Print ISSN: 1738-3110 / Online ISSN 2093-7717
JDS website: http://accesson.kr/jds
http://doi.org/10.15722/jds.23.12.202512.1

Does Supply Chain Innovation and Application Pilots Policy Enhance China's Urban Trade Resilience: Evidence from China

Tianqi YU[1], Yibei ZHANG[2], Jingtian YANG[3], Xiaoyu YAO[4]

Received: October 27, 2025. Revised: November 29, 2025. Accepted: December 05, 2025.

Abstract

Purpose: This study evaluates the impact of China′s Supply Chain Innovation and Application pilot policy on urban trade resilience in the context of global uncertainties and U.S. tariff shocks. **Research design, data and methodology:** Using a difference-in-differences (DID) model and panel data from 285 Chinese prefecture-level cities (2012–2022), we examine the policy′s net effect on trade resilience, measured by resistance, recovery, and transformation capacities. **Results:** (1) The supply chain innovation and application pilot policy significantly enhances the trade resilience of pilot cities, a conclusion that remains robust after undergoing a series of robustness tests, including altering the sample period, applying propensity score matching, and adding fixed effects. (2) Mechanism analysis indicates that the pilot policy improves urban trade resilience by enhancing industrial synergy, fostering new quality productive forces, and optimizing the business environment. (3) The policy′s effect on improving urban trade resilience varies across cities, showing more pronounced positive impacts in cities with digital economy policies, cities with stronger intellectual property protection, and non-resource-based cities. **Conclusions:** The study recommends expanding the pilot program, building multi-stakeholder empowerment mechanisms, and implementing regionally tailored policies to strengthen urban trade resilience. These insights offer practical guidance for enhancing supply chain innovation and trade sustainability in China and similar contexts.

Keywords : Supply Chain Innovation, Supply Chain Innovation and Application Pilot, Urban Trade Resilience

JEL Classification Code: F14, O25, R11

1. Introduction

1.1. Research Background

As key nodes in global trade, cities play a pivotal role, and their trade resilience has emerged as a core factor influencing economic stability and sustainable development. External shocks, such as the recent U.S. "reciprocal tariff" policy, have disrupted global supply-demand structures and intensified supply chain fragility (Contractor, 2025). Under such shocks, a city's trade resilience directly determines its vulnerability and recovery speed. Cities with strong resilience can leverage diversified trading partner structures to shift away from affected markets, thereby maintaining stable trade volumes.

1 First Author. Bachelor's Degree, Zhejiang Normal University, China. Email: ytq15356638772@gmail.com
2 Corresponding Author. Bachelor's Degree, Zhejiang Normal University, China. Email: 19558285449@163.com
3 Second Author. Bachelor's Degree, Zhejiang Normal University, China. Email: 19548990993@163.com
4 Third Author. Degree: Bachelor's Degree, Zhejiang Normal University, China. Email: xiaoyuyao200602@outlook.com

In the competitive market environment, the supply chain has become a key source of enterprise innovation (Basole et al., 2017). Recognizing this, the Chinese government has elevated supply chain innovation to a national strategy. Beginning with the Guiding Opinions on Actively Promoting Supply Chain Innovation and Application in 2017, China has launched a series of pilot programs, selecting hundreds of enterprises and cities to participate in supply chain innovation and application initiatives.

Although these policies have yielded substantial benefits, insufficient research exists on how the pilot policy specifically influences the mechanism of urban trade resilience. Its impact mechanisms and pathways of action warrant further exploration. Therefore, this research helps deepen the understanding of the policy's operational mechanisms and provides scientific evidence for policymakers, facilitating the integration between pilot policy and urban trade resilience.

1.2. Contributions

This study's contributions are threefold. First, it deepens the understanding of the internal logic and effectiveness of the supply chain innovation and application pilot policy, providing a theoretical foundation for related policies. Second, it conducts a comprehensive measurement of trade resilience at the city level, enriching the application of economic resilience theory in the field of trade. Finally, utilizing panel data from Chinese prefecture-level cities, it investigates the impact and underlying mechanisms of the pilot policy on urban trade resilience. The mechanism analysis reveals specific pathways--improving the business environment, enhancing new quality productive forces, and fostering industrial synergy--contributing to a better theoretical understanding of urban trade resilience enhancement.

In the context of accelerating global economic integration, the supply chain has become a core pillar of trade activities. This paper provides referential policy recommendations for governments in other regions to promote the construction of supply chain innovation and application pilot programs in a manner tailored to local conditions. It also offers insights into how to further leverage these pilot initiatives to enhance urban trade resilience. These recommendations are of great significance in stimulating the endogenous momentum of urban trade development, guiding cities to increase investment in supply chain innovation, optimize supply chain configurations, improve trade efficiency, strengthen their capacity to withstand external shocks, achieve high-quality and sustainable development of urban trade, and elevate their competitiveness and position within the global trade landscape.

1.3. Research Content and Structure

This paper investigates the impact of the supply chain innovation and application pilot policy on urban trade resilience, identifies the underlying mechanisms, and provides decision-making references.

The structure of this paper is as follows:

Section 1 (Introduction) outlines the research background, contributions, content structure, methods, innovations, and limitations.

Section 2 (Literature Review) summarizes existing research on supply chain innovation and urban trade resilience, identifying the research gap this study addresses.

Section 3 (Theoretical Foundation and Research Hypotheses) builds the analytical framework based on endogenous growth theory, dynamic capabilities theory, and innovation diffusion theory, and develops testable hypotheses.

Section 4 (Research Design) details the data sources, variable definitions (including the core DID variable and measures of urban trade resilience and mediating mechanisms), and the empirical model.

Section 5 (Empirical Analysis and Results) presents the benchmark regression, a series of robustness tests (including placebo tests), heterogeneity analysis, and mechanism tests.

Section 6 (Conclusions and Policy Implications) summarizes the main findings and derives targeted policy recommendations.

1.4. Research Methods

Literature Research Method. By systematically reviewing a large number of journal articles from academic platforms such as CNKI and Google Scholar, as well as government work reports and research studies, this study summarizes the existing research findings in the fields of urban trade resilience and supply chain innovation pilot programs. The research clarifies the basic concepts and main measures of supply chain innovation pilots, and deeply analyzes their impact mechanisms on the resistance, recovery, and transformation capabilities within urban trade resilience, as well as the interaction mechanisms between pilot policies and urban trade resilience. The potential heterogeneous relationships between the two lay a theoretical foundation for subsequent empirical analysis.

Deductive Hypothesis Method. Starting from existing theories and viewpoints, this study employs logical reasoning to infer the possible impacts of the supply chain innovation and application pilot policy on urban trade resilience. By reviewing theoretical frameworks in related fields--such as endogenous growth theory, economic resilience theory, and supply chain innovation theory--this paper identifies the impact mechanisms and action pathways through which the supply chain innovation and application pilot policy influences urban trade resilience. On this basis, empirical research methods can be further designed to validate and quantify these inferences, leading to more specific conclusions.

