

The Impact of Institutional Opening-up on the Development of New-Quality Productivity in Enterprises: A Quasi-Natural Experiment Based on Cross-Border E-commerce Pilot Zones

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Abstract: *The symposium on promoting the comprehensive revitalization of Northeast China, held in September 2023, called for vigorously developing “new quality productive forces” and fostering new drivers of economic growth. The establishment of comprehensive pilot zones for cross-border e-commerce represents a significant institutional innovation undertaken by China to navigate the new opportunities and challenges of a new era of economic development. As of April 2025, China had established 178 such zones across the country in seven batches. These zones aim to vigorously develop an export-oriented economy and resolve deep-seated institutional issues through institutional innovation; in doing so, they foster regional economic growth and drive the digital transformation and upgrading of enterprises, ultimately promoting the development of new quality productive forces within those enterprises. This paper takes listed companies from 2011 to 2022 as the research object and uses the multi-period difference-in-differences (DID) model method to explore the impact mechanism of the comprehensive pilot zone policy on the new quality productivity of enterprises. At the same time, it further explores the mediating role of innovation incentives and digital empowerment between the two. Finally, it conducts heterogeneity analysis from the aspects of regional differences and differences in enterprise ownership, and explores the relationship between them in depth.*

Keywords: Cross-border e-commerce pilot zone, New-Quality productivity, Innovation incentives, Digital empowerment.

1. Introduction

In September 2023, during his inspection tour of Northeast China, General Secretary Xi Jinping first proposed the innovative concept of “new-quality productive forces.” In January 2024, during the 11th collective study session of the Political Bureau of the CPC Central Committee, General Secretary Xi Jinping elaborated on the new-quality productive forces, clearly pointing out that they differ significantly from traditional productive forces.

Since the launch of the cross-border e-commerce comprehensive pilot zones in 2015, various regions have actively implemented policies and promoted the rapid development of the industry, with particularly significant achievements in technological innovation. However, there is still room for improvement in overall development. The report of the 20th National Congress of the Communist Party of China clearly stated the importance of promoting a higher level of opening up and called for the establishment of a higher-quality institutional opening-up system. The country has further emphasized deepening opening up and promoting the construction of an institutional opening-up system. The cross-border e-commerce comprehensive pilot zones are an important practice of this strategy. Through institutional innovation and policy support, they help enterprises break through traditional trade restrictions. Specifically, the pilot zones implement policies such as customs clearance facilitation, tax incentives, and overseas warehouse support, effectively reducing the time and management costs of SMEs in foreign trade, enabling them to participate in international trade in a more efficient and flexible manner. At the same time, through the organic combination of the online “single window” platform and the offline “comprehensive park” platform, they vigorously promote emerging technology rules such as

blockchain technology, promote enterprises to accelerate digital transformation and upgrading, and form a virtuous cycle of mutual promotion between policy innovation and the improvement of new quality productivity.

2. Literature Review

As an important carrier of institutional opening-up, the construction of cross-border e-commerce pilot zones, according to Wei Dayu (2019) [1], needs to actively learn from the experiences and lessons of developed regions. According to Ma Shuzhong et al. (2022) [2], cross-border e-commerce pilot zones bear the historical mission of creating a benchmark for institutional innovation. Their operation model can bring practical experience that can be learned from and widely applied to other cities, promote other cities to actively accept and spontaneously innovate, and drive the development of local economies. At the same time, the construction of cross-border e-commerce pilot zones can optimize the redistribution of regional resources based on their comprehensive innovation model of piloting first.

Luo et al. (2025) [3] showed that the construction of comprehensive pilot zones has led to a continuous expansion of regional employment, and the policy dividends have shown an increasing trend year by year. Its mechanism of action is mainly reflected in stimulating the increase in export trade and enhancing the entrepreneurial activity of market entities. The research data shows that the average annual growth rate of enterprise registration in the cities where the comprehensive pilot zones are located is 5.8 percentage points higher than that in non-pilot areas, thereby increasing the demand for labor. In addition, the cross-border e-commerce comprehensive pilot zone policy can effectively promote import and export exchanges between regions.

