

Do Cross-Border E-Commerce Pilot Zones Foster Retail Enterprise Innovation? Empirical Evidence from China's A-Share Listed Firms

Buxin Li

School of Science and Technology, Nanchang University, Nanchang, Jiangxi 330029, China

Abstract: *This study evaluates the impact of China's Cross-border E-commerce Comprehensive Pilot Zones on technological innovation in retail enterprises, using panel data from Shanghai and Shenzhen A-share listed retail firms over the period 2011–2022. Empirical results indicate that the establishment of these pilot zones significantly enhances enterprise innovation performance, a finding that remains robust after controlling for trends and addressing endogeneity concerns. Mechanism analysis reveals that the policy effect operates through alleviating financing cost pressures within pilot areas, thereby creating favorable conditions for innovation. Based on these findings, this paper proposes policy recommendations for deepening pilot zone implementation, expanding financial support, and strengthening industry-university-research collaboration to sustain and amplify innovation gains.*

Keywords: Establishment of Cross - border E - commerce Comprehensive Pilot Zones; Technological Innovation of Retail Enterprises; Quasi - natural Experiment; Financing Cost.

1. INTRODUCTION AND LITERATURE REVIEW

The report of the 20th National Congress of the Communist Party of China emphasizes the importance of the innovation-driven development strategy, proposing to strengthen the in-depth integration of industry, education, and research led by enterprises, strengthen goal orientation, and improve the transformation and industrialization level of scientific and technological achievements. As an important product of global economic integration in the new era, the reform and development of cross-border e-commerce not only concern the vitality of China's foreign trade but also are a key force in promoting the technological innovation of domestic retail enterprises. In 2015, the State Council approved the establishment of the cross-border e-commerce comprehensive pilot zone policy, providing a broad market space and convenient trade channels for related industries, and bringing great development prospects for enterprise technological innovation and model transformation. However, in the actual development process, the internal connection and influence mechanism between the establishment of the cross-border e-commerce comprehensive pilot zone and the technological innovation of retail enterprises have not been fully revealed. Especially in the context of increasingly fierce global market competition, how retail enterprises can effectively improve their technological innovation capabilities through the establishment of the cross-border e-commerce comprehensive pilot zone to cope with the changing external environment has become an urgent problem to be solved.

Enterprise technological innovation is an important driving force for economic development and is affected by various factors. By sorting out the relevant research literature in recent years, some scholars have conducted certain research from two aspects: internal factors and external environmental factors of enterprises. First, in terms of internal factors of enterprises, human resources, enterprise strategy, and corporate culture all have a significant impact on technological innovation. Ye Hongyu (2021) focused on studying the impact of equity structure on enterprise innovation and found that the proportion of non-state-owned equity is significantly positively correlated with the innovation activities of private enterprises. Li Xiaotao (2022) pointed out that in technology-intensive industries, a large salary incentive positively regulates the innovation investment of enterprises. In addition, the research results of Hu Shulin (2024) show that management ability significantly and positively affects the innovation level and innovation efficiency of enterprises. Second, external environmental factors, such as government policies and market environment, also have an important impact on technological innovation. Quan Xijian (2022) found that government subsidies can increase the stock of high-tech skilled human capital, thus promoting enterprise technological innovation. The research of Xu Jianbin (2020) shows that the transfer of enterprise production activities from countries with high tax rates to countries with low tax rates has a positive impact on innovation activities. In addition, the support of the capital market is also regarded as an important driving force for technological innovation. Qin Xinyi (2023) believes that the capital market can invest in

information-asymmetric and high-risk technological innovation projects to obtain high rates of return.

In recent years, with the rapid development of cross-border e-commerce, its impact on retail enterprises has become increasingly significant. The research by Liu Huizheng (2023) shows that cross-border e-commerce provides retail enterprises with a global sales channel, helping enterprises expand overseas markets and achieve global operation. Zhang Xiaheng (2022) pointed out that cross-border e-commerce has changed the supply chain model of traditional retail enterprises and improved the efficiency of the supply chain. The research by Liu Bin (2022) found that cross-border e-commerce platforms provide retail enterprises with a global brand display platform, helping to enhance brand awareness and influence.

