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Technology Import and China's Innovation Capability: Does Institutional Quality Matter?

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Abstract: With the rapid growth of China's economy, technology import plays a crucial role in enhancing regional innovation capability. Based on inter-provincial panel data from 2007 to 2016, this paper uses three benchmark linear regression models of Ordinary Least Squares (OLS), Difference-Generalized Method of Moments (DIFF-GMM), and System-Generalized Method of Moments (SYS-GMM) to explore the improvement of China's regional innovation capability by technology import. Then, the regional institutional quality level is measured from the three dimensions of politics, economy, and law, and the two-step difference GMM threshold panel model is used to analyze the effect of technology import on regional innovation capability under different institutional quality conditions. The results show that: (1) In the benchmark linear regression model, technology import has a significant role in promoting regional innovation capability. (2) With the rise of regional corruption, the quality of political institution declines, and the promotion effect of technology import on regional innovation ability is weakened. (3) The improvement of the marketization level and intellectual property protection level strengthen the role of technology introduction in promoting regional innovation capability. On the contrary, in regions with low economic and legal institutional quality, technology import has no significant impact on regional innovation capability.
***Keywords*:** technology import, institutional quality, regional innovation capability, GMM threshold model, China

1. Introduction

In the context of China's economic development entering the "new normal" phase, the driving force of regional innovation has shifted from being driven by resource elements to being driven by technological innovation[1]. The report of the 19th National Congress of the Communist Party of China has repeatedly emphasized that technological innovation plays an essential role in enhancing the development of regional innovation capability in China[2]. Although most regions in China have strong momentum in encouraging and developing technological innovation capability, due to the late implementation of the technological innovation strategy, the technological level is still at the bottom of the vertical division of labor in the global value chain[3]. This has led to adverse problems such as low efficiency of technological innovation and weak original innovation capability[4]. Technology import is an essential source of technological innovation, and its development model and role have an essential impact on the improvement of regional innovation capability[5]. The key to whether technology imports can play its role smoothly and effectively lies in the impact of the exogenous institutional environment[6]. Especially under the conditions of an open economy, multinational companies need to coordinate production and transaction links, if transaction costs are too high and transaction risks are difficult to control, it will inevitably hinder the successful introduction of foreign high-tech products and advanced technologies[7]. Therefore, how to construct a regional institutional quality environment with coordinated development of politics, economy, and law, so as to maximize the promotion of technological innovation by technology import, has become an important issue for the development of regional innovation capability in China.

The research results of scholars on the regional innovation capability of technology import are mainly concentrated in four aspects: "technology imitation and regional innovation", "technology complementary and regional innovation", "technical substitution and regional innovation", "technology absorption and regional innovation". Chuang[8] pointed out that the introduction of advanced foreign technologies in underdeveloped regions can enrich their technology resource base, increase the stock and diversity of technologies in the region through imitation, and indirectly promote the improvement

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of innovation capability in the region. Some scholars agree that the introduction of foreign advanced technologies and local related technologies have formed complementary development, bringing about a virtuous circle of "introduction-innovation-re-introduction-re-innovation", thereby promoting the growth of regional innovation capability[9]. The increase in technological proprietary or profitability can stimulate the input of production factors required for innovation, stimulate the enthusiasm of innovation subjects for research and development (R&D), and improve the prior incentives for innovation[10]. Li[11] used panel data from 21 high-tech industry sectors in China from 1995 to 2004 to study the impact of corporate R&D investment, foreign technology import, and purchase of domestic technology on innovation capability. The results showed that the introduction of foreign advanced technology has significantly promoted the improvement of the innovation capability of Chinese enterprises. Fracasso[12] took 24 OECD member countries from 1971 to 2004 as the research object, using the panel smooth transition regression model (PSTR) to verify that international technology spillovers can effectively promote the improvement of total factor productivity.

