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How Supply Chain Finance Innovation Drives High-Quality Development in E-Commerce Logistics

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Abstract: ***Against the backdrop of emerging challenges confronting the high-quality development of domestic e-commerce logistics, investigating whether supply chain finance innovation can empower such development—particularly in support of constructing a unified national market—holds considerable practical significance. This paper empirically examines the impact of supply chain finance innovation on the high-quality development of e-commerce logistics using provincial panel data spanning the period 2013 to 2022. The empirical results yield three principal findings. First, supply chain finance innovation exerts a statistically significant positive effect on the high-quality development of e-commerce logistics. Second, this empowering effect exhibits notable regional and industrial structural heterogeneity. Specifically, the promotional impact diminishes progressively from the eastern to western regions in geographical space, and the effect is more pronounced under conditions of a more optimized industrial structure. Third, further decomposition of spatial effects reveals that the indirect effect of supply chain finance innovation on the high-quality development of e-commerce logistics is more substantial than its direct effect. These findings contribute to a deeper understanding of the mechanisms through which financial innovation within supply chains can facilitate logistics sector advancement, with important implications for regional development policy and industrial structure optimization.***

Keywords: Supply chain finance innovation, High-quality development of e-commerce logistics, Spatial effects, Regional differentiation.

1. Introduction

The high-quality development of e-commerce logistics is an important foundation for promoting the modernization and security of supply chains and industrial chains. Currently, China's e-commerce logistics development has achieved remarkable success in terms of quantity. According to data released by the China Federation of Logistics and Purchasing, the Chinese e-commerce logistics index in August 2024 was 114.2, up by 0.1 from the previous month, with both supply and demand in the e-commerce logistics market remaining stable. Specifically, the total business volume index of e-commerce logistics was 130.5, up by 0.3 from the previous month; the logistics timeliness index and fulfillment rate index increased by 0.4 and 0.2 respectively, maintaining high operational levels. However, it should also be noted that due to increased uncertainty in the economic environment, intensifying industry competition, and insufficient innovation-driven momentum, the transformation and upgrading, value chain enhancement, and high-quality development of e-commerce logistics have been significantly constrained, leaving substantial room for improvement in qualitative development. As an innovative outcome spanning supply chain, industrial chain, and financial activities, the innovative development of supply chain finance plays a crucial role in breaking through traditional economic constraints and promoting efficient resource integration within the supply chain and industrial chain of e-commerce logistics (Zhang Wen et al., 2024). Therefore, exploring the impact of supply chain finance innovation on the high-quality development of e-commerce logistics holds significant practical value for building a modern supply chain and industrial chain and driving the high-quality development of China's economy.

In recent years, the innovation of supply chain finance and the high-quality development of e-commerce logistics have received extensive attention from the academic community. From the perspective of existing research, the synergistic effect, penetration effect, and driving effect of supply chain financial innovation have been discussed from multiple perspectives and levels, including supply-demand matching, various economic entities, and the overall societal level. This has facilitated factor mobility, optimized allocation, and industrial among supply chain and industry chains (Bu Jun and Zhu Yue, 2024; Li Guangrong et al., 2024). However, in current research, there is limited discussion on the integration of supply chain financial innovation with the high-quality development of e-commerce logistics, indicating a need for further studies to fill this gap. Based on this, using provincial panel data from 2013-2022 as the research object, this paper explores the impact and spatial effects of supply chain financial innovation on the high-quality development of e-commerce logistics through econometric analysis, aiming to provide theoretical basis and practical reference for improving industrial and supply chains.

2. Theoretical Analysis and Hypotheses

As the globalization trend of the internet economy continues to deepen, supply chain finance has gradually become an important factor affecting the efficient flow of the distribution industry chain. The innovative development of supply chain finance is particularly beneficial for e-commerce logistics enterprises to acquire resources and enhance competitiveness (Chen Yue et al., 2023). On one hand, the innovative development of supply chain finance expands the transaction groups, business scope, and profit channels of e-commerce logistics within the supply chain. By integrating upstream and downstream businesses in the supply chain, it effectively leverages economies of scale, guiding positive cooperation among various entities in the e-commerce logistics industry chain, enhancing innovation momentum, and promoting efficient development of the e-commerce logistics industry.

