

Influence in International Standardization and Patent Citations: Evidence of China's Ascension to ISO Standing Committee Membership

Yiming Qin

*School of Economics, Minzu University of China, Beijing, China
gilbert0225@qq.com*

Abstract. Standardization is a core part of China's institutional opening-up. Participation in international standard-setting helps enhance the global influence of domestic technologies. Using city-level panel data from 2004 to 2017 and a difference-in-differences framework based on China's 2008 accession to the ISO Executive Board, this study investigates how international standard-setting power affects urban patent citations. Results show that greater influence significantly boosts patent international impact, raising citations by 4.67% on average. Benefits concentrate in developed and densely populated cities, with limited effects in resource-based and old industrial cities. FDI and overseas talent serve as key transmission channels. This paper reveals the micro mechanisms through which institutional openness drives innovation, offering empirical implications for China's standardization strategy and high-level opening-up.

Keywords: standard, patent citations, institutional opening-up, DID

1. Introduction

Standards are an essential pillar of institutional openness and modern industry; they serve as inputs and output to innovative accumulation at the same time [1]. Nowadays, economic competition has shifted from a contest over products and technologies to standards. Since it has entered into the WTO, China has witnessed steady industrial expansion [2], and there is a fantastic growth of its trade volume [3], yet still has completely insufficient power for a small role in defining international standards [4]. A series of recent policies attach great importance to institutional opening-up and strive to align domestic laws, regulations and standards with prevailing international rules.

Proactively participating in and leading the formulation of international standards can eliminate differentiated technical trade barriers across countries [5], advance high-standard opening-up, and foster new competitive strengths. The globalization of standards facilitates cross-border knowledge flows and the diffusion of cutting-edge technologies and professional know-how [6], thereby deepening exchanges of advanced technologies. The year 2008 marked a pivotal turning point, when China officially became a permanent member of the International Organization for Standardization (ISO). This represented a historic transformation of China's role: shifting from passively complying with international rules to actively engaging in rule-making, and accelerating the integration of

Chinese standards into global standard systems. Nevertheless, existing literature rarely explores how a country's discourse power in international standard-setting shapes the global recognition of its indigenous technologies. Has China's rising status within the ISO extended the international influence of its domestic patents? Addressing this question can uncover the internal logic through which institutional opening-up empowers technological innovation.

To identify this policy effect, this paper treats China's accession to the ISO Executive Board in 2008 as a quasi-natural experiment. Using city-level panel data of China from 2004 to 2017, we employ a difference-in-differences (DID) model to empirically test the causal effect of standard-setting discourse power on city-level patent citations. We control for city fixed effects and year fixed effects, and divide the treatment group and control group based on each city's trade dependence prior to policy implementation. Meanwhile, robustness tests, heterogeneity tests, mechanism tests and an intensive DID design are conducted to verify the reliability of baseline regression results.

This paper makes three major theoretical contributions, as outlined below: First, existing literature merely concentrates on the certification and reputation effects of standards themselves. Breaking through this limitation, this study broadens the research frontier of standards and innovation. Taking China's official acquisition of permanent membership in the International Organization for Standardization (ISO) in 2008 as an exogenous shock, this paper identifies the causal effect of institutional influence in international standard-setting on patent citations, and provides empirical evidence on how institutional opening-up drives technological innovation.

Second, this research enriches studies concerning institutional opening-up. Most existing literature in this field proceeds from the perspective of international trade and focuses on trade and industrial policies[7, 8]. This paper uncovers the transmission channel through which discourse power over standard-setting raises the international visibility and reputation of indigenous technologies, filling the relevant research gap.

Third, prior studies generally overlook the role of international standard recognition [4]. By contrast, patent citations can reflect innovation quality and avoid data distortion caused by patent bubbles[9, 10]. This paper incorporates discourse power in international standard-setting into the analytical framework of patent citations, elaborates the internal mechanism through which international institutional recognition boosts the global recognition of indigenous technologies, and further improves the research system on determinants of patent citations.