To sum up, enterprise technological innovation is affected by various factors, including internal enterprise factors, external environmental factors, and the impact of cross-border e-commerce. However, previous studies have mostly focused on one aspect of the influencing factors and lack comprehensive research. In addition, the impact of the establishment of cross-border e-commerce comprehensive pilot zones on the technological innovation of retail enterprises is also a direction worthy of in-depth study. Therefore, the innovation of this paper is to take the cross-border e-commerce comprehensive pilot zone as a quasi-natural experiment and empirically analyze the impact of the establishment of cross-border e-commerce comprehensive pilot zones on the technological innovation of retail enterprises, providing theoretical support and practical guidance for the comprehensive and high-quality development of enterprises.

2. MECHANISM ANALYSIS AND RESEARCH HYPOTHESES

2.1 Direct Impact of the Establishment of Cross-border E-commerce Comprehensive Pilot Zones on the Technological Innovation of Retail Enterprises

From a theoretical perspective, the establishment of cross-border e-commerce comprehensive pilot zones has had a profound impact on the technological innovation of retail enterprises. It has not only effectively expanded the market scale of the retail industry but also provided a fertile ground and scenarios for the technological innovation of relevant retail enterprises. Specifically:

First, the establishment of cross-border e-commerce comprehensive pilot zones, by providing various preferential policies and facilitation measures, has effectively reduced the operating costs of retail enterprises, enhanced their market competitiveness, and enabled them to allocate more funds and resources to technological innovation. Through technological innovation and process reengineering, enterprises can effectively improve their internal operating efficiency, enhance the consumer experience, and ultimately increase their market share and profitability. Second, the establishment of cross-border e-commerce comprehensive pilot zones has promoted the digital transformation of the retail industry. Driven by the policies of the pilot zones, relevant enterprises have gradually increased their digital investment and used technologies such as big data and artificial intelligence for digital marketing, further achieving efficient inventory management and customer service, providing a more personalized shopping experience for consumers, and thus enhancing customer satisfaction. Third, the establishment of cross-border e-commerce comprehensive pilot zones can effectively promote supply chain innovation. Within the pilot zones, relevant enterprises can optimize and upgrade the supply chain ecosystem by leveraging the advantages of resource concentration, conveniently obtaining high-quality goods, and promoting the optimization and upgrading of the supply chain ecosystem. At the same time, through cooperation with suppliers at home and abroad, retail enterprises can introduce more novel and unique products to further meet consumer demands. Finally, the establishment of cross-border e-commerce comprehensive pilot zones has brought an international perspective and competitive landscape to retail enterprises. With the continuous deepening of economic globalization, relevant retail enterprises face more competition pressures and challenges from the global market, which also prompts them to continuously increase their technological innovation efforts to adapt to market changes. For example, by building e-commerce platforms with multiple languages and currencies, enhancing the international operation capabilities of enterprises, helps retail enterprises stand out in the international market and achieve sustainable development. Therefore, this paper proposes the following research hypotheses:

H1: The establishment of cross-border e-commerce comprehensive pilot zones can significantly promote the improvement of the technological innovation level of retail enterprises.

2.2 Mechanism of the Establishment of Cross-border E-commerce Comprehensive Pilot Zones on the Technological Innovation of Retail Enterprises

The establishment of cross-border e-commerce comprehensive pilot zones has effectively reduced the time cost and capital occupation of enterprises in cross-border transactions through a number of measures such as optimizing trade processes, improving customs clearance efficiency, and simplifying tax procedures. Specifically: within the comprehensive pilot zones, enterprises can enjoy preferential loan policies, foreign exchange settlement convenience and other financial services, which directly reduce the external financing costs of enterprises. At the same time, the establishment of cross-border e-commerce comprehensive pilot zones has promoted information transparency and market competitiveness, enabling financial institutions to provide more reasonable and preferential financing conditions for enterprises, further reducing the financial burden and financing costs of enterprises.

