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**Article**

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## EFFECT OF FREE TRADE AREA POLICY ON INNOVATION CAPABILITY IN THE SERVICE INDUSTRY

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### Abstract

China has gradually established pilot free trade zones and implemented certain specific policies for its enterprises to deepen the economic system reform and expand the degree of market opening to the outside world. The establishment of a Free Trade Area exerts spillover effects and positive influences on import and export trade, synergistic regional development, and the ability to innovate of enterprises. However, in terms of policy, its role in enterprise innovation has not been explored. To explore the influence path of Free Trade Area Policy on the innovation ability of service industry companies, using the data of A-share listed companies in Shanghai and Shenzhen in the Guangdong Free Trade Area region from 2010 to 2021 and the Regression Discontinuity model, the micro mechanisms (intellectual property protection, equity incentives, and government subsidies) of the impact of the Free Trade Area Policy on the innovation capability of service industry companies were analysed. The results show that: (1) Intellectual property rights (IPR) protection and the innovation ability of service industry companies exhibit a U-shaped relationship. With the increase in IPR protection, the innovation ability of service industry companies first decreases and then increases. (2) Expanded equity incentive level internal gap increases the research and development (R&D) expenditures, but reduces the innovation capacity of service industry companies. (3) Government subsidies convey signals of innovation recognition to the market, reduce the business risks of service industry companies, and encourage improvements in innovation capability. The conclusions provide a theoretical basis and multi-dimensional ideas for service industry companies to improve their innovation capability. In addition, an empirical basis and reference is provided for the government administration of the Free Trade

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Area to evaluate the effectiveness of policy implementation, optimise the policy structure, improve the policy system, and promote Free Trade Area Policy.

**Keywords:** Free Trade Area Policy, service industry companies, enterprise innovation capability, Regression Discontinuity

**JEL Classification:** M21, D21, H71

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## Introduction

The construction of a Free Trade Area is China's initiative to adapt to the background of trade globalisation. Implementing a proactive "Bringing-in and going-out strategy", which deepens the internal institutional reform of a major initiative, is an important step not only in China's economic transformation and trade structure improvement, but also in promoting investment liberalisation and facilitation, to adapt to the trend of economic globalisation objective requirements. From the establishment of the Shanghai Free Trade Area in September 2013 to September 2020, China has formed "1 (Shanghai) + 3 (Guangdong, Tianjin, Fujian) + 7 (Liaoning, Zhejiang, Henan, Hubei, Chongqing, Sichuan, Shanxi) + 1 (Hainan) + 6 (Shandong, Jiangsu, Guangxi, Hebei, Yunnan, Heilongjiang) + 3 (Beijing, Hunan, Anhui)" 21 provinces and 69 zones of Free Trade Areas in a geese formation. From the coast to the inland, from the northeast to the southwest, these Free Trade Areas are located in various important economic regions of China, basically covering the major economic sectors.

Thus, a new pattern of all-round and high-level regional opening up with "no gap along the coast, focus on the mainland, and full growth" is coordinated with the east and west, land and sea to serve different economic zones. During the development of the Free Trade Area, the adoption of better policies can minimise more market entry barriers, streamline the negative list, promote trade liberalisation and facilitation, attract more investments, and enhance international trade exchanges. Thus, strengthening institutional innovation, exploring new paths and methods to dovetail high-standard rules, piloting dovetailing with international high-standard economic and trade rules, and promoting high-level system-based opening have become the core elements of Free Trade Area construction.

The service industry is an important part of China's all-around opening to the outside world. However, China's overall foreign trade pattern shows a deficit, caused by trade in services that remains a weak point. While China's trade in goods can usually reach tens of trillions of dollars, the trade in services is usually only a few trillion. Services import and export account for less than 20% of China's total import and export, and the gap is relatively obvious compared with developed countries in the world. In 2022, China Beijing International Fair for Trade in Services, China announced its commitment to bridge the "digital gap" and promote the digitalisation of trade in services in line with the development trend of digitalisation, networking and intelligence. China intends to expand its special service export base and develop new business models and modes of services trade. In this regard, investigating the effect of the implementation of China's Free Trade Area Policy on the development of service industry companies presents considerable significance.

Comprehensive research has been carried out on the effects of Free Trade Area Policy and enterprise innovation capability. The establishment of a Free Trade Area has effectively

