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Institutional Openness and the Technical Complexity of Corporate Exports

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Abstract. The Central Economic Work Conference in 2018 first proposed "institutional opening-up," marking a shift in China's opening-up strategy from the flow of goods and factors to institutional dimensions such as rules and regulations. The report of the 20th National Congress of the Communist Party of China reaffirmed this core pathway. At the same time, improving export technological complexity has become an inevitable choice for the high-quality development of foreign trade. As an institutional opening-up pilot platform, the Cross-border E-commerce Comprehensive Pilot Zones provide a practical carrier for institutional innovation, accumulating replicable and scalable experience through pilot reforms and strongly supporting high-level opening-up. Against this background, this paper adopts a micro-firm perspective and uses data on the establishment of Cross-border E-commerce Comprehensive Pilot Zones (2012–2023) and Chinese listed firms to empirically examine the impact of such pilot zone establishment on firms' export technological complexity. A multi-period difference-in-differences (DID) model is employed for in-depth analysis. The empirical results show that: (1) The establishment of Cross-border E-commerce Comprehensive Pilot Zones significantly promotes the improvement of firms' export technological complexity. (2) The effect of pilot zone establishment on export technological complexity varies across geographic location and industry characteristics. Compared with coastal cities, the establishment of such zones in inland cities has a significantly stronger positive effect on export technological complexity. From the perspective of industry classification, the establishment of the pilot zones has a significant positive effect on export technological complexity for capital-intensive and technology-intensive manufacturing firms, while the positive effect is not significant for labor-intensive manufacturing firms. (3) Mechanism analysis indicates that the establishment of Cross-border e-commerce pilot zones enhances firms' export technological complexity by promoting firms' innovation input, innovation output, and innovation efficiency.

Keywords: institutional opening-up, export technological complexity, innovation input, innovation output, innovation efficiency

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1. Introduction

Against the changing global economic and trade landscape and revised international rules, China has moved from "flow-based opening-up" to "institutional opening-up." This shift means opening-up now focuses less on cross-border movement of goods and production factors. More importantly, it aims to support high-quality growth and better competitiveness. It does this by improving institutional supply and raising institutional competitiveness. As China works to become a "strong trading country" from a "large trading country," firms' export technological complexity matters greatly. This term refers to the technical level and sophistication of exported products. It has become a key micro indicator. The indicator measures a country's role in global value chain division, industrial competitiveness, and ability to gain trade benefits. So a key question emerges: can institutional opening-up effectively raise firms' export technological complexity? What are the main ways it works? Do these effects differ by industry traits and regional conditions? Studying these questions helps explain the link between institutional environments and firms' export upgrades in theory. It also provides real evidence and policy ideas. These ideas support building a new open economic system with Chinese features. They help align with high-standard international trade rules, boost firms' innovation, and lift export structure quality.

Existing research has looked at specific institutional factors. These include institutional quality, trade facilitation, and intellectual property protection. The studies focus on how these factors affect firms' export size, product quality, or survival chances. But most of them see "opening-up" as a fixed macro background or a static institutional setting. However, few studies focus on China's active and systematic "institutional opening-up" policy. This policy centers on aligning rules and changing institutions. Few works confirm its direct effects and working ways on firms' export technological complexity. In fact, institutional opening-up can greatly change firms' innovation motivations and actions. It creates a stable, fair, open, and predictable business environment. This in turn affects the technical level and complexity of their exported goods. Without deep analysis of this dynamic process, we cannot fully understand key micro drivers. We also cannot grasp how to build a strong trading nation.