However, some scholars emphasized that if a region invests capital in technology import, then the local region's investment in independent research and development will be relatively reduced. The increased investment in technology import will have a "crowding-out effect" on independent innovation activities, which is not conducive to regional innovation. Laursen and Salter[13] used the data of 2707 manufacturing companies in the United Kingdom and found that companies spending a lot of time and money in seeking external technological innovation will inhibit the growth of independent innovation capability. Quan[14] studied the impact of technology import on independent innovation from the perspectives of "production effect", "diffusion effect" and "learning effect", and found that when the "diffusion effect" is smaller than the "production effect", the introduction of technology is negatively related to the ability of independent innovation. Liu and Hu[15] used the data of large and medium-sized industrial enterprises in 30 provinces in China from 1997 to 2010 to study the relationship between the introduction of foreign technology and the growth of local innovation. They found that the introduction of foreign technology has an impact on the innovation of local enterprises. The capability growth has a significant "innovative substitution" rather than an "innovation complementary" effect. Hu[16] found that technology transfer affects industry innovation efficiency through interaction with domestic R&D, and domestic R&D capabilities play a vital role in absorbing external technology. Hagedoorn and Wang's[17] research show that the effect of external R&D on the company's innovation output depends on its situation. When the level of internal R&D investment is high, internal R&D and external R&D have complementary effects. When the level of internal R&D is low, the two can substitute for each other. Besides, some scholars, starting from the absorptive capacity of technology import, believe that advanced foreign technologies are explicit technological knowledge. The key is that developing countries need to transform the imported technologies before they can successfully absorb them. Whether developing countries can absorb the technology of developed countries and realize imitation innovation and independent innovation depends on their own technology absorption capacity.

In summary, the analysis of existing research results shows that: First, most of the existing literature makes research and judgments on whether technology import will promote regional innovation capability from the role of technology and development methods while ignoring the impact of technology import in different exogenous institutional environments. Next, the research on the difference in the improvement of regional innovation capability. The second is that most research methods are limited to the static level, and potential endogenous problems will cause the fixed effects model (FE) estimation to be biased, which reduces the applicability of the traditional static threshold model. It is impossible to test the validity of instrumental variable selection and the correlation of residual series. In terms of the nature of the research method, it is still a static threshold analysis. In view of this, this paper uses the provincial panel data from 2007 to 2016 to establish a regional innovation capability model, and selects the quality of the institution as the evaluation standard of the exogenous institutional environment, and then divides the quality of the institution into the quality of the political institution, the quality of the economic institution, and the quality of the legal institution. In this way, we construct a two-step differential GMM threshold panel model for institutional quality and empirically examine the differences in the impact of technology import on the improvement of China's regional innovation capability under different institutional quality.

2. Methodology and data

2.1 Construction of regional innovation capability model

First, the innovation is actually the ability of a new knowledge output. Based on the Griliches-Jaffe knowledge production function, this paper constructs a new knowledge production function model reflecting innovation capabilities:

$$Y_i = \varphi \, \mathrm{Re}search_i^{\beta_1} Other_i^{\beta_2} \varepsilon \quad (1)$$

In formula (1), Y is the regional innovation ability, the *research* represents the R&D input variable, and the *other* represents other variables that affect the regional innovation ability. β_1 versus β_2 representing the elasticity coefficient of regional innovation capability brought by R&D and non-R&D investment, respectively. ε represents a random error term.

Secondly, R&D investment usually includes R&D capital investment and R&D labor input and further transforms formula (1) into:

$$Y_i = \varphi K_i^{\beta_1} L_i^{\beta_2} Other_i^{\beta_3} \varepsilon \quad (2)$$

Thirdly, according to the open innovation theory, the improvement of regional innovation capabilities is not only affected by the investment in R&D funds and R&D personnel, but also the effect of non-R&D investment. Therefore, this paper selects indicators such as technology introduction, human capital and foreign direct investment, and constructs the measurement model as follows:

$$Create_{it} = \alpha RD_{it}^{\beta_1} RDP_{it}^{\beta_2} Cti_{it}^{\beta_3} Hum_{it}^{\beta_4} FDI_{it}^{\beta_5} \varepsilon \quad (3)$$

In formula (3), Create represents regional innovation capability, *RD* represents R&D investment, *RDP* represents R&D labor input, *Cti* represents technology introduction, Hum represents human capital stock, and *FDI* represents foreign direct investment. The legitimization of formula (3) results in the following empirical model:

$$\ln Create_{it} = \beta_0 + \beta_1 \ln RD_{it} + \beta_2 \ln RDP_{it} + \beta_3 \ln Cti_{it} + \beta_4 \ln Hum_{it} + \beta_5 \ln FDI_{it} + \alpha_i + \varepsilon_{it} \quad (4)$$

Finally, considering that the current regional innovation capability will be affected by the previous period, the first-order lag term of regional innovation capability ln$Create_{it\text{-}1}$ is added to the equation (4) to obtain the following dynamic panel model[18].

$$\ln Create_{it} = \beta_0 + \beta_1 \ln Create_{it-1} + \beta_2 \ln Cti_{it} + \beta_3 \ln RD_{it} + \beta_4 \ln RDP_{it} + \beta_5 \ln Hum_{it} + \beta_6 \ln FDI_{it} + \alpha_i + \varepsilon_{it} \quad (5)$$