2.1 Relevant Research on the Measurement of New Productivity

The theoretical connotation and practical path of new quality productivity are the core issues of current academic research, among which the measurement of new quality productivity is a research topic involving many scholars. Yao Bolun et al. (2025) [5] took the establishment of national-level big data pilot zones as the basis for natural experiments and used A-share listed companies in Shanghai and Shenzhen from 2011 to 2022 as samples. In the construction of enterprise new quality productivity indicators, they innovatively added non-material objects, scientific and technological labor materials and sustainable labor materials as first-level indicators. They comprehensively analyzed and found that the aggregation of data elements effectively stimulated the development of enterprise new quality productivity by improving the quality of production factors, stabilizing the supply chain and attracting digital talents. The promotion effect on non-state-owned enterprises and enterprises in the eastern region was more significant. In addition, Song Jia et al. (2024) [7] collected financial statement data of A-share listed companies from 2015 to 2022 and Huazheng E-index data. According to the theoretical framework of productivity constituent elements, this study selected labor factors and production tool factors as core evaluation dimensions. Using the entropy weight method, they constructed an enterprise new quality productivity evaluation model system that includes three dimensions: living labor input, hard technology innovation and soft technology application. Based on stakeholder theory, they focused on examining the transmission mechanism of the performance of key stakeholders such as shareholder groups, supplier networks and financial institutions on the formation of enterprise new quality productivity.

2.2 Research on the Relationship between Comprehensive Pilot Zone Policies and New-Quality Productivity

From the perspective of the mechanism of institutional opening-up, Dai Xiang et al. (2024) [8] proposed that it can promote the upgrading of labor resources, labor objects and laborers required for new quality productivity by gathering global high-end factors, strengthening the incentive for technological innovation and optimizing resource allocation; Wang Peng et al. (2025) [9] used a multi-period DID model based on panel data of prefecture-level cities to explore the impact of cross-border e-commerce pilot zones on new quality productivity. The results showed that the pilot zone policy can mainly improve the development level of new quality productivity by strengthening regional innovation accumulation, optimizing resource allocation and improving the level of industrial agglomeration. The effect is more significant in cities with better business environment and higher market integration; Lin Xiaowen et al. (2024) [10] conducted an empirical study based on provincial panel data from 2012 to 2021. The study showed that institutional opening-up can significantly improve the level of new quality productivity by promoting industrial structure upgrading, technological innovation and reducing transaction costs. The effect is better in areas with low degree of innovation resource mismatch and high entrepreneurial activity. The impact is more significant on pilot zones that have been established. Liu

Hongduo et al. (2024) [11] used the quasi-natural experiment of the establishment of free trade zones to find that institutional opening up improved the business environment and accelerated market system reform, which increased the level of new quality productivity in the region by an average of 7.49%, and that the level of institutional innovation, the strength of legal authorization and the industrial agglomeration effect could all enhance this promoting effect.

2.3 Literature Review

Existing literature mainly provides rich insights into the relationship between institutional openness and new quality productivity from the two dimensions of theoretical construction and empirical testing. The research perspective is mostly focused on traditional manufacturing and service industries, and there is insufficient discussion on the institutional adaptability of emerging business forms such as digital economy and cross-border e-commerce. For example, issues such as cross-border flow rules of data elements and governance of digital platforms have not yet formed a systematic theoretical framework (Li Hongbing et al., 2023) [13]. At the same time, there are few studies on the impact of comprehensive pilot zone policies on the formation of new quality productivity of enterprises. The policy effect assessment mostly relies on macro data of provincial or prefecture-level cities, and lacks research and analysis on micro data of enterprises. In addition, most existing studies focus on the macro level of institutional openness, and there is insufficient detailed research on cross-border e-commerce comprehensive pilot zone policies, and there is a lack of focus.

3. Theoretical Analysis and Research Hypotheses

From the perspective of production factor matching theory, the basic connotation of new-quality productivity is “the leap forward in laborers, objects of labor, means of labor, and their optimal combination.” The establishment of cross-border e-commerce comprehensive pilot zones can further stimulate the innovation vitality of enterprises, promote the digitalization of industries and the industrialization of digital technologies through the widespread application of digital technologies, effectively advance the digital transformation and upgrading of enterprises, and in this process, enterprises can achieve goals such as reducing R&D costs, improving R&D efficiency, and accelerating the transformation of scientific research results, thereby contributing to the formation of new-quality productivity and achieving sustained and effective economic development. In summary, Hypothesis H1 is proposed:

H1: The policies of the comprehensive pilot zone can effectively promote the development of new quality productivity of enterprises.

Based on the above hypotheses, this paper further analyzes the impact of cross-border e-commerce comprehensive pilot zone policies on the formation of new quality productivity of enterprises from two aspects: innovation incentives and digital empowerment.

In an open economy, establishing a comprehensive incentive

mechanism for technological innovation plays an indispensable role in the development of new productive forces. On the one hand, a stable and proactive policy environment can reduce external risks to business operations and lower transaction and management costs, thereby enabling companies to increase R&D investment and innovation activities. Streamlining market access procedures and lowering the barriers to entrepreneurship, along with building a friendly institutional environment, can effectively attract innovative enterprises and high-caliber talent, providing a continuous driving force for the cultivation and development of new productive forces. In summary, Hypothesis H2 is proposed:

H2: The comprehensive pilot zone policy promotes the development of new productivity for enterprises by strengthening incentives for technological innovation.