2. Literature review and theoretical hypotheses

Competition over standard-setting authority has emerged as a critical frontier in global economic governance. From the perspective of international political economy, scholars argue that the contest over technical standards extends far beyond mere technical coordination, functioning instead as a strategic arena for geopolitical maneuvering and the balancing of national interests. Consequently, securing the initiative in international standard-setting is recognized not merely as a technical choice but as a strategic imperative for global competitiveness.

There is also a closely related body of literature that examines the relationship between standardization and knowledge diffusion. By adopting a dynamic DID approach, Neuhäusler and Blind show that ISO standards dramatically increase the diffusion of scientific knowledge [11]. The mechanism for this is that adoption by an international standard adds authority and credibility to a technology, which in turn attracts more research and citations. In a similar vein, Sun shows that domestically led international standards increase the export competitiveness of firms by shifting international product demand and reducing technical coordination costs [12]. Moreover, a patent that is a standard-essential patent suddenly increases in its value, reflected mostly by an increase in

citations [13], yielding direct evidence that standards are a powerful catalyst for knowledge diffusion.

Another strand of research explores the innovation effects of openness. Recent studies document that the adoption of standards improves enterprise productivity [14] and increase asymmetric innovation [15]. However, little work has been done concerning trade and investment rules or passive adoption of standards. Specifically, not much attention has been paid to the institutional part where actively taking part in international standard-setting, which can increase a country's institutional influence and then affect innovation results.

In sum, although there is significant literature on the technical and regulatory role of standards themselves, there is little insight into how participating in standard-level matters about institutional influence. By using China' 2008 accession to the ISO as a quasi-natural experiment, this study identifies the enhancement of such institutional influence as an exogenous shock. By analysing how this elevated institutional influence drives innovation, I provide novel micro-level evidence for the innovation effects of institutional opening-up.

3. Research design

This study examines 246 prefecture-level and higher-tier cities in China, covering the period from 2004 to 2017. The starting year of the sample was set as 2004 because the SARS outbreak had a significant short-term impact on Chinese firms' exports [16]; commencing in 2004 helps to minimize the influence of SARS on the identification in this study. The end year of the sample period is set as 2017 to avoid potential interference with the estimation results from other major policies implemented after 2017, such as the US-China trade friction in 2018 and institutional reforms. Existing research indicates that trade friction adversely affects breakthrough innovation in developing countries by reducing the flow of knowledge across borders [17]. The reform of the Intellectual Property Court, launched in 2014, significantly improved the quantity and quality of urban invention patents [18]; the reform enhanced export quality by reducing administrative intervention and promoting factor mobility and industrial agglomeration [19].

Appendix Table A presents the descriptive statistics for the main variables in this study. The dependent variable, the logarithm of the number of cited patents, has a mean of 8.38 and a standard deviation of 1.880; after taking the logarithm, the distribution is relatively concentrated. The ranges of values for each variable are reasonable, and no obvious outliers were found. The distributions of the other control variables are all within reasonable ranges.

4. Baseline model

4.1. Model specification

To identify the causal effect of increased influence in international standards on the citation of a city's patents, this paper employs the DID method for estimation. The model is constructed:

$$\ln(\text{Citation}_{ct}) = \alpha_0 + \alpha_1 \text{DID}_{ct} + \beta X_{ct} + \mu_c + \lambda_t + \varepsilon_{ct}$$

where the subscript c denotes the city and t denotes the year. The dependent variable $\ln(\text{Citation}_{ct})$ is the logarithm of the number of patent citations for city c in year t , used to address the skewed distribution of the original data. I constructs the binary explanatory variable