2.2 Institutional quality dynamic threshold model

In order to further study the impact of technology import and the improvement of regional innovation capability under different institutional quality, and to solve the estimation error of the previous static threshold model due to endogeneity, we draw on Kim's[19] dynamic threshold panel model in the research, set the following dynamic threshold panel model:

$$\ln Create_{it} = \beta_0 + \beta_1 \ln Create_{it-1} + \beta_2 \ln Cti_{it} \cdot I(q_{it} \le c) + \beta_3 \ln Cti_{it} \cdot I(q_{it} > c) + \beta_n X_{it} + \alpha_i + \varepsilon_{it} \quad (6)$$

Where i denotes the province (i = 1, 2, 3 ... 30) and t denotes time, $Create_{it\text{-}1}$ is the first-order lag of regional innovation capability; Cti_{it} is the core explanatory variable; q_{it} represents a series of threshold variables. For the sake of simplicity, it is assumed that the threshold variable is exogenous and does not change with time. The threshold variables include the political institution threshold, the economic institution threshold and the legal institution threshold. x_{it} represents a range of control variables, including R&D staff input (*RDP*), R&D capital investment (*RD*), human capital level (*Hum*), and foreign direct investment (*FDI*); $I(\cdot)$ indicates the indicator function, c is the specific threshold; α_i represents individual fixed effects, $\alpha_i = \mu_{it} + \upsilon_{it}$, μ_{it} representing regional fixed effects, υ_{it} express time fixed effects; β_0 versus β_1, β_1, … , β_n represents the constant term and the parameter to be estimated, respectively.

2.3 Indicator selection

2.3.1 Dependent variable

Regional innovation capability (*Create*). Drawing on the research of Liu & Hu[15], the number of patent applications in high-tech industrial zones in various provinces is used as the proxy variable of regional innovation capability. At the same time, the stock of the perpetual inventory method for regional innovation capability is calculated. The stock of the number of patent applications in the *t*-term is expressed as:

$$Create_{it} = (1-\delta)Create_{it-1} + \Delta Create_{it} = \sum_{T=0}^{\infty}(1-\delta)^{T}\,\Delta Create_{it-T} \quad (7)$$

In formula (7), $Create_{it}$ is the regional innovation capability of each province in year *t*, $Create_{it-1}$ is the number of patent applications for *t*-1 high-tech industries in each province, and δ is the patent depreciation rate, with a value of 15%. At the same time, it is necessary to determine the base-period regional innovation capacity accumulation of the provinces and regions. The calculation method is:

$$Create_{i0} = \Delta create_{i0} \sum_{T=0}^{\infty}\frac{(1-\delta)^{T}}{(1-r_i)} = \frac{\Delta Create_{i0}}{r_i+\delta} \quad (8)$$

In formula (8), $Create_{i0}$ is the regional innovation capability of region *i* in 2007, $\Delta Create_{i0}$ is the number of patent applications for high-tech industries in each province in 2007, and r_i is the average annual growth rate of inter-provincial high-tech professional applications from 2007 to 2016.

2.3.2 Explanatory variables

Technology import (*Cti*). Drawing on the research of Zhang and Xu[20], the cost of technology import is used as a proxy variable for technology import. On this basis, the stock introduction cost is calculated by the perpetual inventory method with a depreciation rate of 15%.

2.3.3 Institutional quality

Political institutional quality (Politic). Because the regional political institution is more complicated to quantify, this paper draws on the research of Wu[21], and regards regional corruption as a substitute variable for the quality of regional political institution, and uses the number of criminal cases filed per 10,000 public officials to measure.

Economic institutional quality (Economic). Drawing on the research of He and Wu[22], the China marketization index is used as a substitute variable for the quality of economic institution.

Legal institutional quality (Law). In this paper, using Quan and Chesbrough's[14] research methods, the level of regional intellectual property protection is used as a substitute variable for the quality of legal institution. This calculation method uses four levels of judicial protection level, administrative protection level, economic development level, and education level to measure the intensity of intellectual property enforcement. Finally, according to the arithmetic average of the above four indicators, the level of intellectual property protection in each region is calculated.