Cross-border e-commerce pilot zones, with digital platforms and institutional rules as key carriers, inherently drive enterprises to accelerate digital transformation. Institutional openness, by reducing transaction costs, increasing information transparency, and reshaping factor allocation, changes the production organization and value creation models of enterprises. Empirical results show that institutional openness significantly promotes enterprise

digital transformation, and digital transformation has a highly significant positive impact on new-quality productivity. Among various individual mechanisms, the digital channel explains the highest proportion of policy effects, indicating that digital empowerment is the core transmission path of institutional openness in impacting new-quality productivity. In summary, Hypothesis H3 is proposed:

H3: The comprehensive pilot zone policies promote the development of new productivity for enterprises by strengthening industrial digitalization.

4. Empirical Research

This study selected data from all A-share listed companies, sourced from the Wind database and the Guotai An database. These are authoritative websites, ensuring the credibility and feasibility of the data.

Ultimately, a 12-year sample period from 2011 to 2022 was used, with 4,976 companies and a total sample size of 35,475 data points, which were then incorporated into the model for analysis.

4.1 Variable setting

Table 1: Variable Settings

Variable properties	Variable represents	Variable name	Variable calculation
Explanatory variable	New Productivity of Enterprises	<i>NPRO</i>	Calculated using the entropy method
Explanatory variables	Policy occurrence time	<i>Post</i>	The value is 1 for events occurring and afterward, and 0 for events occurring beforeward.
	Is it the experimental group?	<i>Treat</i>	The experimental group had 1, and the control group had 0.
	Interactive items	<i>DID</i>	The interaction items of the above two
	Enterprise size	<i>Size</i>	The total assets of the enterprise are processed using the natural logarithm.
	Debt-to-asset ratio	<i>Lev</i>	Total liabilities / Total assets
Control variables	Return on total assets	<i>ROA</i>	Net profit / Total assets
	Operating revenue growth rate	<i>Growth</i>	(Current period revenue - Previous period revenue) / Initial revenue
	Shareholding concentration	<i>Top1</i>	shares held by the largest shareholder / total number of shares
	Board size	<i>Board</i>	The number of board members is processed using the natural logarithm.
	Independent Director Ratio	<i>Indep</i>	Number of independent directors / Number of directors
	Company Age	<i>FirmAge</i>	The company's age is increased by 1 and then processed using natural logarithm.
	Year effect	<i>year</i>	Year effect: Use m-1 year dummy variables to prevent dummy variable traps.
	Industry effect	<i>ind</i>	the industry effect, set up n-1 industry dummy variables to prevent dummy variable traps.

4.2 Model Construction

Based on the explained and explained variables set above, the model is configured accordingly.

The first step is to analyze the impact of the comprehensive pilot zone policy on the explained variable, new quality productivity, as the core explanatory variable.

$$NPRO_{it} = \alpha_0 + \alpha_1 Post_t + \alpha_2 Treat_i + \alpha_3 Post_t * Treat_i + CV + \sum year + \sum ind + \varepsilon_{it}$$

The above α_0 is the intercept term, α_3 which is the influence coefficient of DID. A positive value indicates that the implementation of the comprehensive pilot zone policy will increase NPRO; a negative value indicates that the implementation of the policy will decrease NPRO. The other variables are inferred similarly, ε_{it} which is the random error

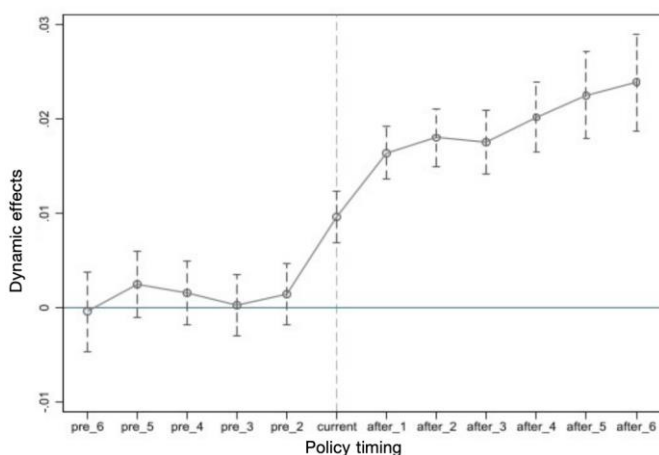
term, containing the influence of other variables not considered in this paper. In order to control for the double fixed effects of year and industry, the year effect and the industry effect *ind* are added. Since the control variables have been shown in the table above, this model design highlights the comprehensive pilot zone policy as the core explanatory variable, and CV is the control variable.

Regarding the measurement of new quality productivity of enterprises, this paper draws on the research of Song Jia et al. (2024) and Li Xinru et al. (2024), and makes comprehensive adjustments to the evaluation indicators based on its own data to construct the evaluation index system of new quality productivity of enterprises as shown in Table 2. Then, the “new quality productivity of enterprises” variable is calculated by the entropy method.

