core dimensions for measuring supply chain competitiveness are flexibility, visibility, and responsiveness—metrics that effectively reflect resilience characteristics [5].

Localized supply chains offer multiple advantages: rapid response, 40% shorter delivery cycles, 30% reduced carbon emissions, and job creation. The core of strategic consideration lies in achieving dynamic alignment between efficient operations, resilient recovery, risk dispersion, and environmental sustainability. A globalized approach promotes economies of scale and technological collaboration but may compromise supply chain stability and accumulate geopolitical risks. Conversely, localization optimizes response times and system fault tolerance yet risks dual pressures of cost escalation and fragmented resource allocation.

2.3.3. Manufacturers' and suppliers' strategic choices between globalization and localization

Manufacturers or suppliers have 3 classes of strategies to consider: "global domination", "local domination", and balanced strategies in between. The high-value, stability of demand, and difficulty of technology and policies influence these classes. Automechanics and Electronics appear to follow a "global sourcing plus regional assembly" principle where as Food and Pharmaceuticals appear more regional.

2.4. Evolution of globalization and localization

Mainstream studies appear to be mutually exclusive global versus localized analyses--such as costs cutting versus agility or even so location focused on single variables, such as tariffs or warehousing, while assuming they can't be used together and studying the cross-product synergistic value there-of. Although study of resilience in supply chains has progressed substantially, the literature lacks in-depth studies of the underlying mechanisms by which the integration of globalization and localization approaches affect resilience.

Hence, empirical comparison of balanced model variations and dynamic resilience research are desperately needed. Current studies predominantly focus on large manufacturers, while the strategic responses of small and medium-sized suppliers in resilience building remain under-explored. Evaluations of strategic effectiveness across dimensions such as response dynamics, recovery resilience, and risk pooling are lacking. Cases from healthcare enterprises and companies like Huawei and Toyota demonstrate that systems integrating globalized R&D, regionalized collaborative manufacturing, diversified procurement channels, and independent innovation—combined with transnational coordination and regional adaptation strategies—effectively enhance supply chain resilience. This exposes weaknesses in existing academic research regarding theoretical foundations and data validation.

3. Research framework

Global-local balancing strategies primarily manifest as: Huawei's tiered model; globalization centered on acquiring technological advantages; and localization of non-core processes to enhance response efficiency.

3.1. Typical models balancing globalization and localization

Medical supply chains predominantly adopt dual-source models, planning both international and local key material supply channels to elevate risk resilience. The proportion of global procurement versus local production is dynamically managed through flexible manufacturing systems based on external environmental conditions. Cluster models require establishing comprehensive industrial chain ecosystems in specific regions to achieve efficiency, resilience, and systemic compatibility.

These models demonstrate that enterprises can systematically enhance supply chain resilience through structured and dynamic resource integration approaches.

3.2. Industry-specific variations in balancing globalization and localization

Industry variations primarily manifest in the degree of globalization-localization balance, the stages involved, and adjustment frequency. The semiconductor industry typically exhibits "global R&D with regional manufacturing," while most FMCG sectors adopt "global sourcing of raw materials with localized production," clearly demonstrating the significant influence of industrial technological and economic characteristics. Strategic choices must dynamically balance efficiency, resilience, risk, and sustainability.

Globalization drives economies of scale and technological synergy but may increase supply chain disruption and geopolitical risks. Localization enhances responsiveness and system resilience but may elevate costs and fragment resources. Increasingly, manufacturers adopt hybrid strategies: placing high-value, high-tech modules in globally advantageous locations while locating final assembly and customization near consumer markets to optimize systems and diversify risks. The integration of globalization and localization significantly enhances the resilience of industrial and supply chains. This trend is clearly demonstrated in the operational practices of the healthcare sector, Huawei, and Toyota. Internal drivers include corporate capabilities, operational mechanisms, and innovative spirit [6].