Quantitative Analysis Method. By systematically collecting reliable data from multiple sources, including the China City Statistical Yearbook, innovation capability reports, and the National Bureau of Statistics, this study selects core variables of urban trade resilience--such as resistance, recovery, and transformation--while taking into account factors like market share and economic development level. After data preprocessing, Stata software is used to conduct mathematical modeling and empirical analysis on the relationship between the supply chain innovation pilot program and urban trade resilience. The research not only reveals the significant impact and direction of the supply chain innovation pilot on urban trade resilience, but also explores the underlying mechanisms in depth.

1.5. Research Innovation and Limitation

For the research innovation for this article, it includes three parts. From the research perspective, unlike previous studies that have primarily focused on the impact of supply chains on corporate competitiveness or macro-level factors of trade resilience, this study takes a unique approach by analyzing the role of supply chain innovation pilots on urban trade resilience at the city level, thereby filling a research gap in the existing literature concerning city-level analysis. From the research methodology perspective, the Difference-in-Differences (DID) model is employed to ensure the scientific rigor, accuracy, and reliability of the study. From the research content perspective, in addition to examining the direct impacts, this study also explores indirect effects and heterogeneous influences, providing a theoretical basis for the formulation of differentiated policies.

Next, come to the limitation of this article. First, consider the sample scope: This study focuses on data from 285 prefecture-level cities in Chin, potentially excluding cities with unique economic structures or extreme geographical locations. Thus, the generalizability of the findings to non-pilot cities and broader urban contexts remains to be further verified. Second, data quality poses additional constraints. Some datasets exhibit issues in accuracy and completeness, while statistical standards vary across sources. In addition, key variables--such as cultural factors and social capital --were not included in the analysis, which may weakenthe model’s explanatory power. Finally, policy evaluation faces challenges. The complex global economic environment and fluctuating trade policies may introduce unaccounted exogenous variables. At the same time, the dataset (2012-2022) might not fully capturethe long-term lag effects of supply chain innovation policies.

2. Literature Review

In 2016, the Global Enterprise Center emphasized in its Digital Supply Chain White Paper that supply chain digitalization has become a key trend for future development. The white paper defined it as a customer-centric platform that leverages digital technologies to comprehensively collect and analyze real-time information, thereby achieving demand stimulation, acquisition, matching, and management, ultimately reducing risks and enhancing efficiency. Buyukozkan et al. (2018), based on value creation theory, proposed that supply chain digitalization is, in essence, an intelligent, value-driven, and highly efficient process system. From a risk management perspective, Calatayud et al. (2019) offered a different view, defining the digital supply chain as an intelligent system with autonomous decision-making capabilities.

Meanwhile, the Chinese government has also placed high importance on the development of supply chain digitalization. In the 2015 Government Work Report, the "Internet Plus" initiative was introduced, defining smart supply chains as a new type of supply chain system that utilizes digital technologies to drive intelligent management. Domestic scholars have also achieved fruitful research results in the field of digital supply chains. Sharma et al. (2025) described the smart supply chain as an integrated system architecture that deeply combines Internet of Things (IoT) technology with modern supply chain management methods and techniques.

In recent years, the implementation of the pilot policy on supply chain innovation and application has achieved certain results. Cao et al. (2025), using data from Chinese listed companies, found that the pilot policy improves the operational efficiency and profitability of enterprises. Gu & Xu (2024) found that the pilot policy significantly enhanced supply chain efficiency. However, the pilot policy still has certain shortcomings in some aspects. Yuan (2024) pointed out that the policy still faces issues such as insufficient policy instruments and rising risks of deglobalization.

The concept of "resilience" originally stems from the field of ecology, referring to the recovery capacity of an ecosystem after experiencing disruptions. Foreign trade resilience refers to the resistance, recovery, and organizational restructuring capabilities of a specific region's foreign trade system after experiencing shocks. Synthesizing prior research, this paper posits that trade resilience mainly includes three dimensions: resistance, recovery, and restructuring (transformation) capacities.

Currently, in the field of resilience research, the impact of specific factors on economic resilience is a research hotspot. A large number of studies have focused on macroeconomic resilience, while some have examined specific aspects such as industrial resilience and trade resilience. Synthesizing prior research, trade resilience is primarily influenced by factors including: topological structure (Alexander, 2019), urban scale and industrial structure, the stability of supply chains (Mena et al., 2022), the establishment of trade agreements and trading partners (Kuhla et al., 2023), uncertainty in trade policies, and digital trade.

Although existing research on supply chain and urban trade resilience has achieved certain results, there are still obvious deficiencies. Domestic and international literature mostly focuses on independent studies of supply chain digitalization and supply chain management, as well as the identification of influencing factors of urban trade resilience, but there are few systematic discussions directly linking supply chain innovation and urban trade resilience. Meanwhile, although some scholars have mentioned the role of supply chain stability in trade resilience, few have deeply studied the direct impact of supply chain innovation on urban trade resilience, lacking a clear explanation of the mechanism between the two. How supply chain innovation affects the specific mechanisms of the three stages of "resistance-recovery-reconstruction" of urban trade resilience remains unclear.

Based on this, this paper, through combing and analyzing the existing literature, sorts out the key paths through which supply chain innovation may affect urban trade resilience, and deeply explores the internal mechanisms and heterogeneous manifestations of the impact of supply chain innovation on urban trade resilience, in order to provide better decision-making support for policymakers and practitioners in urban trade development.

3.Theoretical Foundation and Research Hypotheses

3.1. Theoretical Foundation

The theoretical foundations of this study include the endogenous growth theory, dynamic capabilities theory, and innovation diffusion theory.

The core idea of endogenous growth theory is that the sustained growth of an economy does not rely on external factors, but stems from endogenous variables within the system, such as technological progress, knowledge accumulation, improvement of human capital, and innovation activities.

The core proposition of the dynamic capabilities theory is that the ability to integrate, build, and reconfigure internal and external resources to adapt to environmental changes is key to maintaining competitive advantage.

The core of the diffusion of innovations theory lies in the process where innovations spread within a social system through specific channels, and are accepted and applied by adopters.

While each of the aforementioned theories provides valuable insights individually, this study integrates them into a cohesive, multi-level framework. Endogenous Growth Theory establishes the fundamental source of resilience. Dynamic Capabilities Theory elucidates the key processes through which these endogenous factors are translated into resilience. Innovation Diffusion Theory accounts for the temporal and spatial heterogeneity of the policy's impact. This integrated framework posits that the Pilot Policy triggers and disseminates supply chain innovations, which are internalized by cities as endogenous growth factors and then operationalized through dynamic capabilities, ultimately manifesting as enhanced urban trade resilience.

In essence, this integrated framework posits that the Pilot Policy (Innovation Diffusion Theory) triggers and disseminates supply chain innovations, which are internalized by cities as endogenous growth factors (Endogenous Growth Theory). These factors are then operationalized through the dynamic capabilities of resource integration and reconfiguration (Dynamic Capabilities Theory), ultimately manifesting as enhanced urban trade resilience. This interlocking theoretical logic not only provides a robust foundation for our empirical analysis but also guides the formulation of our research hypotheses, particularly the mediating roles of industrial synergy, new-quality productive forces, and the business environment.