$DID_{ct} = Treat_c \times Post_t$, where $Treat_c$ serves as the treatment group variable. In the intensive DID specification, trade dependency is used, whilst in the classic DID specification, a binary variable is employed, defined as follows: if a city's trade dependency in 2007 exceeds the mean for that year, the value is 1; otherwise, it is 0. $Post_t$ is the policy time dummy variable, taking the value 1 for 2008 and subsequent years, and 0 otherwise. X_{ct} is a set of city-level control variables, including the proportion of the workforce employed in the wholesale and retail trade sector, economic development level, industrial structure, level of informatisation, and population size. μ_c and λ_t represent city fixed effects and year fixed effects, respectively, whilst ε_{ct} is the error term; standard errors are clustered at the city level to mitigate potential serial correlation issues.

Given that trade dependency is a continuous variable, and to make better use of the differences in the extent to which different cities are affected by the policy while avoiding the subjectivity of artificially dividing treatment groups, the preferred model in this study is the intensity DID model. This replaces the binary treatment group variable used in traditional DID with the continuous value of a city's trade dependency in 2007, defining the interaction term as $Trade\ dep_{c,2007} \times Post_t$, where $Trade\ dep_{c,2007}$ represents the ratio of the city's total foreign trade to GDP in 2007; it measures the intensity of the impact of enhanced international standard-setting influence on each city. For both the traditional- and intensity DID, the core coefficient of interest is α_1 . If significantly positive, this indicates that China's accession to the ISO Executive Board increased the level of patent citations.

4.2. Results of the baseline regression

4.2.1. Standard DID for the treatment group based on trade dependence in 2007

Table 1 reports the estimation results of the baseline regression. In column (1), the coefficient for $High\ dependence \times Post$ is 0.163, which is significantly positive at the 1% level; in column (3), after including control variables, the coefficient is 0.246, which remains significant at the 1% level. It suggests that, compared with the control group cities, cities in the treatment group saw an average increase of approximately 24.6% in patent citations following their election as permanent members of the ISO in 2008, which is of significant economic importance.

Table 1. Baseline results

	(1)	(2)	(3)	(4)	(5)	(6)
High dependence $\times$ Post	0.163*** (0.040)		0.246*** (0.041)			
Trade dep. $\times$ Post		0.284*** (0.056)		0.355*** (0.061)		
Coastal cities $\times$ Post					0.086** (0.042)	
Dist. to coastline $\times$ Post						-0.023*** (0.005)
trade employees(%)			0.203	-0.404	-0.203	0.005

Table 1. (continued)

			(1.125)	(1.177)	(1.188)	(1.180)
LogGDPpa			0.356***	0.357***	0.300***	0.290***
			(0.073)	(0.072)	(0.074)	(0.072)
Industrial structure			-0.376***	-0.379***	-0.361***	-0.392***
			(0.059)	(0.058)	(0.059)	(0.059)
LogInternet			0.087***	0.092***	0.080***	0.079***
			(0.023)	(0.023)	(0.023)	(0.023)
LogPop			1.632***	1.599***	1.727***	1.724***
			(0.222)	(0.222)	(0.222)	(0.221)
Constant	8.346***	8.332***	-5.836***	-5.723***	-5.725***	-5.487***
	(0.010)	(0.011)	(1.582)	(1.589)	(1.600)	(1.569)
City FE and Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	3444	3444	3177	3177	3177	3177
R-squared	0.950	0.951	0.956	0.956	0.955	0.956

Note: The dependent variable is ln(citation); Robust standard errors are reported; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

4.2.2. Strength of DID measured by the continuous value of trade dependence

In Column (2), the coefficient is 0.284 (significant at 1%); in Column (5), after controlling for covariates, the coefficient is 0.355 and remains significantly positive. This indicates that cities with higher trade dependency experience greater patent citation growth post-policy, consistent with standard DID findings. Notably, the coefficient has significant economic significance: it measures the average increase in log(citation) increase in 2007 trade dependency. After China's 2008 ISO permanent membership, a one-standard-deviation increase in trade dependency raised about 12.8% patent citations. With the mean of log(citation) at 8.38 in my sample, the marginal increase accounts for 42.6% of the mean. In Columns (3) and (6), I used coastal cities and the distance to coast as alternative treatment groups. Results show significantly positive effects for coastal cities and significantly negative coefficients for distance to coast, consistent with my main findings. These confirm that enhanced international standard influence boosts patent international impact.