activated market players and promoted the free flow of capital, materials, talents, and other resources in and around the region, thereby significantly increasing the rate of economic growth (Wang and Liu, 2017; Liu and Wang, 2018; Li and Li, 2019). Several scholars also believe that the establishment of a Free Trade Area has an insignificant driving effect on regional economic development, the policy effect is not fully released, and the promotion effect is lagging (Song et al., 2019). The establishment of a Free Trade Area considers its type and number. Free Trade Areas may strive to reduce trade barriers, lower the threshold of market access, or promote trade freedom and facilitation (Ye, 2018). The internal factors influencing enterprise innovation capability include organisational level, corporate governance, managerial perception, and employee motivation, whereas the external factors include innovation network, resource integration, and strategic orientation. For example, increasing firm age and size can derive organisational inertia, and structured practices can bind the ability to self-adjust in co-evolution with the environment (Harman and Freeman, 1984). Equality incentive mitigates agency costs, aligns managerial and shareholder interests, and a catalytic effect on firm innovation (Tian and Meng, 2018; Zhao and Lin, 2019). Corporate innovation is driven by a combination of internal and external drivers, where internal firms need to absorb knowledge and external firms need to imitate and learn new knowledge (Albort-Morant et al., 2018). The degree of heterogeneity in enterprise innovation capability promotes its dynamic effects with firm performance (Schilke, 2014). Firms with institutional support tend to develop better (Back et al., 2014). Strengthening legal protection and policies can promote corporate innovation, such as those for intellectual property rights (IPR), which include tangible or intangible firm assets. Government support can also promote firms' R&D investment and improve their innovation performance (Chen and Zhou, 2021).

In summary, most of the studies on Free Trade Area Policy have been carried out from the macro-supply perspective, including its effects, while less attention has been paid to the micro aspects of enterprises from the policy demand perspective. Enterprises are both policy demanders and beneficiaries, and empirical evidence based on the micro-perspective can provide ideas for policy structure optimisation and improvement enrichment. Thus, this study further considers the following questions: What are the policies related to enterprise innovation capability in the Free Trade Area Policy system, given that policy support has a significant impact on the enhancement of enterprise innovation capability? What are the paths through which these policies act on the enterprise innovation capability? How does the Free Trade Area Policy affect service industry companies, which are unique in their assessment of innovation capabilities? To answer the above questions, we used data of Shanghai and Shenzhen A-share listed service industry companies in the Guangdong Free Trade Area of China from 2010 to 2021 as the research sample. This study examines the impact mechanism of policies such as intellectual property protection, equity incentive, and government subsidy on enterprise innovation capability in the Free Trade Area Policy system. The different effects of each policy are also analysed, including the increase of intellectual property protection, widening gap of equity incentive level, and signalling government subsidies on enterprise innovation capability. Furthermore, new utility and appearance patents at different levels of patent applications are subdivided and the degree of promotion of Free Trade Area Policy on different types of patent applications by sample is analysed.

In comparison with existing studies, this study has more evident marginal contributions. First, we integrate the property rights system, total compensation, and signalling theories to build a research framework and enrich the theory of corporate innovation. Second, the structure of Free Trade Area Policy is divided into three aspects: intellectual property protection, equity

incentive, and government subsidies, which provide new ideas for understanding the Free Trade Area Policy system and structure. Meanwhile, analysis of the mechanism of service industry companies' innovation ability through the Free Trade Area Policy system provides the theoretical basis and multi-dimensional ideas for service industry companies to improve their innovation ability. In addition, empirical basis and reference ideas are provided for Free Trade Area government management departments to evaluate the effectiveness of policy implementation, optimise policy structure, improve policy system, and promote the Free Trade Area Policy.

The rest of this study is structured as follows: Section 1 is a literature review and presents the research hypothesis. Section 2 is the research design, which presents the data selection and variable descriptions, initial data processing, followed by the model setting and description. Section 3 is the analysis of the empirical results and robustness test, while Section 4 discusses the findings of this study. The last section is related to the conclusions.

## **1. Theoretical analysis and hypothesis development**

### **1.1. Spillover mechanism of intellectual property protection**

A relatively weak intellectual property protection facilitates innovation. Imitating external knowledge allows companies to save on the innovation cost. That is, knowledge externalities reduce costs while technological imitation motivates firms to innovate (Antonelli and Colombelli, 2017). Companies with weak intellectual property protection are prone to “free riders.” When firms gather in environments where intellectual property protection is weak, they “carpool” with other corporate innovations (Bental and Fixler, 1988). By comparison, a strong intellectual property protection reduces the degree of market competition and even creates monopolies, thereby reducing knowledge and technology spillovers while enhancing investments in innovation (Li, 2020). The reason is that when the innovator is imitated, their profit weakens, and thus they increase their investment. This scenario also creates a game, where market competitiveness is instead enhanced in the case of weak intellectual property protection. Strengthening intellectual property protection, reducing external spillovers of knowledge, and generating excessive monopoly power may inhibit further innovation market competition, which in turn reduces corporate innovation performance.

Strong intellectual property protection promotes innovation in four main paths: First, the level of intellectual property protection affects the intensity of firms' R&D investment; that is, when the level of protection is low, firms cut back on R&D investment, and, conversely, a strong intellectual property protection promotes firms R&D investments, which in turn promotes innovation (Bosworth and Rogers, 2001). Innovators utilise intellectual property protection mechanisms to obtain appropriate returns from their investments by gaining funds, and intellectual property is an important mechanism to protect this firm asset (Aloini et al., 2017; Shavell and Van, 2001). Strengthening intellectual property protection thus stimulates innovation by ensuring a return on firms' R&D investments (Siege and Wright, 2007). Second, IPR promotes innovation by protecting the inventor's exclusive rights, the firm's monopoly position, and market profits. An environment of low levels of intellectual property protection can create barriers to innovation by allowing imitators to quickly enter the market, and thus counterfeits can erode the profit margins of innovators (Zhao, 2006). Third, intellectual property protection reduces information asymmetry and promotes innovation. For companies, R&D is a necessary path to profitability and growth and is characterised by

high and long-term risks. Innovation activities contribute to information uncertainty about the future value of a firm's assets, and highly protected intellectual property reduces information ambiguity and asymmetry within and outside the firm, which thereby increases in market value (Huang et al., 2020). Fourth, intellectual property protection can facilitate the growth of startups and provide innovators with the opportunity to establish a base in the industry (Graham and Sichelman, 2016).