3.2. Research Hypotheses

From the perspective of enterprise operations, supply chain management enhances operational efficiency through scientific procurement and information-sharing platforms. These measures optimize resource allocation, build trust among supply chain members, and improve stability through collaborative problem-solving.

Regarding trade competitiveness, supply chain informatization significantly improves operational efficiency and response speed. The integration of information technologies enables seamless connectivity and real-time data sharing, allowing enterprises to better predict market trends, optimize production and inventory management, shorten product cycles, and reduce operational costs and risks through digital monitoring systems.

In dealing with emergencies, the policy addresses the inherent fragility of supply chains, particularly for small and medium-sized enterprises. The digital transformation promoted by the policy operates through two key channels: the goods chain and the capital chain. For the goods chain, advanced technologies like big data and artificial intelligence enhance demand insight and optimize production-supply-marketing coordination. For the capital chain, digitalization improves information flow to stakeholders including investors and financial institutions, facilitating capital acquisition and providing financial resilience against external shocks. Based on the above, the following hypothesis is proposed:

H1: The supply chain innovation and application pilot has improved urban trade resilience.

The supply chain innovation and application pilot policy aims to promote enterprise innovation through the following pathways: first, providing policy and financial support to reduce the innovation costs of enterprises; second, encouraging enterprises to use information technologies to innovate supply chain management and collaborative mechanisms; third, by releasing dual signals of supply chain innovation recognition and supervision based on government credit, helping enterprises obtain external investment, thus ensuring the smooth and sustainable conduct of innovation activities. These measures together build an ecosystem to support enterprise innovation, aiming to improve the technological innovation level of enterprises. As an important starting point for enterprise digital transformation, supply chain digitalization is deeply affected by digital technologies, increasingly promoting the process-oriented production and operation of enterprises, efficient information transmission, and agile customer response. It effectively reduces transaction costs, improves production and operation efficiency, enhances the risk-bearing level of node enterprises, improves the collaborative relationship among enterprises, and thus effectively promotes the improvement of supply chain efficiency. Based on the above, the following hypothesis is proposed:

H2: The supply chain innovation and application pilot improves urban trade resilience by improving the business environment.

Supply chain digitalization fundamentally enhances inter-enterprise collaboration. Compared to traditional models characterized by information silos and poor coordination, digital technologies significantly improve transparency and trust among partners, thereby strengthening collaborative relationships and boosting supply chain efficiency.

The policy breaks down barriers between enterprises, such as those separating retailers from suppliers and logistics providers, thereby promoting information sharing and resource complementarity. This close collaboration enables faster access to external innovation resources and market intelligence, accelerating innovation processes while reducing associated costs and risks.

Industrial collaboration strengthens urban trade resilience through three core mechanisms: supply chain optimization that reduces costs and improves efficiency; enhanced innovation capability through knowledge sharing and cross-boundary cooperation; and market diversification that reduces dependence on single markets through shared channels and resources. Based on the above, the following hypothesis is proposed:

H3: The supply chain innovation and application pilot improves urban trade resilience by promoting industrial collaboration.

The policy cultivates new-quality productivity through four key channels. First, standardized supply chain construction enables optimal resource allocation through seamless integration and structural reconstruction. Second, collaborative platform building reduces costs and improves efficiency through real-time data flow and broken information barriers.

Third, the development of shared-interest communities fosters strategic synergy, knowledge sharing, and reduced internal friction. Fourth, innovation synergy is promoted through specialized R&D support and the application of advanced technologies like big data and IoT, which optimize production processes and promote sustainable development.

These innovations collectively generate the high efficiency and quality that characterize new-quality productivity, fundamentally enhancing the adaptability and resilience of urban trade systems. Based on the above, the following hypothesis is proposed:

H4: The supply chain innovation and application pilot improves urban trade resilience by improving new-quality productivity.

4. Research Design

4.1. Resarch Model

This study designates supply chain innovation and application pilot cities as the treatment group and the remaining cities as the control group to examine the impact of the supply chain innovation and application pilot policy on the performance level of urban trade resilience. A fixed-effects difference-in-differences (DID) model is constructed, and the DID model is used to identify the net policy effect of the pilot on urban trade resilience. The benchmark model and the mediation effect model are set as follows:

$$Y_{i,t} = \alpha_0 + \alpha_1 \cdot Policy_{i,t} + \alpha_2 \cdot X_{i,t} + \mu_i + \eta_t + \varepsilon_{i,t}$$
$$MV_{i,t} = \beta_0 + \beta_1 \cdot Policy_{i,t} + \beta_2 X_{i,t} + \mu_i + \eta_t + \varepsilon_{i,t}$$
$$Y_{i,t} = \gamma_0 + \gamma_1 \cdot Policy_{i,t} + \gamma_2 \cdot Med_{i,t} + \gamma_3 \cdot X_{i,t} + \mu_i + \eta_t + \varepsilon_{i,t}$$

Here: $MV_{i,t}$ is the mediating variable, β_1 representing the impact of the supply chain innovation and application city pilot on the mediating variable; γ_2 represents the effect of the mediating variable on urban trade resilience after controlling for the influence of the supply chain innovation and application city pilot; γ_1 represents the effect of the supply chain innovation and application city pilot on urban trade resilience after controlling for the influence of the mediating variable, β_0 and γ_0 are constant terms, β_2 and γ_3 are the coefficient vectors of the control variables.

4.2. Independent Variable

The independent variable in this study is the interaction term between the group dummy variable (Treat) and the time dummy variable (Post). The group dummy variable (Treat) is used to distinguish between cities where the supply chain innovation and application pilot is implemented and other cities. The data for pilot cities are sourced from the list of supply chain innovation and application pilot cities published by the Ministry of Commerce, as shown in Table1. For the experimental group (i.e., cities where the supply chain innovation and application pilot is implemented), the value of the Treat variable is 1; for the non-experimental group (i.e., cities where the supply chain innovation and application pilot is not implemented), the value of the Treat variable is 0. The time dummy variable (Post) is used to mark the time range of policy implementation. The supply chain innovation and application pilot policy was implemented starting in 2018. Therefore, for the years before the policy implementation (2012-2017), the value of the Post variable is 0; for the year of policy implementation and subsequent years (2018-2022), the value of the Post variable is 1.

4.3. Dependent Variable

The dependent variable in this study is urban trade resilience. Urban trade resilience refers to a city's ability to maintain and restore its trade activities when facing various internal and external shocks and pressures, as well as its capacity to achieve sustainable development and adapt to changes in the field of trade. Following the approach of Zhang et al. (2024), this study divides urban trade indicators into resistance capacity, recovery capacity, and transformation capacity. Resistance capacity is measured by the robustness of corporate supply chains and the scale of urban foreign trade; recovery capacity is measured by regional consumption levels and fiscal decentralization; and transformation capacity is measured by innovation capability evaluation and product technology level.