Table 2: Evaluation Index System for New Productivity of Enterprises

Primary indicators	Secondary indicators	Level 3 indicators	Calculation method	property
New type of laborers	Employee quality	R&D personnel ratio	(Number of R&D personnel / Number of employees) * 100	just
		Proportion of highly educated personnel	(Number of employees with postgraduate degrees or above / Number of employees) * 100	just
	Management quality	Executive Green Awareness	ln(Green Annual Report Keywords + 1)	just
		Management with overseas background	If you have an overseas background, the value is 1; otherwise, the value is 0.	just
New quality labor objects	Ecological environment	Environmental governance score	Huazheng E-Indicator	just
	Future Development	Fixed assets as a percentage	(Fixed Assets / Total Assets) * 100	just
		Capital accumulation rate	(Increase in owners' equity / Total amount) * 100	just
New quality labor materials	Science and Technology Labor Materials	Innovation level	ln(number of patents + 1)	just
	Digital Labor Data	Digitalization level	ln(digital keyword + 1)	just
		Intangible assets as a percentage	(Intangible assets / Total assets) * 100	just
	Green Labor Materials	Green technology level	ln(number of green patents granted + 1)	just
		Green patent percentage	(Number of green licenses / Number of patent licenses) * 100	burden

4.3 Parallel Trend Test

**Figure 1:** Parallel trend test chart

Note: pre_ means before the policy, current means during the current period of the policy, and after_ means after the policy.

Empirical analysis shows that during the six observation periods before the policy implementation, the differences between the experimental group and the control group in terms of new quality productivity indicators did not require a significant test. This means that there were no significant differences between the two groups of enterprises before the policy intervention. However, in the period when the comprehensive pilot zone policy was first implemented and in the subsequent observation periods, the lower limit of the confidence interval was significantly higher than 0. This

empirical result strongly confirms that the comprehensive pilot zone policy has a promoting effect on the development of new quality productivity of enterprises.

4.4 Descriptive Statistics

The sample size is 35,475, indicating that there are no missing data and the data has been processed in advance. The mean of NPRO is 0.1268, with a fluctuation range of 0.0072-0.3746, which is relatively small. The standard deviation is 0.0735, which is also less than the mean, indicating a low coefficient of variation. The mean of DID is 49.01%, the mean of debt-to-equity ratio is 0.4148, and the mean of revenue growth rate is 0.1561, which are relatively large fluctuations.

Table 3: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
NPRO	35475	0.1268	0.0735	0.0072	0.3746
Post	35475	0.4901	0.4999	0.0000	1.0000
Treat	35475	0.8809	0.3239	0.0000	1.0000
DID	35475	0.4901	0.4999	0.0000	1.0000
Size	35475	22.2056	1.2820	19.9906	26.0706
Lev	35475	0.4148	0.2052	0.0559	0.8825
ROA	35475	0.0422	0.0629	-0.2034	0.2100
Growth	35475	0.1561	0.3507	-0.5001	1.8241
Top1	35475	0.3408	0.1478	0.0900	0.7288
Board	35475	2.1179	0.1960	1.6094	2.6391
Indep	35475	0.3767	0.0534	0.3333	0.5714
FirmAge	35475	2.9195	0.3263	1.9459	3.5264

Note: The coefficient of variation mentioned below is the standard deviation/mean. The higher the value, the greater the fluctuation.

4.5 Correlation Analysis

Table 4: Correlation Analysis

Variables	NPRO	Post	Treat	DID	Size	Lev	ROA	Growth	Top1	Board	Indep	FirmAge
NPRO	1											
Post	0.2251***	1										
Treat	0.0779***	0.3605***	1									
DID	0.2251***	1.0000***	0.3605***	1								
Size	0.1765***	0.0740***	-0.0155***	0.0740***	1							
Lev	0.0106**	-0.0110**	-0.0264***	-0.0110**	0.5146***	1						
ROA	0.0185***	-0.0390***	0.0183***	-0.0390***	-0.0279***	-0.3818***	1					
Growth	0.0236***	-0.0292***	0.0045	-0.0292***	0.0423***	0.0243***	0.2818***	1				
Top1	-0.0566***	-0.0706***	-0.0041	-0.0706***	0.1838***	0.0424***	0.1388***	-0.0048	1			
Board	0.0267***	-0.1142***	-0.0491***	-0.1142***	0.2605***	0.1496***	-0.0023	-0.0079	0.0195***	1		
Indep	0.0131**	0.0584***	0.0211***	0.0584***	-0.0039	-0.0126**	-0.0100*	-0.0057	0.0409***	-0.5558***	1	
FirmAge	-0.0194***	0.2703***	-0.0069	0.2703***	0.1948***	0.1855***	-0.1231***	-0.0740***	-0.1023***	0.0373***	-0.006	1

The measure of correlation analysis can initially determine whether the relationship between variables is significant based on the t-test of the correlation analysis (whether or not the software automatically outputs an asterisk). The sign of

the correlation coefficient indicates the direction of the correlation between variables. If it is positive, the variables change in the same direction; otherwise, they change in opposite directions. The higher the absolute value of the

correlation coefficient, the higher the correlation. However, correlation is only a relationship between two variables and should only be used as a preliminary basis for judgment.