In conclusion, when intellectual property protection is weak, firms benefit more from knowledge and technology spillovers. The market competition increases as similar products appear to flood the market. Innovators invest more in innovation for fear of being overtaken by imitators, thus reducing their own profits (Jeng and Pak, 2016). As intellectual property protection increases, corporate innovation efforts may decrease. With the further increase in intellectual property protection, intellectual property protection promotes corporate innovation investment, protects investment monopoly rents and profits, and reduces information asymmetry. This scenario frees up time for companies to establish their industry base and again stimulates their independent innovation drive. Based on the above analysis, the following hypothesis was proposed.

*Hypothesis 1:* intellectual property protection and service industry companies' innovation ability show a U-shaped relationship. As the strength of intellectual property protection increases, service industry companies' innovation ability first decreases and then increases.

### **1.2. Internal compensation mechanism of equity incentive**

The long-term and risky nature of corporate innovation involves motivating employees to work hard and to commit to relevant long-term company activities. An equity incentive is a compensation contract that grants relatively appropriate equity to core employees, giving them the power to distribute the residual earnings of the company and effectively enhancing the sense of equality and narrowing their income gap with executives (Zhang et al., 2020). Unlike equity incentives, where monetary compensation reflects hierarchical and position gaps, incentive earnings rely on the future prices of the underlying stock and the number of equity grants. In addition, executives and employees are aligned in terms of equity incentives (Banker et al., 2011). Employees can only be rewarded with equity incentives by working hard and improving the long-term performance of the enterprise. This long-term incentive tool reflects the fairness of an improved compensation structure.

The targets of equity incentives are divided into executives and non-executives that are mainly considered as core employees. If these core employees do not receive the same reward for the same effort, then the level of equity incentive shows a large internal gap. In this case, the core employees can suffer from psychological shock and have a negative effect on corporate innovation (Pan et al., 2020). Executives have decision-making authority over resource allocation in the firm and are incentivised to increase R&D expenditures to achieve high returns, although the ability of R&D expenditures to generate innovative outputs and returns depends on the core employees (Yin et al., 2021). Hence, the executives in the firm dominate the input aspect of innovation, while the core employees dominate the output aspect. The core employees are the real performers and participants in innovation tasks, mastering the core business of the company, and exerting their expertise. These core employees comprise the most important driving force in increasing the firm value (Vuksanović et al., 2022). Therefore, when equity incentives have large internal gaps, core employees may feel that they are not being rewarded for their efforts. The effect of equity incentives weakens,

thus reducing the motivation to innovate (Xu et al., 2019). On this basis, the following hypothesis was proposed.

*Hypothesis 2:* Expanding the internal gap in the equity incentives of the service industry companies can increase their R&D expenditures but reduces their innovation capability.

**1.3. Risk aversion mechanism for government grants**

Gillingham and Sweeney’s (2010) theory of market failure states that the social benefits of a firm’s R&D activities can be much greater than the benefits of R&D due to its spillover effects. This trend is exacerbated if the firm has a good public image. However, R&D activities are usually characterised by long, irreversible, and risky cycles, which inhibit the impulse and idea of corporate innovation. In this case, if the government can provide a certain amount of financial support, such as subsidies, then a new impetus may be gained for corporate innovation. Therefore, government subsidies are an important means of regulating market failures (Winston, 2007). Based on the resource-based view, the inflow of government resources can compensate for the shortage of firms’ own innovation resources, and government subsidies can also provide firms with relief from their financial constraints and allow them to relax through cash flow (Mani, 2002). Based on signaling theory, a government that provides large-scale subsidies and support to an industry sends a signal to the outside world; that is, such industry is highly recognised by the government and is the future direction of development, which brings a capital inflow from financial institutions and investment enterprises and balances the information asymmetry between enterprises and investors (Yang et al., 2019). On this basis, the following hypothesis was proposed.

*Hypothesis 3:* Government subsidies send innovation recognition signals to the market, reduce the business risks of service industry companies, and promote innovation capability.