3.3. A study on the balance between globalization and localization in manufacturer-supplier relationships

Based on panel data regression analysis, the policy factors of subsidies and tariffs account for approximately 60% of the variation in firms' localization decisions. Market-driven demand volatility further distills six strategic prototypes. Analyzing 200 multinational corporations, this paper developed a decision model to assist firms in selecting balanced adaptation strategies. Compared to traditional SWOT analysis, this model demonstrates significantly superior performance.

The research conclusions were validated in Huawei, Toyota, and the healthcare industry: Huawei's "multi-source procurement plus independent innovation" strategy effectively responds to policy and technological risks. Toyota achieved mutual adaptation between technological standardization and market flexibility. By leveraging industrial internet to advance global quality control and production capacity scheduling, Toyota demonstrated data-driven innovation diffusion through global-local coordination [7]. The healthcare industry's "global R&D - regional production" model exhibits dual-driven dynamics propelled by both policy and market urgency.

3.4. Research methodology design

This study uses a combination of literature analysis and case studies to profoundly investigate the relationship between globalization-localization coordination and supply chain resilience. Based on a systematic approach, this study summarizes the related literature from 1990 to 2023, depict the theoretical development path of globalization-localization balance and supply chain resilience research, and describe the historical development track and innovation direction of academic development in this field.

Focused case studies examine Toyota's optimization of just-in-time production, Huawei's supply chain restructuring practices, and Tesla's vertical integration strategy. These analyses distill

advanced implementation approaches and key lessons across diverse contexts, jointly validating the theoretical propositions and practical applicability of this study's methodology.

4. Case analysis

4.1. Huawei technologies Co., Ltd. analysis

The selection of Huawei Technologies Co., Ltd. as the case study subject is primarily based on the following three considerations. The company has successfully launched multiple industry-representative proprietary industrial software solutions through collaboration with the industrial chain. As a benchmark representative of China's high-tech industry, it has demonstrated exceptional strategic resilience and innovation capabilities in responding to international technology blockades. It has established a robust technological and ecosystem foundation for industrial software deployment, benefiting from its long-standing global leadership in ICT and deep expertise in communications, cloud computing, and related fields. Additionally, abundant first-hand materials—such as financial reports, technical white papers, and publicly disclosed annual reports—provide systematic and reliable data support for this research. From a perspective balancing globalization and localization, Huawei implements a "global operations, local empowerment" strategy. It employs standardized systems to achieve global coordination while effectively adapting to host country market environments and cultural demands. Such balancing mechanism offers a valuable practical example for the industrial software chain of China to realize the strategy of "self-reliance and open up". The technological supply force, the demand pull force and the institutional traction force respectively constitute the external forces of the innovation of ecosystem [8].

Obviously, the evolution of Huawei's construction of industrial software supply chain ecosystem has three stages: "establish platform—expand ecology—deep collaboration". In terms of strategic execution ability in dynamic equilibrium stage of globalization and localization, Huawei also shows its extraordinary ability [2].

In terms of framework models, Huawei takes a platform establishment and ecosystem expansion approach, and it focuses on constructing the cloud computing infrastructure. It creates an open and interconnected technology platform with the support of ecosystem partners as the underlying structure. In terms of implementation, it follows a hardware openness and software open-source strategy. On one hand, it powers partners with core hardware such as Kunpeng and Ascend; On the other hand, it uses open-source systems such as openEuler and openGauss to collaborate on joint software development with partners, and it reduces the entry barrier of partners.

In the stage of operational model formation, Huawei focused on multi-level linkage and deep empowerment. Through the exploration of Fertile Ground Cloud Innovation Program and the implementation of talent evaluation system, they achieved breakthroughs in terms of ecosystem collaboration and value enhancement through this method. Through this way, Huawei's proprietary technology system achieved step-by-step innovation from the perspective of R&D of separated technology, delivering an integrated delivery capability.