The correlation coefficient between DID and NPRO is 0.2251. At the 1% significance level, an increase in DID significantly leads to an increase in NPRO, initially validating the hypothesis. However, due to the inaccuracy of correlation analysis, the relationship between variables needs to be more accurately determined by controlling for more factors. Therefore, further validation through regression is required. Except for the first column, the absolute value of the correlation coefficients from the second to the last column is the highest at 0.5558, which does not exceed the critical value of 0.8. Therefore, the collinearity of the model is not severe, and regression analysis can be performed without interference.

4.6 Multicollinearity Test

The VIF test is a method used to verify whether a model has high multicollinearity. It has high accuracy. This method relies on fitting each explanatory variable to the remaining non-explained variables. When the R-squared value of the fitted variable is not higher than 0.9, its VIF value will be less than 10, which means that a certain degree of collinearity has not been reached. If it is higher than 10, the variables that cause high collinearity need to be removed for further analysis.

Table 5: Model VIF Test

Variable	VIF	1/VIF
Lev	1.7300	0.5793
Board	1.6300	0.6131
Size	1.6200	0.6172
Indep	1.5000	0.6684
ROA	1.4000	0.7165
FirmAge	1.1600	0.8639
Growth	1.1200	0.8908
DID	1.1200	0.8967
Top1	1.0900	0.9212
Mean VIF	1.3700	0.72992

Lev's VIF value is 1.7300, and its reciprocal is also greater than 0.1, which meets the standard. The remaining variables all meet the standard that VIF is less than 10 and the reciprocal of VIF is greater than 0.1. Therefore, further verification shows that the model has no serious collinearity and will not be greatly affected by interference.

4.7 Benchmark Regression Results

This study controlled for the effects of year and industry, because the explained variables differ across years and industries, and the results obtained using a two-fixed-effects model are more accurate.

The results of the baseline regression model show that the first column presents the baseline regression results with only explanatory variables and two-way fixed effects, while the second column shows the estimation results after the introduction of control variables. The empirical analysis shows that regardless of whether control variables are included, the coefficient estimates of the core explanatory variables show statistical characteristics. After the control variables are added to the model, the goodness of fit index of the regression equation is improved to 22.78%, and hypothesis H1 is valid based on the regression results.

Table 6: Benchmark Regression

VARIABLES	No control variables were added.	Add control variables
	(1)	(2)
DID	0.0143*** (13.4367)	0.0151*** (14.7877)
Size		0.0153*** (43.2007)
Lev		-0.0097*** (-4.1840)
ROA		0.0090 (1.3861)
Growth		0.0001 (0.1114)
Top1		-0.0190*** (-7.6757)
Board		0.0177*** (7.7756)
Indep		0.0231*** (2.9276)
FirmAge		-0.0252*** (-20.5570)
Constant	0.1198*** (189.5009)	-0.1831*** (-19.8687)
Year fixed effect	Yes	Yes
Industry fixed effects	Yes	Yes
Observations	35,475	35,475
R-squared	0.1624	0.2278
F	180.5462***	355.0787***

Note: *, **, *** indicate that the test passed at the 10%, 5%, and 1% significance levels, respectively. The more asterisks, the higher the probability of passing the test. The values in parentheses are t-values.

4.8 Robustness Test

Robustness tests are used to help verify whether the results of regression analysis are stable. In other words, if the results of the core explanatory variables are consistent with those in the previous analysis, it means that the results are not random and have credibility.

4.8.1 Robustness test of one-period lagged explanatory variables

This robustness test uses lagged explanatory variables, as shown below:

Table 7: Robustness Test Table for Lagged Explanatory Variables

VARIABLES	NPRO before the experiment	NPRO after the experiment
	(1)	(2)
L.DID	0.0143*** (12.5245)	0.0150*** (13.6504)
Size		0.0152*** (39.2016)
Lev		-0.0086*** (-3.3650)
ROA		0.0146** (2.0339)
Growth		0.0008 (0.6466)
Top1		-0.0189*** (-6.9412)
Board		0.0167*** (6.6994)
Indep		0.0273*** (3.1803)
FirmAge		-0.0272*** (-19.5325)
Constant	0.1234*** (194.8304)	-0.1729*** (-16.9933)
Year fixed effect	Yes	Yes
Industry fixed effects	Yes	Yes
Observations	29,914	29,914
R-squared	0.1597	0.2257

Note: *, **, *** indicate that the test passed at the 10%, 5%, and 1% significance levels, respectively. The more asterisks, the higher the probability of passing the test. The values in parentheses are t-values.