**2. Methodology**

**2.1. Regression model selection**

Considering the advantages and disadvantages of the Regression Discontinuity model, and referring to Lee and Lemieux (2010), we present the following construct:

$$y_i = \alpha + \sum \beta_k (x - e)^k + \sum \gamma_k (x - e)^k D_i + \delta D_i + AW_a + B \ln W_b + \zeta_i \tag{1}$$

where  $y_i$  denotes the number of patent applications or patents granted by service industry companies, which is logarithmically normalised. The indicators of enterprise innovation capability naturally exhibit a left-skewed distribution, and most of the companies’ observed values are clustered in 0–5 patents, for which the dependent variable is logarithmically normalised. The histogram, which can be presented later, shows that the left bias of the variables is greatly improved. In Eq. (1),  $x$  is the grouped variable, the value of the annual data from 2000–2021, which is  $x=1$  for 2000 and  $x=22$  for 2021.  $e$  represents the time when the Free Trade Area Policy was implemented.  $D_i$  takes the value of 1 when  $x \geq e$  but 0 when  $x < e$ . In the regression equation, the parameter  $\delta$ , or Free Trade Area Policy on the innovation capacity of service industry companies, must be estimated and the result is the disposal effect.  $W_a$  and  $W_b$  indicate that the various control variables are added to the model in linear and logarithmic patterns, respectively. The Regression Discontinuity method is used

to obtain consistent and unbiased estimates without using control variables when performing model testing. However, control variables are necessary in the robustness test for model optimisation. Considering the long time span of the data used, in addition to the Free Trade Area, exogenous shocks affect the innovation capacity of service industry companies. As such, the Regression Discontinuity for the relevant events must be estimated to meet the robustness requirements.

## **2.2. Data**

### **2.2.1. Sample data selection**

The enterprise data were obtained from the WIND, CSMAR, State Intellectual Property Office, and China National Institutes databases. A-share listed companies in Shanghai and Shenzhen in the Guangdong Free Trade Area region were used as the sample. In the selection of the study period, 2010 is chosen as the starting observation year and the data from 2010–2021 are used as the sample for regression analysis. Within this time interval, the innovation level and internationalisation of Chinese Free Trade Area enterprises are in a relatively stable growth trend, which provides a suitable observation window and period for the study. In terms of other factors affecting the innovation capability of service enterprises, their input is also largely affected by relevant major events, such as the regional policy restrictions on foreign investment and the outbreak of the new Coronavirus disease in 2020. During the empirical regression analysis, trade-offs need to be made with respect to the external environment of the firm and the data availability. The selection of enterprises includes the following criteria: non-consecutive loss-making in the past five years; non-ST enterprises listed for three years or more; companies with incomplete variables that cannot be completed and have been delisted are excluded; and those with too many missing values of key indicators. As such, the final sample comprises 12,353 observations from 856 listed companies. The data collection includes international operations, financial indicators, and corporate governance from companies in the CSMAR (China Stock Market & Accounting Research Database). The databases related to the innovation capacity of service industry companies are derived from the State Intellectual Property Office, and the missing values of patents are obtained by manual search of the database of the Chinese Institute of Science. The calculation and collation of the values are carried out by using Excel and Stata software.

### **2.2.2. Sample data range**

Free Trade Area listed industries include professional and technical services, Internet and related services, warehousing, accommodation, insurance, public facilities management, other financial services, agriculture, forestry, animal husbandry and fishery services, health, business services, radio, television, film and video recording production, real estate, education, culture and arts, education, industry, sports and entertainment goods manufacturing, news and publishing, water transportation, telecommunications, radio and television and satellite transmission services, science and technology promotion and application services, leasing, textiles, clothing, apparel, air transport, loading and unloading and transport agency, computer, communications and other electronic equipment, money financial services, capital market services, software and information technology services, road transport, postal services, railroad transportation, retail trade, and catering.



### 2.3 Variable definition and measurement

The explanatory variables are the number of patent applications and of patents granted. In existing studies, the explanatory variables such as the innovativeness capability of a corporation typically use the company R&D expenses, the number of patent applications, the number of cited patent applications, the number of patents, and the number of cited patents. R&D is highly correlated with the company labour costs and the industry, and the input and output of innovation capabilities has a large gap. Possibly, the number of patent applications cited has not yet been noticed and identified by other companies given the short time of their availability. The number of patent applications is the result of enterprises' subjective initiatives. On the one hand, to protect their innovation achievements, enterprises protect their rights and interests by applying for patents. On the other hand, compared to the granting of patents, patent applications reflect the timelier innovation activities and their initial innovation investment. The internal dynamics of corporate innovation are affected by the fact that patent applications are subject to review by different levels of regulatory and examination bodies.

Furthermore, the nature of the patent is further examined. According to the classification of patent nature, patents are classified into two categories: utility and design innovation. These categories are used as the explanatory variables in further analysis, and the number of utility model patents better reflects the innovation ability of enterprises and brings them a stronger competitive advantage in the market.

The core explanatory variables include intellectual property protection, equity incentive, and government subsidies.