Moreover, the innovative development of supply chain finance improves the supervision of capital flows and quality control, effectively reducing credit risks for financial institutions, creating a secure and stable business environment, and boosting the high-quality development of e-commerce logistics. On the other hand, supply chain financial innovation can drive the sharing and integration of supply chain data information such as capital flow, logistics, and commercial flow, promoting industrial information exchange among various economic entities in the e-commerce logistics industry chain. It effectively establishes data element innovation platforms between organizations and utilizes the spillover and radiation of technology, knowledge, and advanced elements to promote high-quality development of e-commerce logistics. Additionally, supply chain financial innovation can effectively enhance the integration, concentration, specialization division of labor, and competitiveness of the e-commerce logistics industry, facilitating the innovative development momentum and sustained growth potential of the e-commerce logistics industry chain. Based on this, hypothesis 1 is proposed:

H1: Supply chain financial innovation is conducive to promoting the high-quality development of e-commerce logistics.

China's vast territory means that the participation and flow of capital, human resources, information, and other factors in regional economic activities vary across different spatiotemporal patterns, forming a relatively complex spatial economic network. With the deepening development of the digital economy, supply chain financial innovation exhibits dynamic changes at the spatial level. In this context, the dynamic flow of capital, goods, and information, along with developments in the external market environment, will gradually produce spillover effects on the high-quality development of regional e-commerce logistics (Luo Liping, 2018). Moreover, due to differences in the foundation of supply chain development and financial innovation capabilities between regions, the level of high-quality development of e-commerce logistics is not only influenced by local supply chain financial innovation but also affected by the diffusion and radiation effects of neighboring regions' supply chain financial innovation networks. Based on this, this paper incorporates location and spatial spillover factors into the empirical analysis to explore the regional heterogeneity impact and spatial spillover effects of supply chain financial innovation on the high-quality development of e-commerce logistics, revealing effective pathways for enhancing regional e-commerce logistics. Hence, Hypothesis 2 and Hypothesis 3 are proposed.

H2: The impact of supply chain financial innovation on the high-quality development of e-commerce logistics exhibits regional heterogeneity.

H3: Supply chain financial innovation has a spillover effect on the high-quality development of e-commerce logistics in neighboring regions.

3. Research Design

3.1 Variable Specification

1) Explanatory variable: Supply chain financial innovation (Gjc). Considering that academia has yet to establish a unified measurement standard for supply chain financial innovation, relevant studies often measure it through proxy variables or single variables, which may be partial. Following Wei Lidong and Liu Ru (2023), this paper constructs a comprehensive evaluation index system for supply chain financial innovation from three major dimensions—product innovation, service innovation, and market innovation (see Table 1) and uses the entropy method to specifically measure its composite index.

2) Explained variable: High-quality development of e-commerce logistics (Gdev). The high-quality development of e-commerce logistics is a complex concept involving multiple aspects and dimensions, requiring comprehensive evaluation from various angles. Referring to Han Mingzhu (2024), this paper constructs a comprehensive evaluation system including three major indicator dimensions: scale, structure, and potential of e-commerce logistics development (see Table 1), followed by specific measurement using the entropy method.

3) Control variables. To enhance the robustness of empirical regression, human capital level, social demand level, market potential, and economic development level are added as control variables. Among them, human capital level (Hum) is represented by the logarithm of the number of college students per 10,000 people; social demand level (Xq) is characterized by total retail sales of consumer goods / GDP; regional economic development level (Egd) is measured by GDP per capita; and market potential (Siz) is indicated by regional population density.