Table 1. Intellectual Property Protection Level Indicator

Target layer	Criteria layer	Indicator layer	data processing
Intellectual property protection level	Level of judicial protection	Number of regional lawyers	Number of regional lawyers / total population of the district
		Total population of the area	
	Administrative protection level	Regional patent authorization	(The amount of cases closed in infringement + other patent settlements + the number of cases of counterfeiting others) / patent authorization
		Regional annual patent infringement case settlement	
		Amount of other patent cases	
		Impersonation of patent cases of others	
	The level of economic development	Regional actual gdp	Actual gdp / region population
		Regional population	
	education level	College or above	Junior College × 16 + High School × 12 + Junior High School × 9 +Primary School × 6
		High school culture	
		Junior high school culture	
		Primary school ratio	

2.4 Control variables

Human capital (Hum), R&D capital investment (RD), R&D personnel input (RDP), and foreign direct investment (FDI) are selected as control variables. The weighted average of the education years of the population aged 6 and over in each region is used to measure the human capital of each province. The R&D personnel's full-time equivalent is expressed by the proportion of R&D personnel investment in the proportion of regional R&D expenditure and regional GDP. As a proxy variable invested by R&D personnel, the amount of foreign direct investment is measured by the actual use of foreign direct investment (US$ 10,000).

2.5 Data source

The sample interval of this study is from 2007 to 2016, mainly from China Statistical Yearbook, China Science and Technology Statistical Yearbook, China High-tech Statistical Yearbook, China Procuratorate Yearbook, China Lawyer Yearbook, and China Marketization. Index, Wind Database and China Intellectual Property Protection Bureau. Considering the lack of data on technology import costs in Inner Mongolia, Hainan, Tibet, Qinghai, Ningxia and Xinjiang, as well as the availability of data in Hong Kong, Macao and Taiwan, the research targets are except Inner Mongolia, Hainan, Tibet, Qinghai, Ningxia and Xinjiang 25 provinces outside Hong Kong, Macau and Taiwan. For partially missing data, this article uses linear regression calculation to supplement. The sample statistics are described in Table 2.

Table 2. Statistical description of the sample

symbol	variable	Obs	Mean	St.d	Min	Max
Create	Regional innovation capability	250	8921.892	23715.610	24.947	207663.300
Patent	High-tech patent	250	3128.556	7314.002	16.000	58119.000
Cti	Technology import	250	154873.100	284737.600	11.536	1264621.000
RD	R&D capital investment	250	0.839	0.419	0.001	2.832
RDP	R&D labor input	250	97135.520	94040.040	9779.000	511718.000
Hum	human capital	250	8.721	1.025	6.378	12.033
FDI	Foreign direct investment	250	731623.000	1061683.000	2044.	13100000.000
Economic	Economic institutional quality	250	8.240	2.182	4.320	14.450
Politic	Political institutional quality	250	2.684	0.744	1.153	5.907
Law	Legal institutional quality	250	1.654	0.895	0.696	5.211

3. Empirical result analysis

3.1 Benchmark linear regression analysis

In the benchmark linear regression results, model (1) is the OLS estimation result of the formula (4), and models (2) and (3) respectively represent the DIFF-GMM and SYS-GMM estimation results of formula (5). It can be seen from R2 that the model (1) has a high degree of overall fit and the OLS regression results are credible; the AR (2) test results show that there is no second-order autocorrelation between the model (2) and the model (3) random error terms, and the Sargan test results show The selection of model tool variables is effective; Wald statistics also show that the overall model is highly significant, so the regression results of DIFF-GMM and SYS-GMM are reliable.

Table 3. Benchmark linear regression estimation results

variable	Model (1)	Model (2)	Model (3)
	OLS	DIFF-GMM	SYS-GMM
ln*Create*$_{it-1}$		0.185***	0.620***
		(0.065)	(0.029)
ln*Cti*	0.208***	0.382***	0.090***
	(0.031)	(0.102)	(0.018)
ln*RD*	0.229**	0.023	0.017
	(0.092)	(0.127)	(0.021)
ln*RDP*	1.100***	1.481***	0.892***
	(0.103)	(0.333)	(0.061)
ln*Hum*	-0.950*	1.849	-0.483
	(-0.558)	(1.062)	(-0.485)
ln*FDI*	0.153**	-0.016	0.044
	(0.062)	(-0.076)	(0.028)
Constant term	-7.384***		-7.171***
	(-1.079)		(-1.281)
R^2	0.796		
AR (1)		-2.760	-3.164
		[0.006]	[0.002]
AR (2)		1.460	1.080
		[0.145]	[0.280]
Sargan test		177.860	21.428
		[0.101]	[0.998]
Wald test		3959.07***	58445.93***
Numbers of obs	250	250	250

Note: *, **, *** indicate the significance level of 10%, 5% and 1% respectively, the value in () indicates standard error, and the value in [] indicates p value.