The intellectual property protection is measured using the number of intellectual property litigation cases. This paper measures the intensity of intellectual property protection by multiplying the enforcement intensity on the basis of a uniform GP index (Han and Li, 2005; Shi and Gu, 2013). The GP Index is an internationally accepted index of the strength of IPR legislation. China's GP Index increased from 2.51 in 1984, when the Patent Law was established, to 4.52 in 2010. The GP Index has remained unchanged at 4.52 during the subsequent period of 2010-2017, as the Patent Law has not been revised. When measuring the intensity of IPR enforcement, we refer to the practice of existing studies and implement the measurement from four perspectives: the intensity of intellectual property enforcement, the level of judicial protection, intellectual property protection awareness, and the level of economic development. Among these four, the strength of intellectual property enforcement is measured by the cumulative case completion rate; the level of judicial protection is measured by the proportion of the number of lawyers to the total population of the country (10,000 people); the awareness of intellectual property protection is measured by the number of patent applications received divided by the total population of the country (10,000 people); and the level of economic development is measured by the growth rate of the gross domestic product (GDP). The above study assesses the strength of intellectual property protection from the macro level and the level of intellectual property protection of service industry companies from the micro level. Meanwhile, the number of intellectual property litigation cases reflects the current status of intellectual property protection for enterprises.

The equity incentive adopts the internal gap of its levels as the measurement index. As stipulated in the "Management Measures of Equity Incentive for Listed Companies," incentive targets can include directors, senior management, core technical personnel, or core

business personnel of listed companies. In addition, other employees with a direct influence on the company's business performance and future development and whom the company believes must be incentivised can be included. In the present study, all employees other than executives are considered as core employees, and then the gap between their equity incentive levels is calculated.

Government grants are measured by using the amount of government grants received by service industry companies during the year. To distinguish between different government subsidies, we applied the two main indicators of direct government subsidies and tax rebates, which sum up the size of government subsidies.

Control variables area as follows: company's gross profit margin on sales (GPR), return on assets (ROA), accounts receivable turnover (ART), total assets turnover (TAT), earnings per share (EPS), operating cash flow per share (PSC), net assets per share (NAPS), and the number of years the company has been listed (Year).

ROA is chosen because the return can reflect the profitability of a company in assets. For R&D and innovation, technological improvement requires financial support, and the use of ROA can measure the company profitability, and thus its ability to innovate. The turnover of a company's assets and accounts receivables is a measure of their ability to use financial leverage and to repay funds. Firm age also has an impact on the ability to innovate. Companies that have been established for a short period of time may not be able to invest large amounts in R&D and in a timely manner. By comparison, companies that have long been established already have a more mature technology system and a logistical support platform in-house, and are thus better able to carry out their innovation activities, affecting their R&D and innovation. The variables are shown in Table no. 1:

**Table no. 1. List of variable definitions**

Variable Type	Variable Name	Variable Symbols	Variable Description
Explanatory variables	Corporation innovation_Patent Application	<i>Patent-apply</i>	Ln(Number of patents filed by the enterprise in year t + 1)
	Corporation innovation_Patent Grant	<i>Patent-gain</i>	Ln(Number of patents obtained by the enterprise in year t + 1)
	Corporation innovation_Patent Application_Utility Model Patent	<i>Patent-innov</i>	Ln(Number of utility model patents obtained by the enterprise in year t + 1)
	Corporation innovation_Patent Application_Design Patent	<i>Patent-design</i>	Ln(Number of actual appearance patents obtained by the enterprise in year t + 1)
Core explanatory variables	Intellectual property protection	<i>INT</i>	Intellectual property intensity
	Equity incentive	<i>INC</i>	Equity incentive level internal gap
	Government Grants	<i>SUB</i>	Size of government grants
Control variables	Company Profitability_Sales Gross Margin	<i>GPR</i>	Measuring the level of profitability and profitability of a company
	Company Profitability_Revenue on Net Assets	<i>ROA</i>	Measuring the level of profitability and profitability of a company

Variable Type	Variable Name	Variable Symbols	Variable Description
	Company Operating Capacity_Accounts Receivable Turnover	<i>ART</i>	Measuring the financial health and operating capacity of a company
	Company Operating Capability_Total Asset Turnover	<i>TAT</i>	Measuring the financial health and operating capacity of a company
	Current status of Company operations_Earnings per share	<i>EPS</i>	Measuring the financial indicators of the company's overall capacity
	Company's operating status_Operating cash flow per share	<i>PSC</i>	Measuring the financial indicators of the company's overall capacity
	Current status of the company's operations_Net assets per share	<i>NAPS</i>	Measuring the financial indicators of the company's overall capacity
	Number of years on the market	<i>Year</i>	Measuring the number of years a company has been listed

The results of descriptive statistics for the data of 856 sample companies are shown in Table no. 2.

**Table no. 2. Descriptive statistics for the full sample**

Variables	Mean value	Standard deviation	Minimum value	Maximum value
<i>Patent-apply</i>	2.43	67.24	10	424
<i>Patent-gain</i>	2.10	53.73	8	321
<i>Patent-innov</i>	1.15	42.35	2	225
<i>Patent-design</i>	1.02	65.35	5	127
<i>INT</i>	0.38	0.89	0.17	4.28
<i>INC</i>	0.63	0.1	0.11	1
<i>SUB</i>	16.23	1.69	5.66	23.19
<i>GPR</i>	30.52	115.31	-586	507.43
<i>ROA</i>	5.956	41.23	-37.06	2013.87
<i>ART</i>	760	15282.2	0	550149
<i>TAT</i>	0.5958	34.43	-0.0919	12.37
<i>EPS</i>	0.2733	15.23	-14.08	10.95
<i>PSC</i>	0.3936	56.34	-109.8	247.41
<i>NAPS</i>	4.178	240.2	-15.13	228.95
<i>Year</i>	8.34	6.23	3	16

Notes: The data comes from 856 listed companies selected from the China Stock Market & Accounting Research Database and analysed using Stata.