3.2 Model Construction

1) Baseline model. To verify Hypothesis 1, this paper constructs the following baseline regression model, specifically as follows:

$$\mathrm{Gdev}_{\mathrm{it}} = \alpha + \beta_0 \mathrm{Gjc}_{\mathrm{it}} + \beta_1 Z_{\mathrm{it}} + \mu_{\mathrm{i}} + \gamma_{\mathrm{t}} + \xi \qquad (1)$$

In Equation (1), $\mathrm{Gdev}_{\mathrm{it}}$ represents the supply chain finance innovation level in region i during period t , $\mathrm{Gjc}_{\mathrm{it}}$ represents the high-quality development level of e-commerce logistics in region i during period t , Z_{it} represents a series of control variables, μ_{i} indicates individual fixed effects, y_{t} indicates time fixed effects, and ξ_{it} represents the random error term.

2. Spatial model. To verify Hypothesis 2, this paper constructs the following spatial econometric model, specifically as follows:

$$\begin{aligned} Gdev_{it} = {} & \alpha + \rho \sum_{j=1}^{n} m_i \, Gdev + \beta \rho G_i c_{it} \\ & + \theta \sum_{j=1}^{n} {}^{n} w_{ij} Gjc_{it} + \mu \ + y_t + \xi_{it} \end{aligned} \qquad (2)$$

Earth external physical feature trajectory physical reference object physical reference object physical data physical data physical data physical data physical data physical

$$\xi_{it} = \lambda \sum_{j=1}^{n} {}^{n} w_{ij} \xi_{it} + v_i \qquad (3)$$

Geophysical mean (13) Classification Number of electric objects (13)

Equation (2) is the SDM model, and when $\lambda = 0$, this model

will transform into SAR and further into SEM model, while when $\lambda = 0$, this model will transform into SAR model, where W_{ij} represents the geographic distance spatial matrix.

3.3 Data Source Description

This paper selects panel data from 31 provincial administrative regions in China (excluding Hong Kong, Macao, and Taiwan areas) from 2013 to 2022 as the research sample. The original data comes from the "China Statistical Yearbook" and the "China Financial Yearbook", with missing values filled using linear interpolation.

4. Empirical Analysis

4.1 Baseline Regression

Following the Huasman test, this paper selects the fixed-effects model for benchmark regression, with results shown in Table 2. From the estimation results in column (1) of Table 2, when considering the impact of supply chain financial innovation on the high-quality development level of e-commerce logistics alone, its estimated coefficient is 0.0983 and is significant at the 5% level. After gradually adding other control variables, the estimated coefficient of supply chain financial innovation remains significantly positive at the 5% confidence level, indicating that at this stage, the positive impact of supply chain financial innovation on the high-quality development of e-commerce logistics is significant and stable, thus verifying Hypothesis 1. This also shows that the innovation in supply chain finance can not only optimize the market-oriented allocation of factors in the e-commerce logistics industry chain, provide more resources and technology to upstream and downstream enterprises in the supply chain, achieving diversified development of e-commerce logistics, but also ensure the sustainability of circulation through supply chain financial innovation, promoting the optimization and innovation of e-commerce logistics, bringing vitality to the development of e-commerce logistics, and paving the way for high-quality development. Among these control variables, the higher the level of human capital and social demand, the better the development of e-commerce logistics, while the current market potential and economic development level have not yet fully empowered the high-quality development of e-commerce logistics.

4.2 Spatial Econometric Analysis

1) Spatial Autocorrelation Test. A spatial autocorrelation test must be conducted before spatial econometric analysis. This paper selects the global Moran's I index to measure and test the spatial autocorrelation of supply chain financial innovation and the high-quality development level of e-commerce logistics in each provincial administrative region. As can be seen from Table 3, the Moran's indices of supply chain financial innovation and the high-quality development level of e-commerce logistics are both significantly greater than 0, indicating a significant positive spatial autocorrelation.