Even with a lagged explanatory variable, the regression coefficient of DID on NPRO is 0.0150, which is still significant. This means that the direction and significance of the influence are consistent, and therefore the result is non-random and reliable.

4.8.2 Robustness test using PSM-DID

Since the cross-border e-commerce comprehensive pilot zone policy is essentially a non-randomized experiment, the selection of pilot cities often takes into account multiple factors, inevitably leading to self-selection bias. However, the PSM method can match each treatment group sample with a specific control group sample, making the quasi-natural experiment approximately random and eliminating endogeneity and selection bias. Following the approach of Li et al. (2021), this paper uses the 1:2 nearest neighbor matching method and kernel matching method to extract high-quality control groups similar to the experimental group in terms of control variables, and then performs regression analysis between the extracted control groups and the experimental group.

Figure 2 uses the nearest neighbor matching method, and Figure 3 uses the kernel matching method. It can be seen that... Analysis of the matched data showed that the systematic bias between the experimental group and the control group was improved, with the bias range generally remaining below 20%. The matching effect met the expected standard. The regression analysis results showed that the cross-border e-commerce comprehensive pilot zone policy had a positive impact on the development of new productivity of enterprises in pilot cities at a maximal level of 1%. This finding also holds true under the condition of a high-quality control group, and its maximal level and regression coefficient are basically the same as the results of the benchmark model, which strongly verifies the robustness of the conclusions of this study.