For these reasons, this paper takes "how institutional opening-up affects firms' export technological complexity" as its main research topic. It tries to make small but valuable contributions in three ways. First, on the research perspective: many studies focus on opening-up's effects on export size or quality. This paper differs by shifting focus to "export technological complexity." This term better reflects technical competitiveness and value chain position. It uses China's real institutional opening-up policies as quasi-natural tests. These policies include expanding pilot free trade zones, cutting the foreign investment access negative list, and carrying out high-standard free trade agreements. It also combines matched micro data from China's Industrial Enterprise Database and Customs Trade Database. The paper uses a stricter research method. This method more accurately measures the direct effect of institutional opening-up on firms' export technological complexity. Second, on mechanism research: this paper starts from firms' innovation processes. It builds a complete analysis framework of "innovation input–innovation output–innovation efficiency." It carefully checks if and how institutional opening-up influences firms' R&D choices, patent results, and innovation resource use efficiency. It does this by easing financing difficulties, boosting knowledge sharing, strengthening market competition, and improving intellectual property protection. All these help raise export technological complexity. Third, on heterogeneity analysis: this paper also checks if institutional opening-up's effects differ across groups. The groups include industries with different technical intensity, firms with different

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ownership, and regions with different institutional bases and market development levels. It aims to offer detailed real evidence for designing more targeted and precise institutional opening-up policies.

2. Literature review

From the perspective of the impact of institutional opening-up on firms' exports, most studies suggest that institutional opening-up significantly promotes firms' export scale and improves export product quality. Li Wenwen and Lang Lihua find that coordination of technical standards helps improve the quality of Chinese firms' export products [1]. Zhou Rui et al., using both provincial-level meso data and firm-level micro data, provide empirical evidence that institutional opening-up improves export product quality through the R&D promotion effect, the quality upgrading effect of imported intermediate inputs, and the reduction in trade costs [2]. Yuan Hankun and Han Minchun point out that institutional opening-up mainly achieves export quality upgrading through productivity improvement and reduced intermediate input costs. Among the five dimensions of institutional opening-up, government function transformation, trade regulation, and investment facilitation are more effective in improving export product quality [3]. Further analysis shows that the quality-enhancing effect of institutional opening-up is stronger for firms' core export products than for non-core export products. Ren Zhicheng and Chen Fengyu find that the synergistic effect of digital transformation and institutional opening-up can effectively promote improvements in export product quality [4]. Dai Xiang and Ma Haowei argue that institutional opening-up promotes export quality upgrading and efficiency improvement not only through direct mechanisms such as encouraging firm innovation and reducing institutional transaction costs, but also through an indirect mechanism via the moderating effect of industrial agglomeration [5]. In addition, the promoting effect of institutional opening-up on export quality and efficiency exhibits significant heterogeneity depending on whether firms are located in coastal regions or in Belt and Road Initiative regions.

Furthermore, regarding the impact of institutional opening-up on firms' export technological complexity, most studies indicate that institutional opening-up helps improve export technological complexity. Dai Xiang et al. argue that institutional opening-up mainly enhances export technological complexity by alleviating distortions in the allocation of production factors [6]. Ke Ming and Dai Xiang further point out that institutional opening-up optimizes factor allocation and improves export technological content through multiple channels, including R&D, imported technology, and cost reduction effects [7]. Bai Yue finds that the establishment of pilot free trade zones can effectively increase firms' export technological complexity by promoting technological innovation and easing financing constraints [8]. This study also shows that continuously improving the technological content and complexity of export products helps optimize foreign trade structure, promote industrial upgrading, and thereby achieve sustainable development in foreign trade and an overall enhancement of competitiveness.

3. Research design

3.1. Model specification

To further examine the intrinsic relationship between institutional opening-up and firms' export technological complexity, the following model is specified:

$$ESI_{it} = \alpha_0 + \beta_0 DID_{it} + \sum \gamma_k Control_{it} + \varepsilon_{it} \quad (1)$$

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where ESI , DID , $Controls$, ε respectively denote firms' export technological complexity, institutional opening-up, a set of control variables, and the error term. α_0 represents the constant term, β_0 and γ_k denote the coefficients of the variables.

3.2. Variable definitions

Regarding the dependent variable—firms' export technological complexity (ESI)—this study follows existing literature and calculates export technological complexity using the CEPII-BACI database. First, based on the export technological complexity indicator constructed from per capita income, the industry-level measure of export technological complexity is defined as follows:

$$\mathrm{ets}_j = \sum\nolimits_n \frac{x_{nj}/X_n}{\sum x_{\mathrm{nj}}/X_n} Y_n$$

where $\mathrm{ets_j}$ denotes the export technological complexity of industry j, x_{nj} denotes the export value of industry j in region n, X_n denotes the total exports of region n, and Y_n denotes the per capita GDP of region n. Considering the specificity of China's export trade, some studies adjust this model using firms' total factor productivity (TFP) to obtain firm-level export technological complexity. The specific formula is as follows:

$$ESI = \frac{tfp_i}{tfp_j} ets_j$$

where tfp_i denotes the total factor productivity of firm i, tfp_i denotes the average TFP at the industry level, and ets_j denotes the average export technological complexity of industry j.