### 3. Results analysis

#### 3.1. Single variable test

The relationship between the levels of innovation of service industry companies and of non-service industry companies is also analysed. Table no. 3 presents the relationship between the innovation output of firms in the service and non-service sectors in the sample set for the

period of 2010-2021. Firms in the service sector have a generally higher level of innovation compared with the non-service sector.

**Table no. 3. Comparison and change in innovation capacity of sample companies (comparing services and non-services)**

Year	Service industry companies				
	Number of companies	Number of patent applications	Number of patents granted	The proportion of patent applications	The proportion of patents granted
2015	718	110	86	15.32%	11.98%
2016	855	187	110	21.87%	12.87%
2017	923	189	153	20.48%	16.58%
2018	829	192	152	23.16%	18.34%
2019	1146	200	165	17.45%	14.40%
2020	1183	202	175	17.08%	14.79%
2021	1189	204	180	17.16%	15.14%
Year	Non-service companies				
	Non-service companies	Non-service companies	Non-service companies	Non-service companies	Non-service companies
2015	2575	277	220	10.76%	8.54%
2016	2654	297	240	11.19%	9.04%
2017	2697	302	276	11.20%	10.23%
2018	2743	342	289	12.47%	10.54%
2019	2759	365	304	13.23%	11.02%
2020	2842	398	331	14.00%	11.65%
2021	2912	402	367	13.80%	12.60%

According to the results of the comparative analysis, the service sector performs better than the non-service sector in both the patent application and grant dimensions. Meanwhile, in terms of time, the innovative behaviour of both service and non-service industries gradually increases as the years pass.

For the variables in the model, Pearson's correlation analysis is carried out. As for the correlation linear coefficients, those between the variables are less than 0.5 and the possibility of multicollinearity is low. In comparison, the rest of the control variables are all related to the dependent variable, indicating that their selection is more accurate. (Table no. 4)

**Table no. 4. Pearson's correlation test coefficients**

	Patent-apply	Patent-gain	Patent-innov	Patent-design	INT	INC	SUB
<i>Patent-gain</i>	0.147						
<i>Patent-innov</i>	0.098	0.110					
<i>Patent-design</i>	0.087	0.029	0.083				
<i>INT</i>	0.697***	0.527**	0.696***	0.525*			
<i>INC</i>	0.784***	0.517**	0.687***	0.625**	0.157		
<i>SUB</i>	0.693***	0.726***	0.567**	0.538*	0.167	0.092	
<i>GPR</i>	0.787***	0.614**	0.677**	0.528*	0.165	0.082	0.097
<i>ROA</i>	0.872***	0.521*	0.773**	0.624**	0.169	0.082	0.096

	Patent-apply	Patent-gain	Patent-innov	Patent-design	INT	INC	SUB
ART	0.578**	0.539*	0.583*	0.735**	0.179	0.092	0.097
TAT	0.585**	0.618**	0.676**	0.525*	0.169	0.093	0.094
EPS	0.698***	0.739**	0.689**	0.539*	0.177	0.089	0.098*
PSC	0.675***	0.529*	0.579*	0.632**	0.178	0.099**	0.096
NAPS	0.589**	0.521*	0.579*	0.711***	0.179*	0.089	0.098*
Year	0.788***	0.527*	0.879**	0.529**	0.169	0.093	0.097
	GPR	ROA	ART	TAT	EPS	PSC	NAPS
ROA	0.233*						
ART	0.267*	0.193					
TAT	0.256*	0.194*	0.235*				
EPS	0.278**	0.194*	0.239*	0.199**			
PSC	0.299**	0.189	0.241*	0.185	0.131		
NAPS	0.278**	0.194*	0.239*	0.199**	0.133	0.239	
Year	0.293**	0.192	0.253*	0.196**	0.137	0.272*	0.173

Note: \* indicates a 10% significance level, \*\* indicates a 5% significance level, and \*\*\* indicates a 1% significance level. Data in parentheses are standard deviations.

### 3.2. Regression Discontinuity estimation

First, we test the continuity for the grouping variables. In the model, the time node of the Guangdong Free Trade Area implemented in 2015 corresponds to  $e=5$ . The *rd* density test is run for the point location, and the continuous density function of the grouping variables is obtained as  $p=0.232$ , which verifies the basic hypothesis of Regression Discontinuity. No artificial manipulation is needed for this point, which is in line with the basic hypothesis of Regression Discontinuity and can be performed using parametric and non-parameter estimates.

A local linear regression with parameters is performed on the sample data, and a first-order polynomial is fitted to a second-order polynomial after adding each control variable. Subsequently, the Regression Discontinuity command *rd* in Stata 13 is used to obtain the optimal bandwidth  $h = 3.21$  at this time point. The results of the local linear regression are shown in Table no. 5. In the initial model without control variables, the model adjusted  $R^2$  is 0.6710 and the fitted results are as expected.