2) Spatial model regression results. To verify whether supply chain financial innovation has a spatial spillover effect on the high-quality development of e-commerce logistics in surrounding areas, LR, LM, and Wald tests indicate that the SAR model is more suitable for this article's spatial econometric analysis. Therefore, based on the SAR model, the spatial spillover effect test of supply chain financial innovation on the high-quality development of e-commerce logistics was conducted, with regression results shown in Table 4. From column (1) of Table 4, it can be seen that the spatial autoregressive coefficient shows 1.4763 at the 1% statistical level, indicating that the high-quality development level of e-commerce logistics in a region is not only influenced by local supply chain financial innovation but also affected by changes in supply chain financial innovation in neighboring regions. Meanwhile, to more accurately measure the spatial spillover effect of supply chain financial innovation on the high-quality development of e-commerce logistics, this article performed partial differentiation on the model. Columns (2), (3), and (4) of Table 4 show that the indirect effect of supply chain financial innovation on the high-quality development of e-commerce logistics is significantly positive, with the absolute value of the coefficient and its significance both higher than the direct effect. This suggests that local supply chain financial innovation can release diffusion and demonstration effects, driving the expansion of e-commerce logistics market coverage and improving the efficiency of factor allocation such as productivity and production materials in neighboring regions, thereby fully empowering the high-quality development of e-commerce logistics in surrounding areas. Finally, for robustness, this article re-conducted econometric regressions using an inter-regional adjacency distance matrix, with results shown in columns (5)-(8) of Table 4, confirming that the above conclusions are fairly robust.

4.3 Endogeneity Test

Based on previous research references, this article selects freight turnover reflected in the high-quality development of e-commerce logistics and lagged one-period supply chain financial innovation as instrumental variables for testing. Additionally, to prevent bias caused by regression methods, this article specifically chose the more efficient and widely applicable Generalized Method of Moments (GMM) estimation to test for endogeneity issues, with regression results shown in Table 5. The estimated coefficients of both types of tests are significantly positive, indicating strong robustness in the baseline regression results.

4.4 Further Analysis

1. Regional heterogeneity. Based on the current situation of China's vast territory and uneven, insufficient development, and to verify Hypothesis 2, a regional heterogeneity regression was conducted, with regression results shown in Table 6. From Table 6, it can be seen that the promoting effect of supply chain financial innovation on the high-quality development of e-commerce logistics ranks as follows in terms of significance and absolute value: Eastern > Central > Western, with no significant impact observed in the Northeast region. This phenomenon may occur because the eastern region, as a pioneer in economic and technological innovation, is rich in financial resources, has a solid foundation for supply chain financial innovation, and boasts a well-established logistics industry chain, enabling supply chain financial innovation to fully empower the high-quality development of

e-commerce logistics. Therefore, the role of supply chain financial innovation in driving the high-quality development of e-commerce logistics is most evident in the eastern region. In recent years, the central region has made significant achievements in supply chain construction, and financial resources have been flowing abundantly; however, the development and improvement of supply chain finance and e-commerce logistics industry chains in the central region are extremely imbalanced, with obvious industrial siphon effects between regions, making the driving effect of supply chain financial innovation on the high-quality development of e-commerce logistics weaker than that in the eastern region. Although the western region has received more policy support over the years, its supply chain infrastructure construction has been continuously improving, and there have been breakthroughs in the development of e-commerce logistics, the region lacks financial resources, resulting in limited positive feedback from supply chain financial innovation on the high-quality development of e-commerce logistics. For many years, the northeast region has suffered from serious loss of capital and talent, has a weak foundation for supply chain financial innovation, and due to geographical location influences, the development of e-commerce logistics has been relatively slow, making it difficult for supply chain financial innovation to show a clear effect on the high-quality development of e-commerce logistics.