Regarding the core explanatory variable—institutional opening-up (DID)—this study follows Huang Lijiang et al. (2025) and uses the list of Cross-border E-commerce Comprehensive Pilot Zones established in multiple batches from 2012 to 2023 (including 315 cities). If a prefecture-level city is identified as a pilot zone, treat is assigned a value of 1; otherwise, it is 0. post is a year dummy variable that equals 1 for the year of policy implementation and subsequent years in pilot regions, and 0 otherwise. DID is defined as the interaction term between treat and post.

Regarding control variables, this study selects a set of firm-level and macro-level control variables, including: (1) firm-level variables: return on assets (ROA), solvency, liquidity, board size, executive compensation, firm age, price-to-earnings ratio, and ownership concentration; (2) macro-level variables: regional industrial structure, regional economic development level, and regional financial development level.

3.3. Data sources and descriptive statistics

This study uses a sample of listed companies on the Shanghai and Shenzhen A-share markets from 2012 to 2023. After excluding ST firms, financial firms, and observations with missing data, the variables are matched accordingly. Export technological complexity data are obtained from the China Industrial Enterprise Database, Customs Database, and National Bureau of Statistics database. Data on institutional opening-up are sourced from the official website of the Chinese government.

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Firm-level and macroeconomic data are obtained from CSMAR and Wind databases, respectively. Descriptive statistics are presented in Table 1.

Table 1. Descriptive statistics of variables

VarName	Obs	Mean	SD	Min	Max
ESI	17080	10.131	1.121	6.249	14.562
DID	15654	0.631	0.483	0.000	1.000
ROA	25485	0.052	0.061	-0.163	0.171
Leverage	22908	1.172	0.564	0.630	4.947
Liquidity	25457	0.780	2.047	-5.723	8.204
Board	17692	8.331	1.646	0.000	17.000
Salary	17644	0.312	0.376	0.005	1.689
Age	25483	9.213	8.380	0.000	27.000
PE	21658	58.711	86.751	6.843	550.452
Top5	25241	0.483	0.187	0.200	0.991
Industry	25691	55.495	10.550	34.500	84.800
GDP	25691	10.775	0.748	6.565	11.818
Finance	25691	1.702	0.440	0.701	2.998

4. Empirical analysis

4.1. Baseline regression analysis

Table 2. Baseline regression results

VARIABLES	(1)	(2)	(3)	(4)
	ESI	ESI	ESI	ESI
DID	0.2744***	0.3625***	0.0986***	0.0500***
	(21.75)	(29.61)	(7.12)	(3.30)
ROA		2.8605***	2.9866***	3.1481***
		(17.99)	(17.20)	(18.16)
Leverage		0.0272**	0.0471***	0.0554***
		(2.36)	(3.76)	(4.44)
Liquidity		0.0040	0.0028	0.0019
		(1.54)	(1.08)	(0.74)
Board			0.0231***	0.0283***
			(4.13)	(5.06)
Salary			-1.0059***	-1.0225***

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Table 2. (continued)

			(-34.72)	(-35.41)
Age			0.0593***	0.0473***
			(31.97)	(21.49)
PE			-0.0008***	-0.0007***
			(-9.75)	(-9.43)
Top5			-0.1025*	-0.0676
			(-1.88)	(-1.24)
Industry				-0.0008
				(-0.43)
GDP				0.1304***
				(5.05)
Finance				0.2401***
				(6.69)
Constant term	9.9314***	9.6817***	9.8093***	8.0769***
	(427.22)	(321.43)	(152.24)	(27.76)
Number of observations	9,795	8,933	6,328	6,328
Number of firms	2,381	2,320	1,591	1,591

*Note: z-statistics are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1*

Table 2 reports the baseline regression results. Column (1) includes only the core explanatory variable, while Columns (2)–(4) sequentially add additional control variables at the firm, industry, and regional levels. The regression results in Table 2 show that, regardless of whether additional controls are included, the estimated coefficients of the core explanatory variable—institutional opening-up (DID)—remain significantly positive and pass the 1% significance level test. This initially indicates that, at the time of policy implementation, institutional opening-up significantly increases firms' export technological complexity, which is consistent with the main conclusion of this study.