Besides, the estimation results of OLS, DIFF-GMM, and SYS-GMM all show that technology import has a significant role in promoting China's regional innovation capability, and DIFF-GMM has the largest output elasticity coefficient. The reason is that although developed countries cannot export their core technologies to China, as long as they are relatively advanced and suitable technologies, it will contribute to the improvement of China's regional innovation capability. For independent research and development, directly importing foreign technology may be more targeted, reducing blindness and uncertainty in independent research and development, and thus having a more significant role in promoting China's regional innovation capability.

From other control variables, except for the DIFF-GMM and SYS-GMM estimation results that indicate R&D investment has not significantly promoted the improvement of China's regional innovation capability, and other estimation results all show that independent R&D investment is the main path for China's regional innovation capability. The DIFF-GMM and SYS-GMM estimation results are not significant. The possible reason is that the existence of "capital substitution" makes the expenditures that should be used for research and development used for the expansion of production scale, and is not really used for research and development investment, and thus cannot be effective to promote the improvement of regional innovation capability. Moreover, the three estimation results of human capital and foreign direct investment are inconsistent, which in turn has significant differences in the improvement of regional innovation capability.

3.2 Institutional quality GMM threshold regression analysis

3.2.1 Threshold effect test and determination of threshold value

Based on the dynamic threshold panel model Wald test self-sampling method (Bootstrap), this paper uses the political institutional quality, economic institutional quality, and legal institutional quality as threshold variables to test the threshold effect under the assumption of no threshold effect. From the Wald statistics and its P-value, we can see that the dynamic threshold model with three dimensions and different organization quality as threshold variables rejects the null hypothesis that there is no threshold effect at the 1% significance level. The threshold value and its threshold value and confidence interval are shown in Table 4. It shows that due to the differences in the quality of the regional institution of various provinces, the impact of technology import on regional innovation capability shows nonlinear characteristics[23].

Table 4. Dynamic threshold self-sampling test

Threshold variable	Threshold	Wald statistic	p-value	Bs times	95% confidence interval	
Political institutional quality	2.203***	54.369	0.000	1000	1.741	4.046
Economic institutional quality	7.760***	66.010	0.000	1000	5.080	12.510
Legal institutional quality	1.132***	83.494	0.000	1000	0.884	3.834

Note: ***, **, and * indicate significant at the 1%, 5%, and 10% levels, respectively, and the P value and the critical value are obtained by repeating the GMM threshold panel regression program 1000 times. The Wald statistic is used to determine the threshold. Whether the feature is obvious, the smaller the corresponding probability, the more obvious the threshold feature.

3.2.2 Institutional quality GMM threshold model correlation test

Table 5 shows the regression of the two-step GMM threshold model and its related test results. Models (4)-(6) respectively represent models constructed with the quality of the political institution, economic institution, and the legal institution as threshold variables. The first-period lagging coefficients of regional innovation capability are all significantly positive at the 1% level, indicating that the current regional innovation capability will be affected by the previous period, that is, there is an inertia trend. From the results of the residual series correlation test, we can see that the P-value of the AR (2) test is greater than the significance level of 10%, therefore, there is no second-order autocorrelation in the random error term. The results of Sargan test and Hansen test show that the selection of instrumental variables is effective. Wald statistics also show that the overall model fits well. Therefore, the regression results of the GMM threshold model are more credible.

3.2.3 Parameter estimation and result analysis

(1) Analysis of technology import and regional innovation ability improvement under the threshold of political institutional quality

The regression results of the model (4) show that there is a significant threshold effect of political institutional quality on the impact of technology import on China's regional innovation capability. When the degree of regional corruption is less than the threshold of 2.203, the impact coefficient of technology import on regional innovation capability is 0.086. When the regional corruption level is greater than the threshold value of 2.203, that is, the political institutional quality of the region is relatively low, the estimated coefficient of technology import becomes 0.082. It is also significant at the 10% confidence level. The reason is that the degree of regional corruption is low, but the regional political institutional quality is higher. Due to the improvement of the government's governance ability and management level, the degree of regional corruption is reduced, which weakens the "rent-seeking effect"[24]. Besides, the improvement of the quality of regional political institution standardizes the market economic behavior, which makes the factor resources originally engaged in rent-seeking activities flow into production activities. It is conducive to reduce the cost of technology import, improve the efficiency of technological production and accelerate the development of technological innovation[25].