The above confirms that China's ISO membership significantly increased international patent citations in high-trade-dependency cities. Theoretically, by aligning domestic technical regulations with international standards, enhanced standard influence lowers the compatibility costs and technical barriers to adopting Chinese technologies. Treatment group cities, with their deeper links to international markets, thus fully captured these institutional benefits.

4.3. Parallel trends assumption

A key prerequisite for the validity of the difference-in-differences (DID) method is that the treatment and control groups exhibit parallel trends before policy implementation. To verify this assumption, an event study approach is adopted to construct the following model:

$$\ln(\text{Citation}_{ct}) = \gamma_0 + \sum_{k=-4}^{-2} \gamma_k D_{ct}^k + \gamma_0 \cdot \text{Current}_{ct} + \sum_{k=1}^8 \gamma_k D_{ct}^k + \beta X_{ct} + \mu_c + \lambda_t + \varepsilon_{ct}$$

where D_{ct}^k denotes dummy variables for the interaction between the treatment group and year k . Taking 2008 as the policy year ($k=0$), the policy period ($k=0$), and 8 post-policy periods ($k=1, \dots, 8$). To avoid perfect multicollinearity, the first pre- period ($k=-1$) is set as the baseline and omitted. The coefficient γ_k measures the change in the patent citation gap between the treatment and control groups in the year k relative to the baseline. This study anticipates that, if the parallel trends assumption holds, the coefficients for pre- period γ_k ($k=0$) will all be insignificant; while post-policy coefficients should gradually become significantly positive.

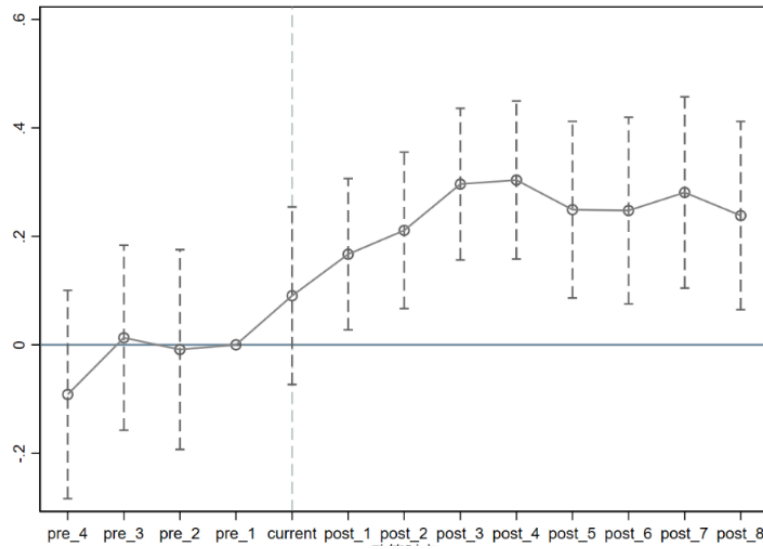


Figure 1. Dynamic effects

Figure 1 plots the coefficients and their 95% CI. Before the policy, although there was a citation gap between the two groups, they were not different from zero. All pre-policy coefficients are insignificant, indicating the parallel trends assumption holds. Post-policy coefficients gradually increase and become significantly positive, validating DID estimation validity, strengthening the policy effect's causal interpretation, and providing reliable support for the baseline results.