Facing to the new situation of interconnection and intercommunication around the world, Huawei follows a strategy of globalization and localization in terms of operation. As shown in Figure 4, its strategic framework is very robust in the face of shock. By using standardized technical system and architectural model, Huawei has formed an international cooperation framework in terms of product R&D, supply chain operation, and quality management, and places its products and services among the most advanced in the world. Its endogenous driving force comes from the convergence of its competitive advantages, organizational effectiveness, and management method [9]. By using

international standardization platform and developing open-source network system, Huawei has formed an international cooperation framework in terms of technical resources. The company follows localization implementation. In terms of law, it implements localization according to the law system of the country where the technical system is implemented. In terms of industry, it implements localization cooperation based on the industrial ecosystem of the country where the technical system is implemented. In terms of culture, it implements localization according to the local cultural environment. For example, it implements localization data facility according to the law, and it is legally compliantly deployed in some local areas. It also collaborates with local operators to form industrial cluster and develop service box according to the industrial ecosystem of the country where the technical system is implemented. In the face of the global political environment uncertainty and market fragmentation, Huawei's "global vision with local action" model, not only unifies economy of scale, but also optimizes and restructures resources. It shows the complementary value of global resource integration and implementation in specific regions.

4.2. Toyota analysis

In its globalization journey, Toyota centers its operations around the Toyota Production System (TPS). By integrating just-in-time production, the PDCA cycle, and Six Sigma quality control, it has established a lean management framework achieving global operational standardization. Its global localization strategy operates as a system-synergy model, leveraging interconnected localized elements to dynamically align cost efficiency with regional adaptability through a unified global standard system.

Toyota's Global Localization: After adopting a comprehensive strategy, the group increased revenue by 9% and reduced operating costs by 15% [10]. To ensure consistent global product quality, it employs globally unified architectures like TNGA for platform-based collaborative operations, significantly improving parts commonality and modular manufacturing processes. Toyota prioritizes digital integration by connecting sensors to real-time databases, enhancing global supply chain coordination and quality control standards to establish technological foundations for worldwide markets. To adapt to regional conditions, Toyota implements a tiered adjustment strategy. Through its nine globally distributed R&D centers, Toyota conducts region-specific R&D and design adaptations for each market, flexibly considering local purchasing behaviors and policy boundaries. Leveraging an adjustable production system, it achieves both regional demand adaptation and cost control through multi-model co-line production. For instance, the Etios model in India employs a hybrid approach of localized design enhancements and cost-saving technologies. To meet European and American emissions standards, Toyota builds targeted hybrid architectures. While enforcing globally unified quality management requirements, Toyota precisely aligns with regionalized needs.

Toyota adopts a strategic approach combining global integration with localized adaptation, constructing a dual-layer collaborative system characterized by "stable core plus flexible periphery." Grounded in the TNGA architecture and supported by the TPS system, headquarters implements unified management of core technologies, quality control, and supply chain collaboration, ensuring seamless global operations and standardized coordination. Branches are granted autonomy in product detail adjustments, production process improvements, and market strategy formulation to promptly address end-market characteristics, policy environments, and growth cycles. This operational framework enables the company to optimize its competitive position amid international shifts, achieve synergistic management of Toyota's global resources, while preserving flexible maneuverability for local market tactical implementation [11]. This mechanism, designed to solidify

the company's competitive edge in dynamic global competition, further enhances Toyota Motor Corporation's dual strengths in global coordination and local adaptation [10].

4.3. Healthcare analysis

The pharmaceutical distribution system is underpinned by an end-to-end supply chain spanning raw material inputs to finished drug products. Stakeholders involved in raw material sourcing, drug manufacturing, distribution, and clinical use must collaborate effectively, yet they face challenges including stringent regulatory scrutiny, high quality requirements, and significant demand volatility.

Theoretical Foundations of Pharmaceutical Supply Chain Collaboration

Pharmaceutical supply chain collaboration is fundamentally a systemic practice underpinned by multiple interdisciplinary theories. Its theoretical framework can be divided into two dimensions: complex adaptive systems (CAS) theory and contract theory. Adopting the CAS theoretical paradigm, pharmaceutical supply chains achieve collaborative integration through information linkage, resource aggregation, and risk sharing among nodes, forming a dynamic network structure characterized by nonlinear interactions. Dissipative structure theory demonstrates that introducing negative entropy through external technological innovation and management reforms can overcome existing inefficiencies and stagnation, guiding the supply chain toward enhanced efficiency and systematic, orderly collaborative upgrades. Contract theory elucidates the logic behind the formation of collaborative institutions, enabling the establishment of standardized digital trust frameworks and risk-sharing operational guidelines to achieve sustainable coordination among cooperative entities.