(2) Analysis of technology import and regional innovation ability improvement under the threshold of economic institutional quality

The regression results of model (5) show that the impact of technology import on China's regional innovation capability also has significant economic institutional quality threshold effects. When the quality of the economic institution is lower than the threshold of 7.760, the influence coefficient of technology import on regional innovation capability is 0.056, but it is not significant. It shows that in regions with low economic quality, the promotion effect of technology import on regional innovation capability is not obvious. When the institutional quality is higher than the threshold value of 7.760, the influence coefficient of technology import on regional innovation capability is 0.099, which is positively significant at the 5% confidence level, indicating that technology import can significantly promote regional innovation ability in regions with high economic quality. The main reasons are as follows. First, in areas with relatively high economic institutional quality, the government has less market intervention, which can not only weaken technical product barriers and enable foreign high-tech products to enter the country more smoothly, but also accelerate market demand for high-tech products, thereby promoting the integration of product market and technology market[14]. Finally, most of China's industrial technology import entities rely on government loans. Therefore, the lack of capital and service support from financial institution has resulted in the simplification of investment entities and restricted the development of corporate innovation activities[6]. Regions with higher economic institutional quality have efficient financial markets and an open market environment, which provide enterprises with capital and path support for the introduction of technology, thereby driving the innovation and development of industries in the region[26].

(3) Analysis of technology import and regional innovation ability improvement under the threshold of legal institutional quality

When the quality of the legal institution is higher than the threshold 1.132, the coefficient of influence of technology import on China's regional innovation capability is 0.067, which is significant at the 10% level. This shows that the higher the quality of the legal institution, the introduction of technology will have a significant effect on regional innovation capability. The reasons are that, first, regions with high-quality legal institution tend to have sound administrative and judicial institution, which can comprehensively coordinate and regulate the rights and obligations of science and technology intermediaries, ensure orderly market competition, and provide regulatory guarantees for regional innovation capability. Second, strict protection of intellectual property rights can prevent patent infringement, stimulate the enthusiasm of enterprises in technological research and development, and to a certain extent promote the improvement of local new technologies and new processes, thereby providing property rights protection for the region's technological innovation capability.

Table 5. Dynamic threshold estimation results of the impact of technology import on regional innovation capability under different institutional quality

variable	Model (4)	Model (5)	Model (6)
	political institution	economic institution	Legal institution
$\ln Create_{it-1}$	0.626^{***}	0.605^{***}	0.601^{***}
	(0.043)	(0.050)	(0.040)
$\ln RD$	0.018	0.034^{***}	0.031^{***}
	(0.020)	(0.005)	(0.006)
$\ln RDP$	0.155^{*}	0.102	0.154
	(0.085)	(0.110)	(0.189)
$\ln Hum$	1.872	0.007	0.727
	(1.819)	(1.615)	(1.506)
$\ln FDI$	-0.023	-0.037	0.029
	(-0.020)	(-0.046)	(0.040)
$\ln Cti \cdot I\,(politic \leq C)$	0.086^{*}		
	(0.049)		
$\ln Cti \cdot I\,(politic > C)$	0.082^{*}		
	(0.049)		
$\ln Cti \cdot I\,(economic \leq C)$		0.056	
		(0.044)	
$\ln Cti \cdot I\,(economic > C)$		0.099^{**}	
		(0.039)	
$\ln Cti \cdot I\,(law \leq C)$			0.051
			(0.036)
$\ln Cti \cdot I\,(law > C)$			0.067^{*}
			(0.036)
Constant term	0.044^{*}	0.075^{**}	0.061^{**}
	(0.026)	(0.029)	(0.030)
AR (1)	-1.860	-1.050	-1.400
	[0.064]	[0.294]	[0.161]
AR (2)	1.180	-0.590	0.130
	[0.236]	[0.556]	[0.898]
Sargan test	79.650	75.440	74.420
	[0.121]	[0.155]	[0.175]
Hansen test	6.070	3.860	5.040
	[1.000]	[1.000]	[1.000]
Wald test	320180.16^{***}	44206.48^{***}	313540.75^{***}
Numbers of obs	250	250	250

Note: ***, **, and * indicate significant levels at 1%, 5%, and 10%, respectively, () internal standard error, and [] indicates P value.The above results are derived from the xtabond2 two-step differential GMM threshold model regression