In order to minimize the interference of other economic and social development factors on the regression results, Column (2) additionally controls for firm-level financial variables such as return on assets (ROA). Columns (3) and (4) further incorporate corporate governance variables and industry- and macro-level variables, respectively. From the regression results in Column (4), even after controlling for multi-dimensional factors including firm financial conditions, corporate governance, industry characteristics, and macro-financial conditions, the estimated coefficient of the core explanatory variable—institutional opening-up (DID)—remains statistically significant. This indicates that, with the implementation of Cross-border E-commerce Comprehensive Pilot Zones, firms' export technological complexity is significantly enhanced. In other words, the implementation of institutional opening-up policies has a robust and significantly positive effect on improving firms'

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export technological complexity in China, and the inclusion of a series of control variables does not alter the qualitative conclusion regarding the core explanatory variable.

4.2. Robustness analysis

4.2.1. Two-way fixed effects

Considering that the effect of institutional opening-up may be confounded by firm-level heterogeneity (e.g., firm size, historical characteristics, and managerial style) and time trends (e.g., macroeconomic cycles and global technological waves), a two-way fixed effects model is employed to control for unobservable individual and time-invariant factors. After incorporating firm and time fixed effects, the results remain significant at the 10% significance level, indicating that institutional opening-up has a marginally significant positive effect on firms' export technological complexity.

4.2.2. Replacement of the dependent variable

Besides, we replace the dependent variable here. The original variable measures firm-level export technological complexity. We use industry-level export technological complexity instead. The regression results stay positive. They are significant at the 1% level. Also, their statistical significance gets better. This shows the impact of institutional opening-up on export technological complexity does not rely on how we measure the variable.

4.2.3. Winsorization

After we winsorize extreme values, the significance of the regression coefficient rises further to the 1% level. This means outliers do not cause the core results. Also, the positive effect of institutional opening-up becomes more stable when we remove extreme data points.

4.2.4. Instrumental variable approach

This study further picks the degree of foreign direct investment (FDI) liberalization as an instrumental variable. It uses two-stage least squares (2SLS) regression to do the estimation. Table 3 Column (4) presents the results. The coefficient of institutional opening-up remains significantly positive. This confirms the improvement in export technological complexity is not driven by firms' own skills or missing variables. Instead, it reflects a real causal effect. This effect comes from a better institutional environment. Also, the instrumental variable passes two tests: the relevance test and the exogeneity test. This means the variable is valid and suitable for this study.

Table 3. Robustness analysis

VARIABLES	(1)	(2)	(3)	(4)
	Two-way Fixed Effects	Replace Dependent Variable	Winsorization	IV
DID	0.0287*	375.0317***	0.0440***	0.6573***
	(1.71)	(4.06)	(3.03)	(9.36)
ROA	3.1319***	648.4980	2.9822***	4.0744***
	(17.74)	(0.62)	(17.72)	(12.83)
Leverage	0.0660***	17.9942	0.0935***	0.0251

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Table 3. (continued)