Table 1: List of Pilot Cities for Supply Chain Innovation and Application (Sorted by Province City)

Number	City name	Number	City name	Number	City name
1	Beijing	20	Wuhu	39	Dongwan
2	Shijiazhuang	21	China (Fujian) Pilot Free Trade Zone Xiamen Area	40	China (Guangdong) Pilot Free Trade Zone Shenzhen Qianhai-Shekou Area
3	Taiyuan	22	Ganzhou	41	Nanning
4	Baotou	23	Jingdezhen	42	Liu zhou
5	Dalian	24	Qingdao	43	Haikou
6	Anshan	25	Dongying	44	Chendu
7	Yingkou	26	Linqi	45	Guangan
8	Changchun	27	Weihai	46	Huzhou
9	Meihekou	28	Yantai	47	Guiyang
10	Haerbing	29	Shouguang	48	Bijie
11	Suihua	30	Jiaozuo	49	Kunming
12	Shanghai	31	Shangqiu	50	Xian
13	Nanjing	32	Xuchang	51	Weinan
14	Zhangjiagang	33	China (Henan) Pilot Free Trade Zone	52	Dingxi
15	Hangzhou	34	Wuhan	53	Xining
16	Ningbo	35	Xiangyan	54	Yinchuang
17	Zhoushan	36	Xiangtan	55	Kuitun
18	Yiwu	37	Guang zhou		
19	Haozhou	38	Shenzhen		

Table 2: The Indicator System for Urban Trade Resilience

Indicator Framework	Proxy Indicators	Description
Resistance Capacity	Enterprise Supply Chain Robustness	Measures the risk resistance and stability of the supply chain (+)
	Urban Foreign Trade Scale	Measures economic openness and the ability to resist external shocks (+)
Recovery Capacity	Regional Consumption Level	Measures the vitality of domestic demand and the potential for economic resilience recovery (+)
	Fiscal Decentralization Degree	Measures local fiscal autonomy and the ability to allocate recoveryresources (+)
Transformation Capacity	Innovation Capability Evaluation	Measures the capacity for R&D investment and technology transfer (+)
	Product Technology Level	Measures the potential for industrial upgrading and market competitiveness (+)

4.4. Mediating Variable

Resource allocation level (RA): Measured using a composite index based on the gross value of production index, average monetary wage index of employees, fixed-asset investment price index, and total market distortion.

New-quality productive forces (NQPF): Referring to Han (2024), this study measures NQPF from three dimensions: new-quality labor, new-quality labor objects, and new-quality means of labor.

Business environment (BUET): This study uses the urban business environment data released by the China Business Environment Evaluation Group, which evaluates prefecture-level cities from multiple dimensions including government, human resources, finance, market, and innovation.

Industrial synergy level (IS): Evaluated from multiple dimensions including transportation and warehousing, financial practitioners, information transmission, and scientific skills, based on data from the China City Statistical Yearbook.

4.5. Control Variable

Market share (MS): Market share reflects the efficient allocation of resources. A high market share usually implies more efficient resource allocation and stronger market adaptability, thereby influencing urban trade resilience. This study uses the export market share to measure market share, where the export market share = total exports / world total exports. The data is sourced from statistical yearbooks.

Economic development level (GDP): Cities with a higher level of economic development usually have a larger market scale and stronger consumption capacity, which provides a stable demand base for trade activities and thus affects the performance of trade resilience. The GDP data is sourced from the National Bureau of Statistics.

Total fixed-asset investment (FAI): Cities with a higher total fixed-asset investment usually have more complete infrastructure and logistics networks, which helps reduce trade costs and improve logistics efficiency, thereby enhancing trade resilience. This study integrates the total fixed-asset investment data of cities from the Wind database.

Financing constraints (FIN): Financing constraints directly affect the provision of urban infrastructure construction and public services. High financing constraints may limit urban investment in transportation, communication, and public services, thereby affecting trade efficiency and resilience. This study uses the "credit accessibility" sub-dimension of the Peking University Digital Inclusive Finance Index inversely to measure financing constraints. A lower index indicates stronger constraints.

Foreign investment level (FDI): Foreign investment brings capital injection and technology transfer to cities, which helps improve the production capacity and technological level of local enterprises, thereby enhancing the trade competitiveness and resilience of prefecture-level cities. This study uses the actual amount of foreign capital utilized in the prefecture-level city statistical yearbooks to measure the foreign investment level.

Logistics efficiency (LE): Cities with high logistics efficiency can better integrate into regional economic cooperation and international trade networks. Through close connections with surrounding regions and countries, they can improve the diversity and stability of the urban trade network, thereby enhancing their trade resilience. This study uses the freight volume in the China City Statistical Yearbook to measure the logistics efficiency of the region.

4.6. Data Source

This study constructs a balanced panel dataset of 285 prefecture-level cities in China from 2012 to 2022. The sample period begins in 2012 to establish a robust pre-policy baseline and ends in 2022, the latest year for which comprehensive data were available at the time of this study. Cities with severe data missingness (e.g., certain prefectures in Tibet due to inconsistent statistical reporting) were excluded to ensure a representative and reliable sample of China's urban landscape.

The data were meticulously sourced from a combination of official statistical yearbooks, authoritative databases, and government documents, as detailed below:

Core Variables:

Dependent Variable (Urban Trade Resilience, CTRI): A composite index synthesized from its sub-dimensions (Resistance-RES, Recovery-REC, Transformation-RST). The underlying raw data for constructing these sub-indicators (e.g., corporate supply chain robustness, urban foreign trade scale, regional consumption level, fiscal decentralization, innovation capability, product technology level) were primarily extracted from the China City Statistical Yearbook (2012-2022).

Independent Variable (Pilot Policy, DID): The list of Supply Chain Innovation and Application pilot cities was manually compiled from the official announcement documents released by the Ministry of Commerce of China and seven other central government departments in 2018.

Control Variables:

Market Share (MS): Calculated as the city's total exports divided by world total exports. Data sourced from city statistical yearbooks and the Wind database.

Economic Development Level (GDP): Data obtained from the National Bureau of Statistics and the China City Statistical Yearbook.

Total Fixed-Asset Investment (FAI): Data sourced from the Wind database.Financing Constraints (FIN): Inversely proxied by the "credit accessibility" sub-index of the Peking University Digital Inclusive Finance Index.

Foreign Investment Level (FDI): Measured by the actual amount of foreign capital utilized, data from city statistical yearbooks.

Logistics Efficiency (LE): Measured by the freight volume, data from the China City Statistical Yearbook.

Mediating Variables:

Business Environment (BUET): Data obtained from the urban business environment index published by the China Business Environment Evaluation Group.

Industrial Synergy Level (IS): A composite index evaluated from multiple dimensions (e.g., transportation and warehousing, financial practitioners, information transmission, scientific skills) based on data from the China City Statistical Yearbook.

New-Quality Productive Forces (NQPF): A multidimensional composite index measured from the perspectives of new-quality labor, labor objects, and means of labor, constructed from data in the China City Statistical Yearbook and the China Statistical Yearbook on Science and Technology.

Heterogeneity Analysis Data:

Intellectual Property Protection: Data on city-level IP protection intensity were sourced from the PKU Law website.

Resource-based City Identification: Data were obtained from the CNRDS (China Research Data Services Platform).

Digital Economy Policy: Information was extracted through textual analysis of city government work reports.