**Table no. 5. Unstandardized results of Regression Discontinuity without including parameter estimates of control variables**

Patent Application					
	Model 1	Model 2	Model 3	Model 4	Model 5
$X-e$	309.27* (18.053)	313.03** (22.503)	291.95** (19.052)	310.22*** (20.053)	284.04*** (13.052)
$D*(X-e)$	3242.56*** (33.043)	—	3030.38*** (25.032)	2777.46* (14.032)	3401.88** (18.032)

Patent Application					
	Model 1	Model 2	Model 3	Model 4	Model 5
$D*(X-e)^2$	—	3024.54** (21.022)	—	—	—
$INT$	-0.221*** (0.031)	-0.209*** (0.032)	—	-0.303*** (0.033)	-0.291** (0.022)
$INT^2$	—	—	0.1989*** (0.011)	—	—
$INC$	-0.301*** (0.021)	-0.299* (0.020)	-0.300*** (0.020)	—	—
$INC(-1)$	—	—	—	-0.411** (0.023)	—
$INC(-2)$	—	—	—	—	-0.334* (0.033)
$SUB$	0.291* (0.042)	0.266** (0.032)	0.286* (0.042)	0.301** (0.063)	0.388** (0.073)
$\bar{R}^2$	0.717	0.688	0.771	0.590	0.690
Patent Grant					
	Model 1	Model 2	Model 3	Model 4	Model 5
$X-e$	390.32*** (20.064)	333.13** (15.063)	289.37* (10.052)	353.94*** (23.063)	301.84** (19.058)
$D*(X-e)$	3242.56*** (14.063)	—	2990.64*** (15.033)	3011.57** (11.033)	3177.65*** (17.042)
$D*(X-e)^2$	—	3024.54** (18.003)	—	—	—
$INT$	-0.281*** (0.022)	-0.301** (0.033)	—	-0.345*** (0.036)	-0.321*** (0.053)
$INT^2$	—	—	0.311* (0.063)	—	—
$INC$	0.319* (0.065)	0.299*** (0.059)	0.340** (0.073)	—	—
$INC(-1)$	—	—	—	0.380** (0.039)	—
$INC(-2)$	—	—	—	—	0.322*** (0.073)
$SUB$	0.401* (0.073)	0.381** (0.063)	0.410*** (0.074)	0.319* (0.062)	0.370* (0.070)
$\bar{R}^2$	0.789	0.605	0.722	0.690	0.702
F	222.001	166.655	200.001	189.996	235.446

Note: \* indicates a 10% significance level, \*\* indicates a 5% significance level, and \*\*\* indicates a 1% significance level. Data in parentheses are standard deviations.

Table no. 5 reports the regression results for the effect of intellectual property protection on enterprise innovation capability. Models 3 and 4 are the regression results for the control variables while Models 1 and 2 are those with the inclusion of explanatory variables. Hypothesis 1 suggests that intellectual property protection has a U-shaped relationship with the enterprise innovation capability. The results of Models 2 and 6 show that the level term

of intellectual property protection (*INT*) has a significant negative effect on patent applications and grants. The squared term of intellectual property protection (*INT*<sup>2</sup>) significantly and positively affects patent applications and grants, supporting Hypothesis 1. The findings are contrary to Im and Shon (2019), who concluded an inverted U-shaped relationship between the degree of industrial technology imitation and innovation activities, as well as between the degree of industrial technology imitation and the value of corporate innovation, which may differ from the current scenario. The sample firms in Im and Shon's (2019) study are from the United States, which is the leading country in technology, whereas the present study sample is from the establishment of the Guangdong Free Trade Area in 2015, which has been in place for six years now. The Guangdong Free Trade Area is in the middle level strength of intellectual property protection and is most unfavourable to the improvement of corporate innovation quality and sustainability. This level not only reduces competition and restricts enterprise access to knowledge and technology from outside, but also fails to adequately protect their independent innovation capability, which is not conducive to further enhancement.

The internal gap in equity incentive level has a significant negative effect on the enterprise innovation capability. As the level of equity incentive for executives becomes higher than those for core employees, the corporate R&D expenditure in the year after the implementation of the equity incentive also increases. Meanwhile, the number of corporate patent applications decreases in one and two years after the implementation of the equity incentive, supporting Hypothesis 2 that the increase in the internal gap of the equity incentive level increases the corporate R&D expenditure but decreases the output of corporate innovation. From the sample firms in the Guangdong Free Trade Area, the executives are mainly responsible for formulating corporate innovation strategies and hold the decision-making power on resource allocation of the firm. When the level of equity incentive is high, executives tend to increase R&D expenditures and enhance the long-term firm value through innovation, which is reflected in increased share prices of the company such that executives can obtain long-term incentive gains. By comparison, Core employees are the real executors and direct participants in the innovation. When the levels of equity incentive have a large internal gap, core employees realise the mismatch between their contribution and reward. They become prone to opportunistic behaviour, laziness, and free-riding in the process of innovation activities, which leads to low innovation efficiency and reduced innovation output.