	(5.22)	(0.24)	(5.68)	(1.02)
Liquidity	0.0019	-1.5392	0.0019	0.0140**
	(0.73)	(-0.10)	(0.79)	(1.98)
Board	0.0135**	55.8311	0.0259***	0.0912***
	(2.30)	(1.64)	(4.59)	(11.84)
Salary	-0.9151***	371.3756**	-0.9922***	-1.5242***
	(-29.05)	(2.10)	(-35.93)	(-36.73)
Age	0.0676***	131.9683***	0.0443***	0.0376***
	(3.31)	(9.47)	(21.06)	(21.17)
PE	-0.0007***	-0.7401	-0.0009***	-0.0022***
	(-8.29)	(-1.57)	(-10.61)	(-12.88)
Top5	-0.1037*	2.4206	-0.0369	0.0278
	(-1.75)	(0.01)	(-0.70)	(0.43)
Industry	-0.0088**	25.4397**	-0.0010	0.0083***
	(-2.14)	(2.23)	(-0.54)	(4.63)
GDP	0.1104	2,094.7521***	0.1145***	-0.0981***
	(0.94)	(12.78)	(4.59)	(-3.75)
Finance	0.0076	116.0441	0.2345***	-0.1530***
	(0.14)	(0.53)	(6.87)	(-2.65)
Constant term	9.1340***	-41.6568	8.2563***	10.0922***
	(7.19)	(-0.02)	(29.13)	(30.48)
Number of observations	6,328	6,338	6,328	6,327
Number of firms	1,591	1,593	1,591	/

*Note: z-statistics are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1*

4.3. Mechanism analysis

Institutional opening-up includes setting up free trade zones and cross-border e-commerce pilot zones. It also means cutting the negative list for foreign investment access. Such opening-up impacts the whole innovation process. It does so by making rules, regulations, governance and standards more international. This paper studies a key transmission path. The path is "institutional opening-up → firm innovation → export technological complexity". It looks at three innovation sides: input, output and efficiency. It uses three mediating variables. These variables are R&D input (RD), innovation output (Patent) and innovation efficiency (InnoEff). This way, it covers all core parts of firms' innovation work.

The results show that institutional opening-up has clear positive effects. The effects apply to firms' innovation input, innovation output and innovation efficiency. For Columns (1)–(2), the regression results are significant at the 1% level. This means institutional opening-up brings real policy benefits. These benefits effectively push firms to spend more on R&D. So firms raise their innovation input. Higher R&D spending further drives technical progress and product upgrades. This in turn lifts export technological complexity. Columns (3)–(4) give results significant at the 5%

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level. It shows institutional opening-up helps R&D inputs turn into patent outputs. It works by boosting technical exchange and better protecting intellectual property. More patents give stronger support to product development. They also become technical strengths in exported goods. Columns (5)–(6) pass the 1% significance test. This means institutional opening-up makes resource allocation better. It also raises how well firms use resources. Thus, firms get more value from their innovation input and improve innovation efficiency. This lets firms reach a better input-output balance when developing products.

In short, these three mechanisms together prove one point. Institutional opening-up boosts export technological complexity. It does this by driving firm innovation through a full-step transmission effect.

Table 4. Mechanism analysis

VARIABLES	(1) RD	(2) ESI	(3) Patent	(4) ESI	(5) InnoEff	(6) ESI
DID	0.0013***	0.0394***	13.1905**	0.0455***	0.0098***	0.0381***
	(3.69)	(2.71)	(2.42)	(3.11)	(5.67)	(2.62)
RD		4.0246***				
		(9.48)				
Patent				0.0000*		
				(1.65)		
InnoEff						1.2033***
						(12.04)
ROA	0.0475***	2.8101***	58.1184	3.0179***	-0.0295	3.1356***
	(10.94)	(16.59)	(0.85)	(17.78)	(-1.38)	(18.45)
Leverage	-0.0016***	0.0975***	-18.3158***	0.0902***	0.0018	0.0975***
	(-4.05)	(5.92)	(-2.87)	(5.42)	(0.88)	(5.89)
Liquidity	-0.0001**	0.0024	-3.1507***	0.0017	-0.0008***	0.0022
	(-2.24)	(0.99)	(-3.23)	(0.67)	(-2.74)	(0.89)
Board	-0.0001	0.0271***	1.5222	0.0263***	0.0010	0.0288***
	(-0.97)	(4.81)	(0.79)	(4.62)	(1.51)	(5.13)
Salary	-0.0005	-0.9965***	-28.2693***	-1.0166***	-0.0322***	-0.9474***
	(-0.71)	(-36.22)	(-3.15)	(-36.11)	(-10.50)	(-34.01)
Age	-0.0004***	0.0447***	1.1962**	0.0461***	0.0009***	0.0434***
	(-9.11)	(21.80)	(2.55)	(21.82)	(5.07)	(21.52)
PE	0.0000***	-0.0010***	0.0207	-0.0009***	-0.0000***	-0.0010***
	(2.93)	(-10.89)	(0.57)	(-10.50)	(-2.73)	(-10.84)
Top5	-0.0007	-0.0361	-48.2044***	-0.0075	-0.0175***	-0.0401
	(-0.53)	(-0.69)	(-2.83)	(-0.14)	(-2.95)	(-0.76)
Industry	0.0000	-0.0009	0.7801*	-0.0011	0.0001	-0.0009
	(0.90)	(-0.49)	(1.66)	(-0.60)	(0.76)	(-0.54)
GDP	0.0081***	0.0831***	14.1435**	0.1010***	0.0297***	0.0766***
	(13.67)	(3.39)	(2.38)	(4.05)	(13.25)	(3.20)
Finance	0.0067***	0.2156***	-18.6293	0.2232***	0.0114***	0.2348***