Data Processing and Variable Construction:

To ensure data quality and consistency, we implemented the following procedures:Missing Data Treatment: For a limited number of missing observations, linear interpolation was applied for gaps within a city's time series. Cities with missing data for more than three consecutive years were excluded from the sample.

Outlier Treatment: To mitigate the influence of extreme values, all continuous variables were winsorized at the 1st and 99th percentiles by year.

Variable Construction: The composite variables (CTRI, IS, NQPF) were constructed according to the methodologies outlined in Sections 4.3 and 4.4, drawing on the established literature.

The final dataset comprises 3,135 city-year observations (285 cities * 11 years). After merging all variables and applying listwise deletion to observations with missing values, the regression sample used in the empirical analysis contains 3,091 observations, as reported in the descriptive statistics.

5. Empirical Testing and Result Analysis

5.1. Descriptive Statistical Analysis

The following table presents the descriptive statistical analysis results of this study. The mean value of the urban trade resilience index is 7.358, with a standard deviation of 3.645, indicating that the overall urban trade resilience index of the sample cities is at a medium level, but there are significant differences among different cities. The mean value of the core explanatory variable DID is 0.072, suggesting that only 7.2% of the sample cities implemented this policy during the observation period, and there is still room for improvement in the policy coverage. The mean value of the market share is 7.847, with a standard deviation of 2.695, indicating that the overall market scale of the sample cities is relatively large but with obvious internal differences. The average value of the economic development level is 10.813, with a standard deviation of 0.570, showing that the economic development levels of the sample cities are relatively balanced. The mean value of the total fixed-asset investment is as high as 16.207, demonstrating that the fixed-asset investment levels of the sample cities are relatively high. The mean value of the financing constraints is 16.658 with a standard deviation of 1.144, indicating that the overall financing constraints of the sample cities are at a relatively high level and the financing constraints of each city are relatively concentrated. The mean value of the foreign investment level is-5.153, with a standard deviation of 1.779, showing that the overall scale of foreign investment in the sample cities is relatively limited, but there are significant differences in the ability of cities to attract foreign investment. The mean value of the logistics efficiency is 11.005, with a standard deviation of 1.326, indicating that the overall logistics systems of the sample cities are relatively well-developed.

Table 3: Descriptive Statistics

Variable	Observation	Average	Standard deviation	Minimum	Maximum
DID	3,091	0.072	0.259	0.000	1.000
CTRI	3,091	7.358	3.645	3.952	28.860
RES	3,091	1.744	3.865	0.005	27.149
REC	3,091	1.192	0.185	0.728	1.580
RST	3,091	81.371	12.655	0.000	99.690
MS	3,091	7.847	2.695	-0.836	16.681
GDP	3,091	10.813	0.570	7.302	16.175
FAI	3,087	16.207	0.854	11.372	17.971
FIN	3,089	16.658	1.144	14.614	19.929
FDI	3,091	-5.153	1.779	-10.710	19.949
LE	3,091	11.005	1.326	8.492	14.864

5.2. Parallel Trends Test

The parallel trends test is a crucial prerequisite for the difference-in-differences model. Its core lies in verifying whether the change trends of the experimental group and the control group are consistent before the policy implementation. If the parallel trends assumption is met, it can be considered that the differences after the policy implementation are mainly caused by the policy itself rather than other potential confounding factors. This paper uses the parallel trends test to examine the dynamic effects of the policy.

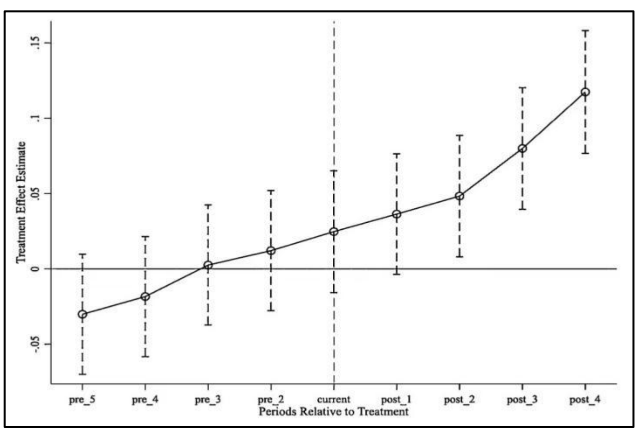

Figure 1: Dynamic Effects Diagram

Figure 1 shows the results of the parallel trends test. The parallel trends test before the policy implementation indicates that the change trends of the urban trade resilience index in the experimental group and the control group are statistically consistent, with 95% confidence intervals all containing zero values, meeting the assumptions of the smooth trends test. A significant positive effect is generated in the current year of the policy implementation, marking the emergence of the initial effect of the policy intervention. After the policy implementation, the policy effect lags by one year and then shows a continuous and strengthening dynamic effect, verifying that the actual effect of the supply chain innovation policy has the characteristic of persistence.

5.3. Benchmark Regression Analysis

The parameter estimation results of the impact of the supply chain innovation and application pilot policy on urban trade resilience are shown in Table 4, Column (1) presents the estimation results without introducing control variables, and the estimated coefficient of the dummy variable DID is significantly positive at the 1% level. In Column (2), after adding control variables, the coefficient estimate still passes the significance test at the 1% level. Column (3) shows the coefficient estimates after adding control variables and city-and time-fixed effects, and the estimated coefficient of the dummy variable DID is significantly positive at the 1% level. Therefore, it can be concluded that the supply chain innovation and application pilot can promote the improvement of urban trade resilience.

Table 4: Benchmark Regression Result

Variable	CTRI		
	(1)	(2)	(3)
	Without control variables	With control variables	With control variables and fixed effects
did	4.238***	0.655***	0.656***
	(0.242)	(0.169)	(0.104)
MS		-0.210***	-0.160
		(0.0167)	(0.113)
GDP		0.641***	-0.233**
		(0.0976)	(0.113)
FAI		-0.226***	-0.0521
		(0.0621)	(0.0407)
FIN		1.883***	0.344***
		(0.0801)	(0.133)
FDI		0.0937***	0.00515
		(0.0266)	(0.0179)
LE		0.494***	0.224***
		(0.0594)	(0.0523)
Constant	7.052***	-30.63***	3.762
	(0.0649)	(1.109)	(2.484)
Year FE	NO	NO	YES
Id FE	NO	NO	YES
N	3,091	3,085	3,085
R^2	0.091	0.619	0.928

Notes: ***, **, * denote significance level at 1%, 5% and 10%.

5.4. Robustness Test

To ensure the reliability of the baseline regression results, this study systematically implemented four robustness tests: altering the sample period, propensity score matching, Replace the explained variable, and adding fixed effects. These tests aim to address potential estimation biases, including the interference of external shocks, sample selection bias, distortion caused by extreme values, and the influence of regional heterogeneous trends. All tests confirm that the positive promoting effect of the supply chain innovation and application pilot policy on urban trade resilience remains robust.