4.4. Instrumental variables method

To address potential endogeneity, this study adopts an instrumental variable approach. Following Lu [20] and Peng [21], I use a city's distance to the coastline as the instrument for the policy variable. This variable meets the relevance condition, as cities closer to the coast tend to have higher trade dependency and stronger policy treatment intensity. As a fixed geographical endowment, it also satisfies exogeneity, as it hardly affects patent citations through channels other than international exchange. Specifically, the interaction $\text{Dist. to coastline} \times \text{Post}$ serves as the instrument, with two-stage least squares applied to both standard and intensity DID models.

Table 2. Instrumental variable results

	(1)	(2)
	ln(citation)	ln(citation)
High dependence × Post	0.990*** (0.217)	
Trade dep. × Post		0.986*** (0.201)
Control	Yes	Yes
City FE and Year FE	Yes	Yes
Obs.	3177	3177
Kleibergen-Paap F	16.888	46.848

Note: The distance to coastline used as IV. Robust standard errors are reported; * p < 0.10, ** p < 0.05, *** p < 0.01.

Table 2 reports the IV results. Column (1) uses the binary variable of the standard DID as the endogenous variable, whilst Column (2) uses the continuous variable of the intensity DID as the endogenous variable. The results of the first stage indicate that the instrumental variable is highly correlated with the endogenous variable; the Kleibergen-Paap F-statistic are both exceeding 10, thereby diminished the concern of weak IV. The results of the second-stage estimation show that the coefficient for the standard DID, following the application of the instrumental variable method, is 0.990, whilst the coefficient for the intensity DID, estimated using instrumental variables, is 0.986; both are significantly positive at the 1% level. Compared with the baseline results, the coefficients estimated using instrumental variables are higher. This may be because the IV identify the LATE between coastal and inland cities, reflecting the heterogeneity in policy effects arising from differences in geographical endowments.

5. Mechanism testing

As discussed in the baseline model, an increase in international standard-setting influence significantly promotes patent citations in cities with high trade dependence. This section further examines the channels through which this effect operates.

5.1. Analysis of mediating mechanisms

Firstly, I examines the mediating mechanisms through which increased influence in international standards affects patent citations. From the perspectives of talent mobility, institutional protection regime and capital flows, this paper considers three potential mediating variables: talent intensity, IPR and FDIFirm. Following Jiang [22], I constructs the following regression model:

$$M_{ct} = \theta_0 + \theta_1 \text{Trade dep.} \times \text{Post}_{ct} + \beta X_{ct} + \mu_c + \lambda_t + \varepsilon_{ct}$$

Table 3 introduces the mechanism of my baseline results. The coefficient on talent intensity, as shown in Column (1), is significant at 5% level, indicating that enhanced standard-setting boosts local talent attraction. I also find a pronounced improvement in the city's intellectual property protection (shown in Column 2). Additionally, as shown in Column (3), the more complete the standard setting, the stronger the agglomeration effect of FDI Firm, and this result is significant at the 10% significance level. Taken together, these results corroborate that obtaining a voice in international standard-setting may help cities raise more talent, IPR, and foreign investment.

Table 3. Mediation mechanisms

	(1)	(2)	(3)
	Talent intensity	IPR	Foreign investment
Trade dep. $\times$ Post	0.009** (0.004)	0.113*** (0.036)	0.109* (0.064)
Control	Yes	Yes	Yes
City FE and Year FE	Yes	Yes	Yes
Obs.	2813	3,177	3029
R-squared	0.330	0.469	0.814

Note: Control variables are consistent with baseline model. I report robust standard errors, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

5.2. Analysis of moderating effects

To examine the heterogeneous impacts of the policy across cities with different characteristics, this paper adds interaction terms between the policy variable and city-level resource endowment variables to the baseline model:

$$\ln(\text{Citation}_{ct}) = \phi_0 + \phi_1 \text{Trade dep.} \times \text{Post}_{ct} + \phi_2 M_{ct} + \phi_3 \text{Trade dep.} \times \text{Post}_{ct} \times M_{ct} + \beta X_{ct} + \mu_c + \lambda_t + \varepsilon_{ct}$$

The variables in the formula correspond respectively to FDI Firm (the count of foreign-invested enterprises), LogInflow (it is the logarithmic value of FDI Inflows), Organization (the number of entities participating in international organizations processed via inverse hyperbolic sine transformation), and LogIndFirm (the logarithmic value of industrial enterprises).