Table 1: Supply Chain Financial Innovation and High-Quality Development Level Evaluation Indicators for E-Commerce Logistics

Target Layer	Element Layer	Indicator Layer	Indicator Direction
Supply Chain Finance Innovation Level	Product Innovation	Savings Deposits	+
		Banker's Acceptance Amount	+
		Consumer Loan Balance	+
	Service Innovation	Regional Premium Income / GDP	+
		Financial Industry Employees	+
		Total Bank Loans / Savings Deposits	+
	Market Innovation	Number of Financial Listed Companies	+
		Inventory Scale of Industrial Enterprises Above Designated Size	+
		Number of New Rural Financial Institutions	+
		Finance Industry Value Added / GDP	+
High-Quality Development Level of E-commerce Logistics	Development Scale	E-commerce Logistics Transaction Volume	+
		E-commerce Transaction Volume	+
		Total Online Retail Sales	+
	Development Structure	E-commerce Logistics Employees	+
		Freight Turnover	+
		Internet Broadband Access Ports	+
	Development Potential	Growth Rate of Courier Service Volume	+
		Technology Market Transaction Volume	+
		Fixed Asset Investment in Distribution Industry	+

Table 2: Benchmark Regression Results

Variable	(1)	(2)	(3)
Gjc	0.0983**	0.0174°	0.0369**
	(2.07)	(1.89)	(2.23)
Xq		0.4658***	0.5275**
		(3.17)	(2.13)
Hum		0.2279	0.2146**
		(3.68)	(2.04)
Siz			0.3303
			(0.97)
Egd			0.7129
			(1.19)
Ind	Y	Y	Y
Time	Y	Y	Y
N	310	310	310
R^2	0.71	0.74	0.77

Note: *, **, and *** denote significance at the 10%, 5%, and 1% levels respectively, with t-values in parentheses; the same applies to the table below.

Table 3: II Moran's Index

Gdev			Gjc	
Moran's I	P	year	Moran's I	P
0.347	0.000	2013	0.247	0.000
0.314	0.000	2014	0.247	0.000
0.328	0.000	2015	0.249	0.000
0.347	0.000	2016	0.250	0.000
0.351	0.000	2017	0.249	0.000
0.335	0.000	2018	0.246	0.000
0.340	0.000	2019	0.247	0.000
0.334	0.000	2020	0.247	0.000
0.336	0.000	2021	0.247	0.000
0.339	0.000	2022	0.238	0.000

Table 4: IISAR Model Regression Results

Variable	Geographic distance matrix				Adjacent distance matrix			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ρ	1.4763				1.3027**			
	(4.88)				(3.48)			
Gjc	0.0387**	0.0635	1.8456**	1.0071*	0.0439*	0.0137**	1.4875	1.0492
	(2.08)	(2.04)	(3.84)	(2.89)	(2.27)	(2.24)	(3.53)	(2.58)
Control variable	Y	Y	Y	Y	Y	Y	Y	Y
Ind	Y	Y	Y	Y	Y	Y	Y	Y
Time	Y	Y	Y	Y	Y	Y	Y	Y
N	310	310	310	310	310	310	310	310
R^2	0.72	0.73	0.77	0.76	0.73	0.76	0.71	0.68

2) Industrial structure. The rationalization of the industrial structure is a necessary path for the current transformation of China's economic momentum. The rational development of the industrial structure can provide technological and industrial integration drivers for supply chain financial innovation, promoting the upgrading of the e-commerce logistics industry structure towards a more advanced direction. However, a single, homogeneous industrial structure between regions may lead to an incomplete industrial chain and supply chain, low efficiency in the allocation of market factors, which is not conducive to empowering high-quality development of e-commerce logistics through supply chain financial innovation. Based on this, this article selects the ratio of the added value of the tertiary industry to the added value of the secondary industry to measure the rationalization degree of the industrial structure, and verifies the impact of the interaction between the industrial structure and supply chain financial innovation on the high-quality development of e-commerce logistics. From the regression results in Table 6, a reasonable industrial structure can complement the advantages of supply chain financial innovation, perfecting and upgrading the industrial chain and supply chain, improving the efficiency of factor resource allocation in the e-commerce logistics industry, thereby exerting the radiation effect of factor allocation and promoting the high-quality development of regional e-commerce logistics.