To ensure the robustness of the baseline regression results, we conduct a test of model robustness by replacing the explained variable in the regression. This approach verifies the robustness of the baseline regression results by using different explained variables. In this paper, the resilience leap index is used to replace the resilience indicator for the test. This method constructs a relative resilience progress indicator by calculating the ratio of each city's actual resilience value in the current year to its historical average resilience level, eliminating the differences in the baseline resilience values caused by factors such as resource endowment and geographical location. In Column (4) of the table below, the regression coefficient of the supply chain pilot policy variable (did) is 0.0245 and is significant at the 5% level. This confirms that the policy promotes the relative progress of resilience, truly driving cities to surpass their own historical development trajectories. Overall, it shows that the promoting effect of the supply chain pilot policy on urban trade resilience is robust, not only increasing the resilience value but also enabling cities to achieve a resilience breakthrough that transcends historical norms.

The core of changing the sample period is to adjust the time interval, sample size range, or observation frequency of data collection or analysis to meet analytical needs, balance the data volume, eliminate time-scale biases, or handle data missingness and anomalies. This paper excludes the pandemic years (2020-2022). In Column (1) of the table below, the results of changing the sample period show that after excluding the interference of the pandemic, the DID coefficient is 0.352, remaining positively significant at the 1% significance level. After the sample size is reduced from 3090 to 2,150, the core conclusion remains unchanged, indicating that the policy effect is not affected by the special period. This method effectively isolates the abnormal disturbances of the pandemic on the urban economic system, enabling the policy effect evaluation to focus more on the real effects under normal economic conditions. The test results show that after excluding the interference of the pandemic, the promoting effect of the supply chain innovation policy still maintains a high level of statistical significance, and the magnitude of the coefficient change is within a reasonable fluctuation range. This confirms that the policy effect has the continuity and stability to resist major external shocks and is not a temporary phenomenon in a specific period. This further strengthens the robustness of the baseline regression results.

To mitigate the sample selection bias caused by inherent characteristic differences between treatment-group and control-group cities, the kernel matching method is employed to construct a counterfactual control group. The kernel matching function is used to generate sample weights (allowing the repeated use of control-group samples), reconstruct a balanced sample, and conduct weighted regression. The regression results show that the DID coefficient remains a significantly positive value of 0.134, with a standard error of 0.285, demonstrating statistical significance ($p < 0.01$). The model fit goodness is as high as 0.925, confirming the effectiveness of the matching process. The test results indicate that after controlling for sample selection bias, the policy treatment effect remains highly significant and the coefficient is stable, proving that the baseline regression results do not stem from the special attributes of the treatment-group cities. The significant improvement in the explanatory power of the model after matching further validates the effectiveness of this method, confirming that the policy effect is universal across different characteristic city groups. This result verifies the stability of the baseline regression, further substantiates that the policy effect does not arise from non-random sample selection, and shows that the research conclusions remain consistent even under stricter sample conditions.

To control for potential confounding factors, address heterogeneity effects, and verify the robustness and reliability of the model results, as well as to prevent the estimated values from being influenced by potential biases or abnormal observations, this paper follows the approach of Liu Yongyan et al. (2025) and incorporates city-year interactive fixed effects to control for time-varying unobservable effects at the city level. As shown in Column (4) of the table below, regional-year interaction terms are constructed to capture spatio-temporal differences. The regression results are presented in the table below. Under these conditions, the DID regression coefficient is 0.677 and remains significant at the 1% level, while the model's explanatory power simultaneously increases to 0.930. The significant policy effect under these strengthened control conditions serves as the mostconvincing robustness evidence. This result confirms that the baseline regression conclusions do not stem fromthe heterogeneous trends of regional development, and the supply chain innovation policy's effect on enhancingurban resilience has universal applicability that transcends regional spatio-temporal differences.

Table 5: Robustness Test Result

Variable	Change the sample period	Propensity Score Matching	Replace the explained variable	Add fixed effects
	city_resilience	city_resilience	city_resilience	city_resilience
did	0.398***	0.352***	0.0245**	0.677***
	(0.119)	(0.134)	(0.0107)	(0.104)
market_share_1	3.971***	-0.221	-0.0288**	-0.233**
	(0.716)	(0.144)	(0.0116)	(0.114)
GDP_1	-0.145	-0.504***	-0.0225*	-0.216*
	(0.128)	(0.161)	(0.0116)	(0.122)
fixed_investment_1	-0.438***	-0.248***	0.0182***	-0.0586
	(0.105)	(0.0594)	(0.00418)	(0.0426)
financing_constraint_1	0.136	0.373**	0.0505***	0.323**
	(0.157)	(0.178)	(0.0137)	(0.141)
FDI_1	-0.00913	0.0138	-0.000963	-0.0116
	(0.0199)	(0.0270)	(0.00184)	(0.0199)
LE_1	0.243***	0.242***	0.00745	0.173***
	(0.0551)	(0.0692)	(0.00538)	(0.0539)
Observations	2,245	2,150	3,085	3,063
R-squared	0.308	0.925	0.331	0.930

Notes: ***, **, * denote significance level at 1%, 5% and 10%.

5.5. Placebo Test

To address potential omitted variable bias, we conduct placebo tests by randomly assigning policy implementation regions and time, following Yin et al. (2025). Through 500 simulations of each approach, the estimated coefficients form distributions concentrated near zero (within [-0.1, 0.1] for regions and [-0.3, 0.3] for time). In contrast, the actual estimated coefficient of 0.656 significantly deviates from these distributions, confirming that the baseline results are unlikely driven by random factors or model specification errors. These tests reinforce the robustness of our findings regarding the policy's positive effect on urban trade resilience.

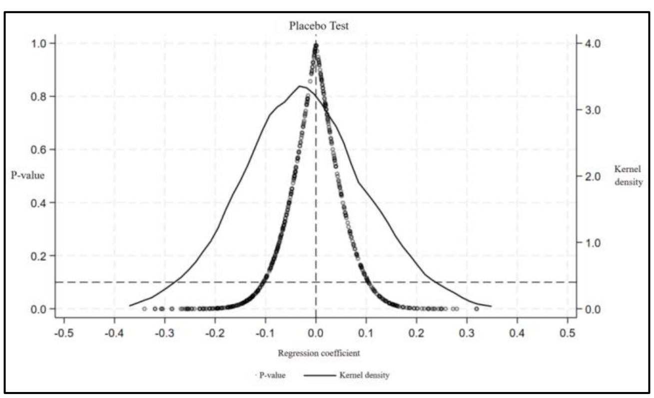

Figure 2: Placebo Test with Randomly Assigned Experimental Regions

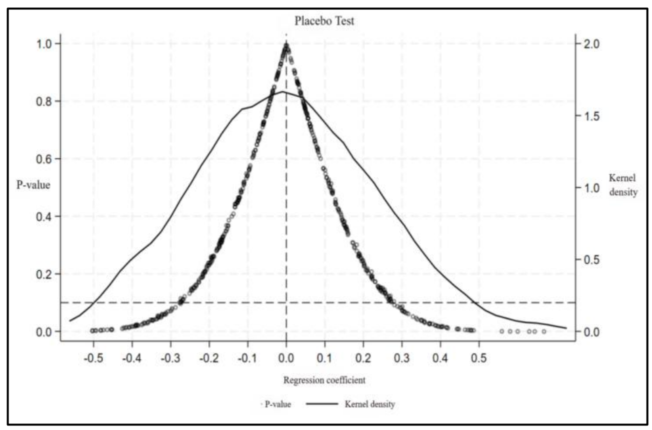

Figure 3: Placebo Test with Randomly Assigned Implem Entation Years

5.6. Heterogeneity Analysis

The effectiveness of the supply chain pilot policy exhibits significant heterogeneity depending on local digital infrastructure support. As shown in Table 6, the policy impact coefficient reaches 0.810 (significant at 1% level) in cities with digital economy policies, compared to only 0.201 (insignificant) in cities without such policies, indicating a strong synergistic effect.