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Table 4. (continued)

	(8.01)	(6.33)	(-1.59)	(6.48)	(2.99)	(6.94)
Constant term	-0.0715***	8.5003***	-110.9057	8.3926***	-0.1774***	8.4068***
	(-10.57)	(30.44)	(-1.49)	(29.60)	(-6.47)	(30.50)
Number of observations	9,771	6,324	9,631	6,214	8,755	6,214
Number of firms	2,314	1,590	2,227	1,521	2,185	1,567

Note: z-statistics in parentheses, *** p<0.01, ** p<0.05, * p<0.1

4.4. Heterogeneity analysis

To further check how institutional opening-up affects firms in different industries and regions, this study sorts industries into three types. They are technology-intensive, asset-intensive and labor-intensive industries. It also divides firms by location: eastern, central and western China. The results show institutional opening-up (DID) has different effects on firms with different traits and in different regions. For industry types, the DID coefficient in technology-intensive industries is 0.0239 (t = 1.32). It has no statistical significance. The coefficient in asset-intensive industries is 0.0496 (t = 1.48). It is also not significant. But the coefficient for labor-intensive industries is 2.863 (t = 2.63). It is statistically significant. This means institutional opening-up has a clearer positive effect on export technological complexity in labor-intensive industries. For regions, the DID coefficient for eastern China is 0.0261 (t = 1.66). It is significant at the 10% level. The coefficients for central China (0.1294, t = 2.20) and western China (0.0350, t = 1.65) are not statistically significant as expected. This shows the policy effects of institutional opening-up are clearer in eastern and central regions. The effect in western regions may not be fully seen yet. This may be due to differences in institutional bases or policy implementation results. In short, the effects of institutional opening-up are more obvious in labor-intensive industries and in eastern and central regions. This reflects that industry traits and regional development levels can adjust how well the policy works.

Table 5. Heterogeneity analysis

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Technology-intensive	Asset-intensive	Labor-intensive	Eastern	Central	Western
DID	0.0239	0.0496	0.0879***	0.0261*	0.1294**	0.0350
	(1.32)	(1.48)	(2.63)	(1.66)	(2.20)	(0.65)
ROA	3.7781***	2.1112***	1.5876***	3.1989***	1.5612**	2.1706***
	(17.57)	(5.90)	(3.95)	(17.77)	(2.44)	(3.26)
Leverage	0.0775***	0.0594	0.1325***	0.0903***	0.1540***	0.0452
	(3.73)	(1.51)	(3.59)	(4.88)	(2.92)	(0.84)
Liquidity	0.0045	-0.0065	0.0038	0.0037	-0.0150*	0.0043
	(1.49)	(-1.13)	(0.65)	(1.42)	(-1.67)	(0.44)
Board	0.0308***	0.0102	0.0272*	0.0247***	0.0144	0.0783***

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Table 5. (continued)