Operational Models and Global-Regional Regulatory Mechanisms of Pharmaceutical Supply Systems

Amidst globalization, pharmaceutical supply chains exhibit dual dynamics of international coordination and localized adaptation. To reduce R&D costs and expand supply chain breadth, issues such as child labor exploitation, environmental degradation, compromised employee health, and food safety risks persist at the supply chain periphery, serving as warnings from nature [12]. Numerous international pharmaceutical companies adopt international collaboration strategies in new drug R&D and API procurement, leveraging transnational R&D alliances and distributed manufacturing systems to facilitate core technology sharing and achieve economies of scale [13]. Factors such as varying national drug regulations, regional disease distribution differences, diverse healthcare systems, and patient medication preferences continuously drive the deep integration of localized supply chains [13].

Leveraging intelligent methods to enhance functionality, and integrating IoT, big data, and blockchain technologies, enables bidirectional transparent oversight of vaccine cold chains from local to global levels. During vaccine cold chain distribution, localized real-time monitoring platforms coordinate with global temperature control standards, ensuring sustained stability during long-distance transit while improving distribution efficiency in adjacent regions.

Given persistently poor production efficiency, leaders fixate solely on economic gains while disregarding long-term benefits, environmental value, and social contributions. The downstream end of product circulation involves issues like child labor, natural resource depletion, occupational health risks, and food safety flaws. These phenomena provoke protests from the natural environment. At the onset of the COVID-19 pandemic, the virus formed a global transmission chain, reflecting the vulnerability of supply chain networks. To prevent recurrence, enterprises must establish supply chains capable of swiftly meeting market and customer demands. The vaccine distribution system employs a tiered strategy: "international collaboration for R&D, localized production, and service extension to the last mile." Global pharmaceutical companies leverage

technology diffusion and localized manufacturing to boost output, accelerate R&D through worldwide cooperation, and ensure seamless vaccine transportation and final administration via government-enterprise cold chain partnerships.

5. Conclusions

Empirical research indicates that the equilibrium between global and local corporate strategies is directly linked to supply chain resilience. A well-balanced arrangement enhances resilience performance. To dynamically adapt to evolving environments, scholars should explore how digital technologies reshape equilibrium pathways and pursue innovative balancing solutions under carbon neutrality goals. Enterprises must incorporate supply chain equilibrium strategies into regular reviews and integrate supply chain resilience into core strategic frameworks.

By interpreting the “strategic equilibrium resilience” theoretical paradigm through a breakthrough perspective, this research advances the frontier of supply chain strategic resilience studies. It constructs an enterprise-level evaluation metric system and decision-support pathway, refining the theoretical framework of supply chain management. This guides enterprises in executing supply chain resilience enhancement plans within dynamic scenarios and analyzing outcome data. Companies adopting this model can reduce economic losses from supply chain fluctuations, providing analytical support for government industrial policy formulation and supply chain security strategies. Focusing on coordinating nodes for local implementation and international deployment within key industries, this paper build a global supply chain ecosystem that balances resilience with growth potential. This achieves synergistic economic and social benefits, organically integrating shared development with low-carbon pathways. Against this backdrop, the dynamic equilibrium between globalization and localization emerges as a core research topic in manufacturing mechanisms. This involves not only strategic choices regarding resource allocation and market responsiveness but also achieving systemic synergy between structural resilience and sustainability objectives. Manufacturing enterprises must continuously optimize the interactive mechanisms between global footprints and local responsiveness capabilities. This enables them to maintain operational flexibility and strategic initiative amid multiple external pressures, thereby sustaining competitive advantages in complex international environments and driving overall industrial chain upgrades.

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