4. Robustness test

4.1 Full sample interaction test

Table 6 shows the results of the full sample interaction test. Models (7), (8) and (9) represent the panel regression models of the interaction terms of political institutional quality, economic institutional quality, legal institutional quality and technology import. The coefficient of political institutional quality and technology import interaction coefficient is significantly negative at 5% confidence level, indicating that with the increase of regional corruption level, the quality of the political institution is gradually decreasing, and the positive effect of technology import on regional innovation ability will be weakened. The interaction between economic institutional quality and technology import is significantly positive at the 1% confidence level, indicating that the impact of technology import on regional innovation capability will increase significantly with the improvement of economic institutional quality. The interaction between the quality of the legal institution and the introduction of technology is significantly positive at the 1% confidence level, indicating that the improvement of the quality of the legal institution will help the introduction of technology and promote the growth of regional innovation capability. In summary, the above conclusions are consistent with the dynamic threshold regression results. Therefore, the full sample interaction term regression results show that the dynamic threshold regression results are robust.

Table 6. Full sample interaction test

variable	Model (7)		Model (8)		Model (8)	
	FE	RE	FE	RE	FE	RE
ln*Cti*	0.189***	0.153***	-0.235***	-0.268***	0.147***	0.113***
	（0.039）	（0.042）	（-0.073）	（-0.080）	（0.031）	（0.035）
ln*RD*	0.039	0.024	0.008	-0.007	0.033	0.016
	（0.053）	（0.062）	（0.050）	（0.058）	（0.051）	（0.061）
ln*RDP*	1.603***	1.456***	1.220***	1.089***	1.239***	1.369***
	（0.129）	（0.130）	（0.142）	（0.143）	（0.148）	（0.141）
ln*Hum*	5.861***	5.740***	4.135***	4.456***	3.813***	4.537***
	（0.829）	（0.781）	（0.793）	（0.747）	（0.838）	（0.875）
ln*FDI*	0.189***	0.176***	0.148***	0.114*	0.189***	0.191***
	（0.059）	（0.065）	（0.056）	（0.062）	（0.056）	（0.063）
ln*Cti* · ln*Politic*	-0.033**	-0.025				
	（-0.015）	（-1.470）				
ln*Cti* · ln*Ecomomic*			0.206***	0.203***		
			（0.036）	（0.038）		
ln*Cti* · ln*Law*					0.137***	0.058**
					（0.028）	（0.027）
Constant term	-26.790***	-24.448***	-18.724***	-17.145***	-18.851***	-21.197
	（-0.915）	（-1.040）	（-1.654）	（-1.712）	（-1.820）	（-1.888）
Hausman test	78.140***		74.660***		199.880***	
F test	388.500***		441.870***		426.890***	
Wald test		1647.280***		1915.400***		1710.300***
R^2	0.914	0.740	0.924	0.765	0.921	0.736
Numbers of obs	250	250	250	250	250	250

Note: ***, **, and * indicate significant levels at 1%, 5%, and 10%, respectively.

4.2 Replace the interpreted variable

In designing the dynamic threshold model, the perpetual inventory method is used to measure the stock of regional innovation capability. In order to test its robustness, this paper replaces the regional innovation capability with the flow rate and re-calculates the dynamic threshold. Table 7 shows the threshold effect saliency test with the political institutional quality, economic institutional quality, and the legal institutional quality as the threshold variable. From the Wald statistics and its P value, we can think that dynamic threshold model with three different institutional qualities as threshold variables rejects the null hypothesis of no threshold effect at the 1% significance level. This shows that the non-linear characteristics of technology import and regional innovation capability are robust.

Table 7. Dynamic threshold self-sampling test

Threshold variable	Threshold	Wald statistic	p value	Bs times	95% confidence interval	
Political institutional quality	3.011^{***}	3.495	0.000	1000	1.741	4.046
Economic institutional quality	7.090^{***}	1.148	0.000	1000	5.080	12.510
Legal institutional quality	1.159^{***}	0.602	0.000	1000	0.884	3.834

Note: ***, **, and * indicate significant at the 1%, 5%, and 10% levels, respectively. The P value and the critical value are obtained by repeating the GMM threshold panel regression program 1000 times, and the Wald statistic is obtained. It is used to judge whether the threshold feature is obvious, and the smaller the corresponding probability, the more obvious the threshold feature.

Table 8 shows the two-step GMM threshold model regression and related test results. Models (10), (11) and (12) are the estimation results of dynamic threshold model based on political institutional quality, economic institutional quality and legal institutional quality as threshold variables, respectively. The AR (2) test result shows that there is no second-order autocorrelation in the random error term. The results of sargan test and hansen test show that the selection of instrumental variables is effective. Wald statistics also show that the overall dynamic threshold regression results of the model are accurate. The impact of technology import on regional innovation capability declines with the increase in regional corruption (decrease in the quality of the political institution), and it has a significant promoting effect in areas with higher economic and legal institutional quality. The results of dynamic threshold regression are consistent. In summary, the above dynamic threshold regression is reliable.