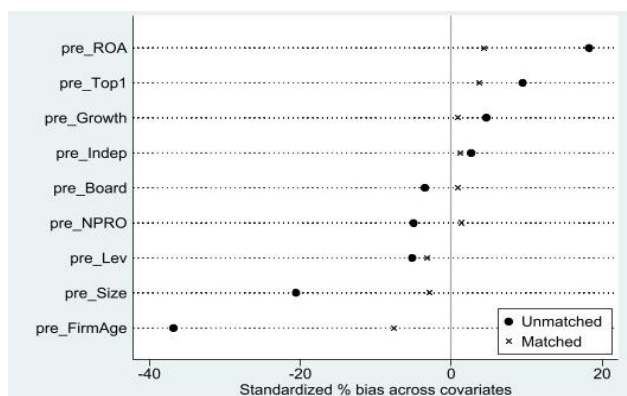


Figure 2: Nearest Neighbor Matching Bias Plot

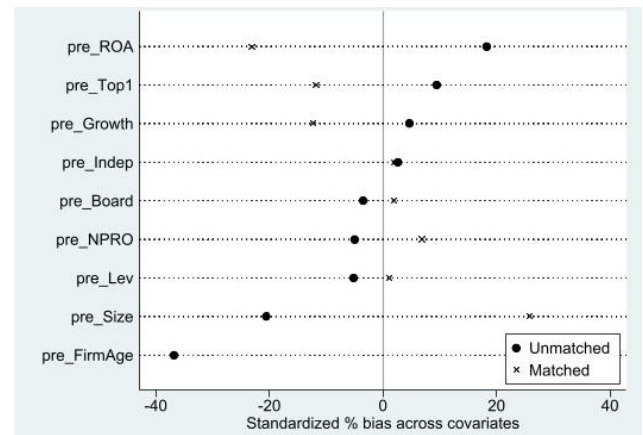


Figure 3: Kernel Density Test Plot

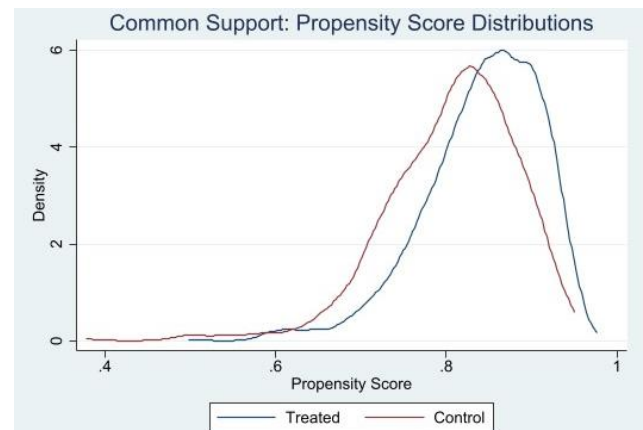


Figure 4: Nearest Neighbor Matching Common Support Graph

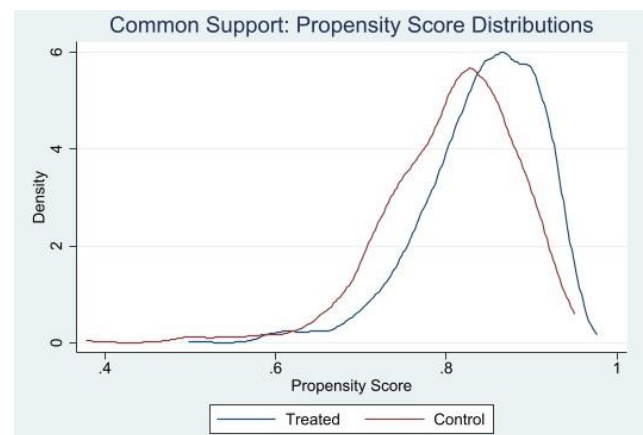


Figure 5: Common Support Plot for Kernel Matching

4.9 Mediation Effect Test

Based on the preceding assumptions, this study argues that the comprehensive pilot zone policies not only directly influence the formation of new-type productivity but also affect it by incentivizing enterprises to increase R&D, improve management efficiency, and alleviate financing constraints. Following Hayes' 2013 Bootstrap analysis framework, this study uses 5000 repeated samples and a 95% confidence interval to examine the mediating effect of trust.

4.9.1 Testing the mediating effect of innovation incentives

Analysis of the mediation effect test results presented in the table shows that the confidence interval for the direct effect of the innovation incentive mechanism is in the range of [0.00152, 0.00211], while the confidence interval for its indirect effect is in the range of [0.00323, 0.00434]. At the 95th percentile level, neither of these intervals contains a zero value. This statistical characteristic indicates that the mediation effect is significant and plays a partial mediating role. Therefore, hypothesis H2 is valid.

Table 8: Test Table of the Mediating Effect of Innovation Incentives

Effect	Observation coefficients	BootSE	Bootstrapping	
			Percentile 95%	
			Lower	Upper
Indirect effects	0.00181	0.00014	0.00152	0.00211
direct effects	0.00379	0.00028	0.00323	0.00434

4.9.2 Testing the mediating effect of digital empowerment

Analysis of the mediation effect test results presented in the figure shows that the confidence interval for the direct effect of the innovation incentive mechanism is in the range of [0.0473, 0.0590]. At the 95th percentile level, this interval does not include zero values. This statistical characteristic indicates that the mediation effect is significant and plays a partial mediating role. Therefore, hypothesis H3 is valid.

Table 9: Test Table of Mediating Effect of Digital Empowerment

effect	Observation coefficients	BootSE	Bootstrapping	
			Percentile 95%	
			Lower	Upper
Indirect effects	0.0053165	0.0002998	0.004729	0.0059041

5. Further Analysis

In addition to the shared influence mechanisms, the inherent attributes of the prefecture-level cities in the comprehensive pilot zone and the nature of enterprises also affect the formation of new quality productivity. Therefore, this paper further examines the heterogeneity of enterprises in the comprehensive pilot zone from four aspects: enterprise geographical location and ownership nature, industry level, etc.

5.1 The Impact of Geographical Location on the Implementation of Policies in Comprehensive Pilot Zones

This paper refers to the National Bureau of Statistics' classification standards for the eastern, central and western regions, divides the pilot cities into three groups, and uses a multi-period difference-in-differences model to conduct a two-way fixed effects regression analysis. The final empirical results can be seen in the table below.

Table 10: Regional Heterogeneity Test

VARIABLES	(1) Eastern region	(2) Central region	(3) Western region
DID	0.017*** (6.22)	0.015*** (6.17)	0.036*** (4.95)
Size	0.016*** (15.51)	0.014*** (12.58)	0.010*** (3.66)
Lev	-0.004	0.003	-0.022

ROA	(-0.67) 0.048*** (2.59)	(0.47) -0.029* (-1.85)	(-1.54) 0.051 (1.19)
Growth	-0.003 (-1.29)	-0.000 (-0.02)	-0.006 (-1.02)
Top1	-0.038*** (-5.47)	0.011 (1.59)	-0.035** (-1.99)
Board	0.017*** (2.72)	0.007 (1.06)	0.021 (1.25)
Indep	0.023 (1.11)	0.002 (0.08)	0.042 (0.77)
FirmAge	-0.026*** (-6.39)	-0.026*** (-8.06)	-0.024** (-2.50)
Constant	-0.200*** (-7.26)	-0.142*** (-4.62)	-0.086 (-1.42)
Observations	4,472	4,311	602
R-squared	0.239	0.204	0.405
F	51.54	32.56	6.762

The regression results show that in the eastern region, the Cross-border E-commerce Comprehensive Pilot Zone (DID) policy, a significant institutional opening-up measure, has a positive and significant impact on enterprise new productivity (NPRO), with a coefficient of 0.017 and a significance level of 1%. Meanwhile, in the central and western regions, the DID policy also has a positive and significant promoting effect on enterprise new productivity (NPRO), but the significance level for both is 1%, with impact coefficients of 0.015 and 0.036, respectively. In conclusion, the impact of the DID policy on enterprise new productivity (NPRO) varies significantly across different regions, with the strongest significance and the greatest promoting effect observed in the western region.