The reduction of enterprise financing costs has a significant promoting effect on the improvement of the technological innovation level of retail enterprises. Specifically: First, the reduction of financing costs means that enterprises can obtain funds at a lower cost, which provides more abundant financial support for technological innovation. Retail enterprises can use these funds to invest in R & D activities, develop new products or improve existing products, thus enhancing market competitiveness. Second, the reduction of financing costs helps enterprises optimize their capital structure and reduce financial risks, which provides a stable financial foundation for enterprises to carry out long-term technological innovation investments. Finally, the reduction of financing costs can also encourage retail enterprises to more actively seek development opportunities and conduct technological innovation, thus enhancing the core driving force for the high-quality development of enterprises. To sum up, the establishment of cross-border e-commerce comprehensive pilot zones creates favorable conditions for the improvement of the technological innovation level of retail enterprises by reducing enterprise financing costs. The reduction of financing costs not only directly alleviates the financial pressure of enterprises, but also provides more financial support and motivation for the technological innovation activities of enterprises. Therefore, this paper proposes the following research hypotheses:

H2: The establishment of cross-border e-commerce comprehensive pilot zones can effectively reduce the financing costs of enterprises, thereby promoting the improvement of the technological innovation level of retail enterprises, that is, financing costs play an indirect mechanism role in the relationship between the establishment of cross-border e-commerce comprehensive pilot zones and the technological innovation of retail enterprises.

3. RESEARCH DESIGN AND VARIABLE EXPLANATION

3.1 Variable Measurement

1) Explained Variable (Innovate): Technological innovation of enterprises. Technological innovation of enterprises generally refers to the production of a new product, the provision of a new service, the use of a new method or the adoption of a new process by an enterprise. Such innovation may not only involve changes in the product itself but also include improvements in the production process and innovations in management methods, etc., which are important means for enterprises to gain competitive advantages and benefits. Considering data availability, this paper selects the value of the cumulative number of patent applications for invention patents, utility model patents, and design patents of the retail enterprises under study in the current period, adds one, and then takes the logarithm as the proxy variable for the technological innovation of enterprises.

2) Explanatory Variable (DID): Establishment of cross-border e-commerce comprehensive pilot zones. The State Council has successively approved the establishment of seven batches of cross-border e-commerce comprehensive pilot zones from March 7, 2015 to November 14, 2022. The core purpose is to provide a better development environment and promote the sustainable and healthy development of the cross-border e-commerce industry through institutional innovation, management innovation, and service innovation. Therefore, this paper refers to the research method of Dai Yanjuan (2024) and uses the interaction term of the pilot areas and implementation periods of the cross-border e-commerce comprehensive pilot zone establishment policy as the proxy variable, which is assigned a value of 1 for the year of establishment of the cross-border e-commerce comprehensive pilot zone policy and subsequent years, and 0 otherwise.

3) Mediating Variable (financing): Financing cost. The financing cost of an enterprise refers to the various expenses that an enterprise needs to pay in the process of raising funds, including financing expenses and fund usage expenses. Therefore, this paper measures it by the ratio of financial expenses to the total liabilities of the enterprise.

4) Control variables. To minimize research biases, especially the impact caused by omitted variables, this study incorporates the following control variables: the total number of enterprise employees is used as the measure of enterprise size (size); the enterprise age (age) is evaluated by the number of years since the enterprise was established; the ownership concentration (share) is measured by the proportion of shares held by the largest shareholder; the debt-paying ability (debt) is evaluated by the ratio of current assets to current liabilities. The ratio of operating profit to sales output value of the enterprise is selected to reflect the profitability (profit) of the enterprise; the ratio of total liabilities to total assets of the enterprise is used to measure the financial leverage (leverage).