In cities with digital policies, existing infrastructure such as 5G networks and data centers provides technological foundation for supply chain digitalization. Enterprises can quickly access digital platforms for full-link visibility and leverage government data-opening platforms for risk earlywarning, forming an effective "policy-data-enterprise" risk buffer mechanism.

Conversely, in cities lacking digital policy support, traditional infrastructure cannot meet digital transformation requirements. Enterprises face higher transformation costs, insufficient special funds, and digital skills gaps among grassroots managers, resulting in inadequate investment in supply chain resilience and weakened policy implementation.

Table 6: Heterogeneity Analysis of Digital Economy Policies

	(1) Cities without digital economy policies	(2) Cities with digital economy policies
VARIABLES	city_resilience	city_resilience
did	0.201	0.810***
	(0.135)	(0.169)
market_share	-0.152**	-2.481***
	(0.0757)	(0.694)
GDP	-0.0165	-0.379*
	(0.116)	(0.204)
fixed_investment	0.147***	-0.0699
	(0.0503)	(0.0645)
financing_constraint	0.190	0.732***
	(0.130)	(0.248)
FDI	-0.0202	0.0337
	(0.0163)	(0.0333)
LE	0.0287	0.149
	(0.0561)	(0.0915)
Constant	1.174	14.80**
	(2.240)	(6.026)
Observations	1,504	1,581
R-squared	0.328	0.242
Number of city_id	272	279

Notes: ***, **, * denote significance level at 1%, 5% and 10%.

To examine the safeguarding role of the institutional environment, this paper divides prefecture-level cities into two groups--low-intellectual-property-protection cities and high-intellectual-property-protection cities--based on the median value of intellectual property protection intensity from the PKU Law website. The policy effect shows significant divergence based on institutional environment quality. When grouping cities by intellectual property protection intensity, the policy impact coefficient reaches 0.929 (significant at 1% level) in high-protection cities, compared to -0.156 (insignificant) in low-protection cities.

Strong intellectual property protection enables pilot enterprises to fully unleash innovation vitality, improves conversion efficiency of technological achievements, and enhances financing capacity through patent assets, creating financial buffers for trade fluctuations. The high-standard IP environment also facilitates alignment with international management systems.

Conversely, in low-protection cities, prevalent technological imitation squeezes innovation space, dampens R&D motivation, and creates disincentives where "innovators bear costs while imitators reap benefits." This undermines the policy's virtuous cycle mechanism and leads to misallocation of policy resources.

Table 7: Heterogeneity Analysis of Intellectual Property Protection

	Low levels of IP protection	High levels of IP protection
VARIABLES	city_resilience	city_resilience
did	-0.156	0.929***
	(0.171)	(0.146)
market_share	2.354***	-0.169
	(0.732)	(0.126)
GDP	-0.185	-0.730***
	(0.138)	(0.221)
fixed_investment	-0.0102	-0.0488
	(0.0525)	(0.0624)
financing_constraint	0.154	0.666***
	(0.175)	(0.221)
FDI	-0.00252	0.0116
	(0.0213)	(0.0299)
LE	0.0549	0.138*
	(0.0737)	(0.0799)
Constant	-10.92**	3.861
	(4.337)	(4.156)
Observations	1,330	1,755
R-squared	0.267	0.280
Number of city_id	247	281

Notes: ***, **, * denote significance level at 1%, 5% and 10%.

To identify the path-dependence of industrial structure and explore whether resource-based cities need special supporting policies to achieve the alignment between policy goals and actual effects, this paper conducts an analysis using data from the CNRDS China Research Data Services Platform. The policy effect demonstrates significant variation based on industrial structure characteristics. As shown in Table 8, the policy impact coefficient reaches 0.771 (significant at 1% level) in non-resource-based cities, while showing an insignificant negative effect (-0.101) in resource-based cities.

This sharp contrast reflects the profound constraints of industrial path-dependence. Non-resource-based cities benefit from diversified industrial ecosystems that enable efficient factor reorganization through digital platforms and flexible export market adjustments, supported by adequate professional talent reserves.

Conversely, resource-based cities face multiple transformation barriers: supply chain systems rigidly structured around resource extraction, severe digital skills shortages leading to idle intelligent management systems, and conservative financial institutions that limit financing space for enterprises. These structural defects create "poor adaptation" during policy implementation, where transformation willingness cannot overcome practical bottlenecks in infrastructure, talent, and financing.

Table 8: Heterogeneity Analysis of Resource-based Cities

	resource-based city	non-resource-based city
VARIABLES	city_resilience	city_resilience
did	-0.101	0.771***
	(0.0839)	(0.152)
market_share	-0.174***	-1.186*
	(0.0485)	(0.706)
GDP	-0.0240	-0.490**
	(0.0632)	(0.221)
fixed_investment	0.314***	-0.316***
	(0.0253)	(0.0685)
financing_constraint	0.163**	0.780***
	(0.0762)	(0.248)
FDI	0.00862	0.000143
	(0.0102)	(0.0323)
LE	0.0637	0.251***
	(0.0396)	(0.0787)
Constant	-1.377	10.08*
	(1.346)	(5.469)
Observations	1,254	1,831
R-squared	0.532	0.257
Number of city_id	114	167

Notes: ***, **, * denote significance level at 1%, 5% and 10.

5.7. Test of the Mechanism of Action

The mediation effect tests confirm three significant transmission channels (Table 9). First, the policy significantly improves the business environment (coefficient=0.0187, p<0.01), which in turn strongly enhances trade resilience (coefficient=14.86, p<0.01), verifying H2 that the policy reduces institutional transaction costs and builds institutional resilience.

Second, the policy effectively promotes industrial synergy (coefficient=0.0755, p<0.01), which significantly contributes to trade resilience (coefficient=0.309, p<0.01). This confirms H3 that the policy breaks down industrial barriers and builds resilient production systems through resource complementarity.

Third, the policy significantly fosters new-quality productive forces (coefficient=0.0159, p<0.01), which demonstrate a strong positive impact on trade resilience (coefficient=35.65, p<0.01), verifying H4 that technological innovation and digital integration fundamentally enhance the trade system's adaptability.