Table 8. Dynamic Threshold Regression Results

variable	Model (10)	Model (11)	Model (12)
	Political institution	economic institution	Legal institution
$\ln Create_{it-1}$	-0.347	0.002	-0.019
	(-0.298)	(0.186)	(-0.157)
$\ln Rd$	0.045	0.071^{***}	0.072^{*}
	(0.029)	(0.024)	(0.021)
$\ln Rdp$	-1.024	-0.050	-0.054
	(-0.640)	(-0.428)	(-0.260)
$\ln Hum$	1.361	4.336	-0.591
	(2.972)	(2.649)	(-3.117)
$\ln FDI$	-0.189	-0.194	-0.182
	(-0.139)	(-0.163)	(-0.136)
$\ln Cti{\cdot}I\,(politic \le C)$	0.354^{***}		
	(0.095)		
$\ln Cti{\cdot}I\,(politic > C)$	0.303^{***}		
	(0.086)		
$\ln Cti{\cdot}I\,(economic \le C)$		0.258	
		(0.106)	
$\ln Cti{\cdot}I\,(economic > C)$		0.298^{***}	
		(0.110)	
$\ln Cti{\cdot}I\,(law \le C)$			0.132
			(0.096)
$\ln Cti{\cdot}I\,(law > C)$			0.208^{**}
			(0.087)
Constant term	0.452^{***}	0.194^{*}	0.271^{***}
	(0.162)	(0.104)	(0.080)
AR (1)	0.540	-1.360	-1.450
	[0.589]	[0.173]	[0.147]
AR (2)	0.880	1.420	0.600
	[0.379]	[0.156]	[0.547]
Sargan test	77.030	77.760	76.310
	[0.166]	[0.153]	[0.181]
Hansen test	7.250	7.110	4.420
	[1.000]	[1.000]	[1.000]
Wald test	10800.030^{***}	13971.160^{***}	8913.250^{***}
Numbers of obs	250	250	250

Note: () The internal standard is a standard error, and the [] indicates the P value. The above results are derived from the xtabond2 two-step differential GMM threshold model regression.

5. Conclusions and policy recommendations

Based on the panel data of 25 provinces from 2007 to 2016, this paper first uses the three benchmark regression models of OLS, DIFF-GMM, and SYS-GMM to verify whether technology import promotes regional innovation capability; Secondly, this paper introduces a two-step differential GMM threshold panel model, and uses political, economic and legal institutional quality as threshold variables to explore the nonlinear impact of technology import on regions and innovation capability under different system quality. Finally, to ensure the robustness of the regression results, this paper conducts a series of robustness tests. The main research conclusions are as follows:

(1) On the whole, the regression results of OLS, DIFF-GMM and SYS-GMM show that technology import can significantly promote the regional innovation capability. (2) From the results of the dynamic threshold model, the impact of technology import on regional innovation capability will be affected by differences in regional institutional quality. With the increase of regional corruption, the role of technology import in promoting regional innovation capability is gradually weakened, and the impact of technology import on regional innovation capability has gradually increased in areas where the quality of the economic and the legal institution is relatively high. (3) The full-sample interaction term's test results show that the dynamic threshold regression results of this paper have good robustness.

In summary, this paper proposes the following policy recommendations: First, to regulate government behavior and create a fair and orderly operating environment for high-tech industries, the government needs to strengthen corruption supervision, build a good political system environment for the introduction of high-tech. In addition, it is necessary to establish and improve mechanisms for the prevention, punishment and supervision of corruption in high-tech industries, formulate special anti-corruption laws and regulations, increase corruption costs, and curb rent-seeking behavior in the process of technology import. Second, it is necessary to clarify the relationship between the government and the market, encourage and build an open market environment. At the same time, it is also essential to clarify the government's position in the market, which can reduce intervention in scientific research and production activities, maintain market competition order in high-tech industries, and build an economic system and market environment conducive to technology import and innovation capability. Third, the government needs to formulate laws, regulations and policies for technology import, establish a legal system environment conducive to technological innovation and technology import. Further improve the laws and regulations related to the protection of intellectual property rights, strengthen the punishment and enforcement of patent infringement, so as to guide enterprises to actively improve the incentive mechanism of patents and intellectual property rights.

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