	(4.57)	(0.76)	(1.80)	(4.14)	(0.61)	(3.43)
Salary	-0.9599***	-0.9332***	-1.2818***	-1.0045***	-0.7353***	-1.1194***
	(-29.28)	(-14.23)	(-15.51)	(-34.58)	(-5.99)	(-9.38)
Age	0.0513***	0.0414***	0.0306***	0.0419***	0.0486***	0.0346***
	(19.53)	(9.06)	(6.34)	(16.76)	(6.42)	(3.77)
PE	-0.0008***	-0.0005**	-0.0012***	-0.0009***	-0.0017***	-0.0004
	(-7.78)	(-2.24)	(-5.97)	(-9.15)	(-5.60)	(-1.51)
Top5	-0.0575	0.2085**	-0.0856	-0.1195**	0.8505***	-0.0745
	(-0.84)	(1.97)	(-0.67)	(-2.14)	(4.18)	(-0.33)
Industry	0.0011	-0.0068	-0.0022	0.0028	-0.0187**	-0.0318***
	(0.50)	(-1.49)	(-0.50)	(1.39)	(-2.27)	(-3.80)
GDP	0.1476***	0.0364	0.0608	0.1520***	0.4279***	0.3003**
	(4.86)	(0.64)	(1.00)	(5.05)	(3.90)	(2.53)
Finance	0.2183***	0.1878**	0.1923**	0.2445***	-0.1079	0.9587***
	(5.36)	(2.10)	(2.25)	(6.70)	(-0.81)	(4.71)
Constant term	7.7857***	9.5251***	8.9080***	7.6558***	6.0699***	6.7755***
	(22.00)	(15.48)	(13.34)	(21.35)	(6.14)	(6.18)
Number of observations	4,110	1,030	1,179	5,366	567	395
Number of firms	1,051	254	305	1,335	151	110

Note: z-statistics in parentheses, *** p<0.01, ** p<0.05, * p<0.1

5. Conclusion

Based on China's institutional opening-up and comprehensive pilot zone policies, this study uses A-share data from 2012 to 2023. It also applies a multi-period DID model to test the link between institutional opening-up and firms' export technological complexity. The main findings are as follows:

First, institutional opening-up clearly helps raise firms' export technological complexity. Empirical results show the core explanatory variable stays significantly positive. The variable is the DID policy dummy for pilot zones. This holds after controlling for many factors. These factors include firms' financial status, corporate governance, industry traits and the macro environment. Comprehensive pilot zones build trade rules that match international standards. They simplify

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regulatory steps and offer efficient customs services. These zones create a stable, fair and transparent business setting. This encourages firms to export products with higher technical content. This result provides strong micro-level evidence. It supports the key idea that institutional opening-up drives high-quality development and high-level opening-up.

Second, institutional opening-up affects export technological complexity through the whole innovation process. Mechanism tests cover innovation input, output and efficiency. They show institutional opening-up brings clear positive effects. These effects come from a better market environment, faster knowledge sharing and better use of production factors. Together, these effects fully boost firms' innovation ability. This in turn lifts their export technological complexity.

Third, institutional opening-up's positive effects differ greatly across cases. For industries, policy benefits are not shared equally. Results show institutional opening-up most strongly improves export technological complexity in labor-intensive manufacturing firms. Its direct effects on capital-intensive and technology-intensive firms are not significant. This reveals a key point. Institutional opening-up first gives institutional support to some industries. These industries, like labor-intensive manufacturing, have long faced institutional barriers. The policy removes obstacles that block their access to global markets, advanced tech and knowledge sharing. It also improves their production processes. So these firms can quickly catch up in technology and upgrade processes. They gain the biggest improvement in export technological complexity. Capital-intensive and technology-intensive firms start with higher tech levels and stronger innovation skills. For them, institutional opening-up mainly improves the innovation environment and market platform. Their progress depends more on long-term internal R&D growth. So policy effects are more indirect, long-term and not linear in the short term.

For regions, institutional opening-up has clearer effects in eastern and central China. It has no significant effect in western China. This means policy success depends heavily on local economic bases. It also depends on market development, infrastructure and human capital. Eastern China has a long history of opening-up. It has a mature industrial system and high marketization. It can better take and use benefits from institutional innovation. Central China shows strong growth. This comes from industrial relocation and policy spillovers. Western China has weaker location strengths and industrial bases. It may need more time to adjust. It may also need more targeted industrial support and infrastructure investment. Only then can it fully gain benefits from institutional opening-up.

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