5.2 The Impact of Enterprise Ownership Nature on the Implementation of Policies in the Comprehensive Pilot Zone

After careful and in-depth study of relevant literature and publicly disclosed information from listed companies, this article systematically classifies listed companies based on the background of their actual controllers. Within this classification framework, companies under the actual control of the state are categorized as state-owned listed companies, while those under the actual control of non-state entities are correspondingly classified as private enterprises and foreign-invested enterprises.

Table 11: Heterogeneity Test by Enterprise Ownership Nature

VARIABLES	(1) State-owned enterprises	(2) private enterprises	(3) Foreign-invested enterprises
DID	0.017*** (6.22)	0.015*** (6.17)	0.036*** (4.95)
Size	0.016*** (15.51)	0.014*** (12.58)	0.010*** (3.66)
Lev	-0.004 (-0.67)	0.003 (0.47)	-0.022 (-1.54)
ROA	0.048*** (2.59)	-0.029* (-1.85)	0.051 (1.19)
Growth	-0.003 (-1.29)	-0.000 (-0.02)	-0.006 (-1.02)
Top1	-0.038*** (-5.47)	0.011 (1.59)	-0.035** (-1.99)
Board	0.017*** (2.72)	0.007 (1.06)	0.021 (1.25)
Indep	0.023 (1.11)	0.002 (0.08)	0.042 (0.77)
FirmAge	-0.026*** (-6.39)	-0.026*** (-8.06)	-0.024** (-2.50)
Constant	-0.200*** (-7.26)	-0.142*** (-4.62)	-0.086 (-1.42)

	(-7.26)	(-4.62)	(-1.42)
Observations	4,472	4,311	602
R-squared	0.239	0.204	0.405
r2_a	0.232	0.197	0.368
F	51.54	32.56	6.762

Empirical results show that the policies of cross-border e-commerce comprehensive pilot zones significantly promoted the improvement of new productivity in enterprises of different ownership types. Specifically, in the sample of state-owned enterprises, the estimated coefficient of the core explanatory variable DID was 0.017, and it was significant at the 1% level; in the sample of private enterprises, the DID coefficient was 0.015, also significant at the 1% level; and in the sample of foreign-invested enterprises, the DID coefficient reached 0.036, with a significance level of 1%. These results indicate that, as an important vehicle for institutional opening-up, the policy effects of cross-border e-commerce comprehensive pilot zones are not limited to specific types of enterprises, but have played a significant promoting role in enterprises of different ownership types, demonstrating strong universality.

In summary, the ownership heterogeneity analysis results indicate that cross-border e-commerce pilot zones, through institutional opening-up and the cultivation of new trade formats, have significantly promoted the new productivity of enterprises with different ownership structures. However, the intensity of this effect varies significantly at the ownership level, with foreign-invested enterprises experiencing a relatively higher degree of policy dividend release. This finding, from the perspective of enterprise heterogeneity, further verifies the important role of institutional opening-up policies in promoting high-quality development and the formation of new productivity.

6. Conclusions and Implications

This paper studies the relationship between the construction of comprehensive pilot zones and the new quality productivity of enterprises based on data of A-share listed companies from 2011 to 2022. The baseline regression shows that the policy coefficient is significantly positive, and the lagged one-period test is consistent with this direction. Bootstrap results indicate that the indirect effects of innovation incentives and digital empowerment are significantly positive.

The policy implications of this are: continuously improve customs clearance, logistics, and information services to reduce the cost for enterprises to utilize institutional conveniences; strengthen the connection between R&D services and digital platforms to promote the integration of technological achievements into production and operation; and provide services tailored to the differences in enterprises' digital capabilities and transformation conditions to help traditional and polluting industries carry out adaptive transformation. These implications do not mean that policy support should be restricted for a particular type of enterprise based on significant differences in grouping.

This study still has limitations. The conclusions drawn from the sample of listed companies should not be directly generalized to all companies; industry fixed effects cannot replace firm fixed effects in controlling for individual

invariant characteristics, and the heterogeneity of effects under phased policy implementation may also affect the estimation. Further research is needed to supplement firm fixed effects, clustering standard errors at policy assignment levels, estimations applicable to phased processing, and to verify mechanism indicators and grouping results to enhance causal explanation and reproducibility.

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