5. Conclusions and Policy Recommendations

In the context that the high-quality development of domestic e-commerce logistics is facing new difficulties and bottlenecks, exploring whether supply chain financial innovation can empower the high-quality development of e-commerce logistics to meet the construction of a unified large market has certain practical significance. This paper uses panel data from 31 provincial administrative regions from 2013 to 2022, and through the construction of various econometric models, empirically analyzes the effect of supply chain financial innovation on the high-quality development of e-commerce logistics. The results show: First, supply chain financial innovation has a positive impact on the high-quality development of e-commerce logistics; Second, the effect of supply chain financial innovation in promoting the high-quality development of e-commerce logistics shows significant regional differences and industrial structural differences, specifically manifested as a decreasing effect from east to west in geographical space, and the promotion effect is more significant when the industrial structure is more reasonable; Third, further spatial effect decomposition finds that the indirect effect of supply chain financial innovation on the high-quality development of e-commerce logistics is more obvious than the direct effect.

Based on the above research conclusions, the following policy implications are proposed:

First, consolidate the foundation of supply chain financial innovation. First, government departments should focus on key areas based on the actual development of supply chain finance in various regions, make top-level designs, and strengthen support for supply chain financial innovation. Secondly, take advantage of the explosive growth of information technology to consolidate the technical support base for supply chain financial innovation, using a variety of digital technologies to innovate supply chain financial tools, especially to benefit underdeveloped areas. Finally, optimize the soft environment for the development of supply chain finance, increase the popularization of financial knowledge among the general public, and provide rich human resources reserves and a good social atmosphere for supply chain financial innovation.

Table 5: Endogeneity Test Results

	Lag one period		Cargo turnover	
Variable	2SLS	GMM	2SLS	GMM
Gjc	0.4907***	0.2138	0.3907***	0.3914
	(3.63)	(3.50)	(3.29)	(3.30)
Control variable	Y	Y	Y	Y
N	279	279	310	310
R^2	0.72	0.74	0.68	0.71

Table 6: shows the regression results of certificate heterogeneity

	Regional heterogeneity				Industrial structure heterogeneity	
Variable	Eastern	Central	Western	Northeast	High	Low
Gjc	0.2797	0.1086**	0.206*	0.4573	3.7461**	0.3039
	(3.61)	(2.28)	(1.62)	(0.85)	(3.68)	(1.36)
Control variable	Y	Y	y	y	Y	Y
Ind	Y	Y	Y	Y	Y	Y
Time	Y	Y	Y	Y	Y	Y
N	100	60	120	30	310	310
R^2	0.82	0.80	0.81	0.81	0.73	0.66

Second, vigorously promote the rationalization of industrial structure. The rationalization of industrial structure has a significant impact on the high-quality development of e-commerce logistics empowered by supply chain financial innovation. China should consolidate the foundation for industrial leapfrogging and focus on promoting the rationalization of industrial structure. On one hand, various market entities should efficiently utilize diverse and novel supply chain financial products to reduce the development costs of e-commerce logistics enterprises and boost industrial

transformation and upgrading. On the other hand, through the deep utilization and promotion of digital technologies such as the Internet of Things, big data, and artificial intelligence, a digital and intelligent development model for e-commerce logistics should be fostered, creating an intelligent and flexible new for the entire e-commerce logistics industry.

Third, promote supply chain financial innovation according to local conditions. According to the empirical analysis results in this article, the promoting effect of supply chain financial innovation on the high-quality development of e-commerce logistics ranks as eastern > central > western, showing a decreasing trend from east to west. Based on this, the eastern region should fully leverage the good advantages of supply chain financial innovation, promote adaptive innovation in supply chain finance, and use financial spillover effects to assist the development of other regions. In the central and western regions, governance structure innovation should be strengthened, reducing ineffective and redundant supply chain financial supply. Combined with the actual development of local e-commerce logistics industries, innovative financial support should be provided.

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