In this subsection, the core coefficient is the interaction term, which quantifies the moderating effect of city characteristics on policy impacts. Table 4 reports the corresponding regression results. Across all model specifications, the coefficients of every interaction term are negative and statistically significant. For instance, when Trade dep. $\times$ Post interacts with FDI Firm stands at -0.074, with 1% significance in statistics (Column 1). Similarly, the coefficient for the interaction between Trade dep. $\times$ Post and LogIndFirm equals -0.104.

Table 4. Moderation effects

	(1)	(2)	(3)	(4)
	FDIFirm	LogInflow	Organization	LogIndFirm
Trade dep. $\times$ Post $\times$ M	-0.074*** (0.026)	-0.100*** (0.035)	-0.154*** (0.029)	-0.104** (0.041)
lower-order term	Yes	Yes	Yes	Yes
Control	Yes	Yes	Yes	Yes
City FE and Year FE	Yes	Yes	Yes	Yes
Obs.	3029	3105	3177	3176
R-squared	0.962	0.962	0.960	0.961

Note: All specifications include the lower-order terms; their coefficients are not reported for brevity. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

From an economic interpretation perspective, a negative interaction coefficient does not imply the policy exerts no influence in cities with superior resource endowments. Instead, it indicates policy effects feature diminishing marginal returns and a convergence trend. In the appendix, I also use raw citation volumes to validate this conclusion: developed cities with abundant foreign capital and sound industrial bases still achieve larger absolute gains in patent citations. However, such cities already possess a high baseline level of internationalization, so the marginal improvement brought by the policy is naturally weaker. In contrast, cities with fewer foreign firms, lower foreign capital stock and weaker industrial foundations exhibit far stronger marginal growth in patent citation volumes.

To conclude, this paper documents two main findings. First, greater influence in international standard-setting fosters local innovation by attracting talent, enhancing IPR, and drawing foreign-invested firms. Second, heterogeneity analysis uncovers a convergence pattern: while cities with stronger initial endowments achieve larger absolute gains in patent citations, those with weaker foundations experience higher marginal benefits. This suggests that participating in international standardization can serve as a catch-up mechanism for less-developed cities, helping to narrow the innovation gap across regions.

6. Conclusions

Treating China's accession to the ISO Executive Board in 2008 as a quasi-natural experiment, this study deploys a difference-in-differences framework, alongside city-level panel data spanning 2004-2017 to probe how power in international standard setting conditions the global reach of domestic technologies.

What emerges from the estimates is fairly clear: the acquisition of standard-setting influence significantly increases patent citations, with treated cities registering citation gains 35.5% higher than those observed in the control group. Regression results from the intensive DID specification support the above findings. Cities with higher pre-policy trade dependence also recorded larger growth in patent citations. Heterogeneity analyses confirm a convergence pattern: the policy boosts patent citations in all sampled cities, with substantially stronger marginal effects observed in low-GDP, lower-tier, non-resource-based and non-old-industrial cities. Consistent with the theoretical

logic of diminishing marginal returns, the moderation test generates consistent results. Developed cities still reap greater absolute gains, whereas regions with a lower initial stock of FDI Firm exhibit stronger marginal growth momentum.

In a word, this paper provides novel causal evidence that participating in international standard-setting can raise the global recognition of indigenous technologies. The convergence effect identified here also suggests that such participation can serve as a catch-up mechanism for less-developed regions, bearing implications for the design of coordinated regional innovation policies.

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