3.2 Model Design

To verify the previous hypothesis H1, this paper sets up the difference-in-differences model as follows:

$$\text{innovate}_{c,t} = \alpha_0 + \alpha_1 \text{DID}_{c,t} + \alpha_2 \text{control}_{c,t} + \mu_c + \iota_t + \varepsilon_{c,t} \quad (1)$$

In equation (1), c represents the research enterprise, t represents the research period, innovate represents the explained variable of the enterprise's technological innovation level, DID represents the core explanatory variable, that is, the policy of the establishment of cross-border e-commerce comprehensive pilot zones, control represents a series of relevant control variables, α_1 represents the impact coefficient value of the establishment of cross-border e-commerce comprehensive pilot zones, η_c 、 ι_t respectively represents controlling the fixed effects of the research enterprise and the research period, and ε represents the residual term.

In addition, to further test the mechanism analysis of the previous hypothesis H2, the following model is set up:

$$\text{financing}_{c,t} = \varphi_0 + \varphi_1 \text{DID}_{c,t} + \varphi_2 \text{control}_{c,t} + \mu_c + \iota_t + \varepsilon_{c,t} \quad (2)$$

$$\text{innovate}_{c,t} = \delta_0 + \delta_1 \text{DID}_{c,t} + \delta_2 \text{financing}_{c,t} + \delta_3 \text{control}_{c,t} + \mu_c + \iota_t + \varepsilon_{c,t} \quad (3)$$

In equations (2) and (3), financing represents the mediating variable, that is, the enterprise financing cost. When the coefficient of φ_1 is significant, it indicates that the establishment of cross-border e-commerce comprehensive pilot zones has a certain impact on the mediating variable. Further testing δ_1 、 δ_2 , when both are significant and δ_1 is less than α_1 , it indicates the existence of a partial mediating effect. When δ_1 is not significant and δ_2 is significant, it means that the mediating variable plays a full mediating effect.

3.3 Data Sources

This paper uses the listed retail enterprises on the Shanghai and Shenzhen A-shares from 2011 to 2022 as the initial research samples, and gradually excludes ST and PT enterprises, finally obtaining 148 enterprises. At the same time, according to the cross-border e-commerce comprehensive pilot zones announced by the Ministry of Commerce over the years, they are matched with the locations of the studied enterprises to determine whether the regions where the enterprises are located are the areas where cross-border e-commerce comprehensive pilot zones are established. Patent data are collected from the patent retrieval system of the State Intellectual Property Office for the relevant patent information of enterprises, and the data of relevant enterprise-level control variables come from the CSMAR Guotai An database and the WIND database.

4. EMPIRICAL ANALYSIS

4.1 Baseline Regression Analysis

Based on the above analysis, to verify the direct impact of the establishment of cross-border e-commerce comprehensive pilot zones on the technological innovation of retail enterprises, this paper conducts a baseline regression analysis. As shown in Table 1, columns (1)-(3) represent the regression results without adding relevant control variables, adding control variables, and adding time and firm fixed effects, respectively. From the results, the estimated coefficients of the establishment of cross-border e-commerce comprehensive pilot zones are all significantly positive, indicating that the establishment of cross-border e-commerce comprehensive pilot zones can significantly promote the improvement of the technological innovation level of retail enterprises. From the results of column (3), when the establishment of cross-border e-commerce comprehensive pilot zones increases by one standard unit, it will drive the technological innovation level of retail enterprises to increase by 0.197 units, which also conforms to the expected hypothesis H1 above. In addition, some control variables selected in this paper also have a significant impact on the technological innovation of retail enterprises. The enterprise scale,

ownership concentration, and solvency of enterprises have a significant positive relationship with the technological innovation of retail enterprises, while the financial leverage has a significant inhibitory effect on the technological innovation of retail enterprises.