6. Conclusions and Policy Implications

This paper takes the pilot work on supply chain innovation and application carried out by eight departments including the Ministry of Commerce in 2018 as a quasi-natural experiment and uses 285 prefecture-level cities in China from 2012 to 2022 as the research sample. Through the difference-in-differences method, it empirically examines the impact of the supply chain innovation and application pilot policy on urban trade resilience and draws the following conclusions: The supply chain innovation and application pilot policy has significantly improved the trade resilience of pilot cities. This conclusion remains valid after a series of robustness tests, including changing the sample

Table 9: Test of the Mechanism of Action

Variable	(1)	(2)	(3)	(4)	(5)	(6)
	BUET	CTRI	IS	CTRI	NQPF	CTRI
did	0.0187***	0.377***	0.0755***	0.632***	0.0159***	0.103
	(0.00186)	(0.102)	(0.0258)	(0.104)	(0.00113)	(0.0990)
BUET		14.86***				
		(1.016)				
IS				0.309***		
				(0.0759)		
NQPF						35.65***
						(1.611)
Controls	YES	YES	YES	YES	YES	YES
YearFE	YES	YES	YES	YES	YES	YES
idFE	YES	YES	YES	YES	YES	YES
Constant	0.144***	1.756	1.559***	3.333	-0.0295	2.934
	(0.0422)	(2.398)	(0.585)	(2.479)	(0.0257)	(2.292)
N	3,085	3,085	3,085	3,085	3,085	3,085
R^2	0.950	0.933	0.828	0.929	0.978	0.939

Notes: ***, **, * denote significance level at 1%, 5% and 10%

period, propensity score matching, winsorized regression, adding fixed effects, and placebo tests. Industrial synergy, new-quality productive forces, and the business environment play mediating roles in the process of the supply chain innovation and application pilot policy enhancing urban trade resilience. The policy indirectly strengthens the resistance, recovery, and transformation capabilities of urban trade by promoting the optimization of these factors. The effect of the supply chain innovation and application pilot policy on improving urban trade resilience is heterogeneous, and it has a more significant promoting effect on economically-policy-supported cities, cities with intellectual property protection, and non-resource-based cities.

To fully leverage the advantages of the supply chain innovation and application pilot policy, it is necessary to deepen the supply chain innovation pilot with differentiated supporting policies, focusing on covering non-resource-based, cities along the Yellow River, and environmentally-friendly cities, and simultaneously improving the supporting support system. Specifically, it is required to dynamically expand the list of pilot cities, extending the policy dividends to cities with a weak trade foundation but great transformation potential, and giving priority to supporting non-resource-based cities in developing diversified supply chain networks. Customized policy packages should be introduced according to regional characteristics. For cities along the Yellow River, the national strategy of "ecological protection of the Yellow River Basin" should be integrated, and special subsidies for green supply chains should be provided. For environmentally-friendly cities, a "low-carbon supply chain certification" system should be established, and certain tax reductions should be given to certified enterprises. Meanwhile, a policy coordination platform should be built. A policy dispatching center led by the Ministry of Commerce and involving multi-department cooperation should be established to unify the support standards for finance, land, and finance, and eliminate cross-departmental policy frictions.

At the same time, to maximize the effectiveness of policy implementation, it is essential to establish a "trinity" empowerment mechanism centered on optimizing the business environment, deepening industrial synergy, and cultivating new-quality productive forces. For business environment upgrading, the "lead enterprise responsibility system" will be implemented, where leading enterprises in pilot cities develop a supply chain credit evaluation system endorsed by the government and shared with financial institutions to improve financing efficiency for small and medium-sized enterprises. Regarding industrial synergy enhancement, an "industrial cluster digital middleware platform" will be built to integrate customs, tax, and logistics data, enabling cross-enterprise production plan coordination and reducing synergy costs, while coastal supply chain management enterprises will be encouraged to jointly establish industrial parks with inland cities with revenue-sharing ratios favoring less-developed regions. For new-quality productive forces incubation, a supply chain science and technology innovation fund will be established with annual funding allocations to support the commercialization of key technologies such as AI prediction algorithms and blockchain traceability, and a "digital craftsmen" program will be launched to offer micro-specialties in supply chain digitization at universities in pilot cities with enterprise-customized talent training.

Finally, policy formulation requires targeted measures: For cities with digital economy policies, it is essential to strengthen the integration of new infrastructure such as 5G and data centers with supply chain digitalization, establish collaborative platforms for government data openness and corporate risk monitoring, and cultivate digital skills talent. For cities with high intellectual property protection, mechanisms to safeguard supply chain innovation outcomes should be improved, intellectual property pledge financing should be promoted, and enterprises should be guided to align with international management systems. For non-resource-based cities, diversified industrial supply chains need to be constructed, industrial synergy should be facilitated through digital middleware platforms, and innovative supply chain financial products should be developed. For cities without digital economy policies, with low intellectual property protection, and resource-based cities, efforts should first focus on addressing shortcomings in digital infrastructure, intellectual property protection, talent, and financing before gradually advancing pilot policies to ensure the precise release of policy effectiveness.

The findings of this study offer valuable insights for policymakers and business leaders beyond China, particularly in developing and emerging economies.

First, the demonstrated efficacy of the pilot policy approach provides a replicable model for other nations. Instead of nationwide, one-size-fits-all mandates, governments can initiate targeted pilot programs in key industrial cities or sectors. This allows for learning-by-doing, minimizes initial fiscal outlays, and creates demonstrable success cases that can guide broader roll-out.

Second, our mechanism analysis confirms that enhancing resilience is not solely about hard infrastructure. The significant mediating roles of the business environment and industrial synergy suggest that policies aimed solely at physical logistics may yield suboptimal results. International development agencies and national governments should design integrated support packages that concurrently address regulatory efficiency (e.g., streamlining customs, securing property rights), financial accessibility (e.g., supply chain finance), and promotion of industrial collaboration platforms.

Finally, the heterogeneity findings serve as a critical warning. The policy's ineffectiveness in cities lacking digital infrastructure or strong intellectual property protection illustrates that supply chain innovation policies cannot succeed in isolation. For international practitioners, this underscores the necessity of complementary investments in digital foundations (5G, data centers) and the institutional framework (IPR regimes, contract enforcement) as prerequisite "enabling conditions." This is especially pertinent for countries participating in the Belt and Road Initiative or regional cooperation frameworks in Asia, Africa, and Latin America, where building comprehensive national resilience requires tailored strategies that account for vast internal regional disparities.

Declarations

Ethics Approval and Consent to Participate

Not applicable. This study did not involve human participants or animal subjects.

Competing Interests / Conflicts of Interest

The authors declare that they have no competing interests.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Author Contributions

[Author 1] conceived and designed the study, conducted the data analysis, and wrote the original draft. [Author 2] contributed to data collection and manuscript revision. [Author 3] contributed to data collection and manuscript revision. [Corresponding Author] supervised the project, secured funding, and critically revised the manuscript. All authors read and approved the final manuscript.

Data Availability Statement

The data that support the findings of this study are derived from publicly available sources cited in the manuscript, primarily the China City Statistical Yearbook, the Wind database, and the EPS database. The processed dataset and Stata code used for the empirical analysis are available from the corresponding author upon reasonable request.

Declaration of Generative AI and AI-assisted Technologies in the Writing Process

AI not used

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