4.2 Parallel Trend Test

To ensure the accuracy and effectiveness of the results of the difference-in-differences estimation model, a key prerequisite is that there should be no significant differences between the treatment group (i.e., retail enterprises located in cross-border e-commerce comprehensive pilot zones) and the control group (i.e., retail enterprises not located in such pilot zones) before the implementation of the policy. In addition, the changes in the explanatory variables in the model should be mainly attributed to the impact of policy adjustments. To further verify the effectiveness of the above test results, this paper will conduct a parallel trend test on the treatment group and the control group, aiming to confirm that the two groups of enterprises indeed maintained similar development trends in key indicators before the implementation of the policy, so as to ensure that the model can accurately capture the effects brought about by policy changes, and the following model is set:

$$\text{Innovate}_{c,t} = \theta_0 + \sum_{m=-5}^5 \theta_m DID_{c,t} + \theta_n \sum_m \text{control}_{c,t} + \eta_c + \iota_t + \varepsilon_{c,t} \quad (4)$$

In Equation (4), m represents the year when the cross-border e-commerce comprehensive pilot zone policy was implemented, and the test results are shown in Figure 1. Judging from the results, before the impact of the cross-border e-commerce comprehensive pilot zone policy, the estimated coefficients were within the 95% confidence interval and all included zero. After the impact of the cross-border e-commerce comprehensive pilot zone policy, the estimated coefficient of the cross-border e-commerce comprehensive pilot zone policy was outside the confidence interval and did not include zero, indicating that the above research content passed the parallel trend test.

4.3 Robustness Test Analysis

1) Propensity Score Matching Method. First, to exclude the differences between the control group and the experimental group, this paper uses the Propensity Score Matching method (PSM) for testing. From the results in columns (1) and (2) of Table 2, under kernel matching and radius matching, the estimated coefficients of the establishment of cross-border e-commerce comprehensive pilot zones are still significantly positive, indicating the robustness of the results of this paper.

2) Instrumental Variable Method. Since the establishment of cross-border e-commerce comprehensive pilot zones is affected by the regional own development level, to further ensure the robustness of the estimation results of this paper, this paper draws on the research idea of Huang Qunhui (2019), and selects the interaction term of the number of fixed telephones per 100 people and the number of post offices in each research province and city in 1984 as the instrumental variable (IV) for the establishment of cross-border e-commerce comprehensive pilot zones to conduct endogeneity analysis. Specifically, the development of cross-border e-commerce is inseparable from the development of communication information technology and logistics distribution, and the historical basic communication construction and post office distribution affect the local cross-border e-commerce development to a certain extent. However, since the promotion of historical communication technology and the number of post offices in 1984 on the current enterprise technological innovation is relatively low, an exclusivity condition is set. Therefore, this paper uses the two-stage regression analysis method to conduct regression analysis on the above instrumental variable. The results are shown in column (3) of Table 2. From the results of the first stage, there is a significant positive relationship between the instrumental variable and the establishment of cross-border e-commerce comprehensive pilot zones. From the results of the second stage, the establishment of cross-border e-commerce comprehensive pilot zones still plays a significant role in promoting the technological innovation level of retail enterprises, further demonstrating the reliability of the results of this paper.

Table 1: Analysis of Benchmark Regression Results

Variable	(1)	(2)	(3)
DID	0.354*** (0.912)	0.264*** (0.667)	0.197*** (0.329)
size	-	0.324*** (0.787)	0.400*** (0.942)
Age	-	0.070 (0.294)	0.321 (0.153)
share	-	0.240*** (0.325)	0.135*** (0.257)
debt	-	1.261** (0.314)	1.398*** (0.391)
profit	-	0.089 (0.257)	0.335 (0.247)
leverage	-	-0.740*** (-0.294)	-0.428*** (-0.284)
cons	1.002*** (2.676)	-5.549*** (-4.409)	-5.879*** (-7.303)

Firm fixed effects	No	No	Yes
Year fixed effects	No	No	Yes
R ²	0.561	0.493	0.498

Note: *, **, *** indicate significance at the 0.1, 0.05, and 0.01 levels respectively. The standard errors are shown in parentheses. The same applies hereinafter.

4.4 Mechanism Tests

The results of the mechanism tests are shown in Table 3. Column (1) represents the results of the baseline regression. From the results in column (2), the estimated coefficient of the establishment of cross-border e-commerce comprehensive pilot zones is -0.005 and is significant at the 1% level, indicating that the establishment of cross-border e-commerce comprehensive pilot zones can effectively reduce the financing costs of enterprises within the pilot areas. When the establishment of cross-border e-commerce comprehensive pilot zones and enterprise financing costs are incorporated into the baseline analysis framework, the results are as shown in column (3). The estimated coefficient of enterprise financing costs is significantly negative, and the estimated coefficient of the establishment of cross-border e-commerce comprehensive pilot zones decreases and is significantly positive, indicating that the implementation of the policy of cross-border e-commerce comprehensive pilot zones has effectively alleviated the pressure on the financing costs of enterprises in the pilot areas, thus strongly promoting the improvement of the technological innovation level of retail enterprises and verifying the setting of hypothesis H2 in the previous text.

Table 2: Robustness Test

Variable	(1) Kernel matching	(2) Radius matching	(3) First stage	(4) Second stage
DID	0.193*** (0.314)	0.191*** (0.327)	-	0.174* (0.178)
IV	-	-	0.131** (0.219)	-
Control variables	Yes	Yes	Yes	Yes
Firm individual fixed	Yes	Yes	Yes	Yes
Research time fixed	Yes	Yes	Yes	Yes
Anderson Rk LM test	-	-	2750.131 [0.000]	
C-D Wald F test	-	-	1435.529 [14.627]	
Hansen J test	-	-	0.005 [0.874]	
R ²	0.569	0.597	0.492	0.507

Table 3: Mechanism Effect Analysis

Variable	(1) innovate	(2) financing	(3) Innovate
DID	0.197*** (0.329)	-0.005*** (-0.304)	0.125*** (0.498)
financing	-	-	-1.092*** (-0.201)
Control variables	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes
R ²	0.498	0.428	0.512

5. COUNTERMEASURES AND SUGGESTIONS

First, deepen the implementation of cross-border e-commerce comprehensive pilot zones and promote successful experiences. Given that the establishment of cross-border e-commerce comprehensive pilot zones has a significant promoting effect on the technological innovation of retail enterprises, it is recommended that relevant government departments accelerate the implementation of measures such as optimizing trade processes, improving customs clearance efficiency, and improving financial services, further reducing the operating costs of enterprises, and stimulating the innovation vitality of enterprises. At the same time, relevant departments should promptly summarize and promote the successful experiences within the pilot zones, guiding more regions and enterprises to participate in the experimental reform, thereby promoting the overall improvement of the technological innovation level of China's retail industry.

Second, increase financial support and reduce the financing costs of retail enterprises. The establishment of cross-border e-commerce comprehensive pilot zones has effectively alleviated the financing pressure of enterprises within the pilot areas. To further promote the technological innovation of retail enterprises, it is recommended that relevant government departments increase financial support. This can be achieved by formulating preferential loan policies, providing financing guarantees, and simplifying financing procedures to effectively reduce the financing costs of retail enterprises. At the same time, relevant departments should encourage financial institutions to innovate financial products and services to further meet the diversified financing needs of retail enterprises during the technological innovation process.

Third, strengthen industry-university-research cooperation and promote the transformation of technological innovation achievements of retail enterprises. To improve the technological innovation level of retail enterprises, it is recommended that the government strengthen industry-university-research cooperation and promote in-depth cooperation among universities, research institutions, and retail enterprises. Through resource sharing, joint research and development, and talent cultivation, etc., promote the transformation and application of scientific and technological innovation achievements. At the same time, the government should increase the rewards and support for the technological innovation achievements of retail enterprises to stimulate the innovation enthusiasm of enterprises and promote the sustainable and healthy development of the retail industry.

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Author Profile

Buxin Li (1973-), female, Han nationality, from Nanchang, Jiangxi, master, lecturer. Research interests: Cross-border e-commerce, trade economy.