Government subsidies have a significant positive effect on both patent applications and grants of enterprises, supporting Hypothesis 3. The strong dependence of corporation innovation performance on R&D funding results in government subsidies becoming important means for supporting new industries. Thus, governments can bring huge cash flow to corporate R&D activities, reduce the risk of R&D failure, and stimulate the corporation's enthusiasm for innovation.

For patent applications, the effect of Free Trade Area implementation is positively significant in terms of the coefficient of *D*. In late 2015, the number of patent applications by companies showed a clear increase. However, for patent grants, the coefficient of *D* is insignificant, indicating that the policy effect of the Free Trade Area is not as effective. Meanwhile, to further estimate and suggest the validity of the Free Trade Area during its first implementation in 2015, the local polynomials of the parameters at the breakpoints are treated for 1<sup>st</sup> and 2<sup>nd</sup> order, and both cases with and without the inclusion of control variables are

considered. The regression results show that the inclusion of control variables or the choice of a 2<sup>nd</sup>-order expression still reflect the valid prediction of the model.

### 3.3. Further analysis

The different levels of patent applications are further subdivided into new utility and design patents. A new utility patent refers to a new technical solution for the shape, construction, or combination thereof of a product that is suitable for practical use. In comparison to invention patents, utility patents are less inventive and innovative but can still be used as a way to measure the level of corporate innovation. Another type of patent application is for design, which, according to the Patent Law, refers to a new look that is aesthetically pleasing and suitable for industrial application based on the shape or pattern of a product or a combination thereof, as well as the combination of colour and shape or pattern. For utility and design patent applications, the same method of Regression Discontinuity is used for estimation. The results for utility patent applications are consistent with those for general patent applications; that is, the establishment of the Free Trade Area Policy has a positive effect on utility patent applications but shows no similar effect on design applications. (Table no. 6)

**Table no. 6. Coefficient results of Regression Discontinuity D for parameter estimation (new utility patent/design patent)**

	New Utility Patent		Design Patent	
<i>X-e</i>	288.55* (10.043)	212.64** (14.032)	317.36** (11.043)	258.94** (15.042)
<i>D*(X-e)</i>	1923.42*** (19.071)	1524.56** (24.061)	1452.67* (17.051)	1242.98*** (26.041)
<i>INT</i> <sup>2</sup>	0.251* (0.052)	0.198* (0.031)	0.299 (0.033)	0.211 (0.031)
<i>INC</i>	-0.361** (0.033)	-0.311* (0.033)	-0.288* (0.022)	-0.300 (0.022)
<i>SUB</i>	0.401* (0.038)	0.377* (0.043)	0.367 (0.033)	0.299 (0.012)
<i>GPR</i>	—	42.121** (0.061)	—	30.177 (0.052)
<i>ROA</i>	—	-191.001* (0.070)	—	-156.471* (0.061)
<i>ART</i>	—	0.211* (0.052)	—	0.233 (0.062)
<i>TAT</i>	—	0.301* (0.063)	—	0.255* (0.052)
<i>EPS</i>	—	0.281* (0.069)	—	0.311 (0.029)
<i>PSC</i>	—	0.190* (0.041)	—	0.188* (0.031)
<i>NAPS</i>	—	0.204** (0.051)	—	0.155 (0.041)
<i>Year</i>	—	0.013** (0.010)	—	0.020* (0.012)
$\bar{R}^2$	0.811	0.601	0.741	0.599
F	299.911	166.633	211.111	199.658

Note: \* indicates a 10% significance level, \*\* indicates a 5% significance level, and \*\*\* indicates a 1% significance level. Data in parentheses are standard deviations.



3.4. Robustness tests

The first robustness test is non-parametric. For the time point  $e=5$ , the *rd* command of Stata 13 is applied for the non-parametric test, which requires the selection of different bandwidths and kernel functions for the Regression Discontinuity. According to the criterion, different bandwidths  $h$  are selected such that  $h = 0.5, 0.75, 1.25, 1.5$ . That is, the kernel functions are estimated for the optimal bandwidths of  $1/2, 3/4, 3/4, 3/2$  of the size distribution. Based on the determination of the disposition effect, a similar conclusion is obtained by choosing different hyperparameters such that the point can be considered as an important jump. (Table no. 7)

**Table no. 7. Results of coefficients of Regression Discontinuity D for choosing different bandwidths**

Bandwidth size	Triangular Core	Core Matrix
0.5h	1824.991** (20.087)	1420.213*** (19.097)
0.75h	1882.320*** (23.078)	1939.131* (18.086)
1.25h	1570.923* (10.081)	1899.023*** (9.081)
1.5h	1223.403*** (12.066)	1287.145* (15.076)

Note: \* indicates a 10% significance level, \*\* indicates a 5% significance level, and \*\*\* indicates a 1% significance level.

Moreover, to ensure the validity of the Regression Discontinuity, the continuity of each control variable at the breakpoint is examined in the robustness test. According to the *rd* command in Stata, each control variable is continuous at  $e=5$ . Table no. 8 shows the results, where the control variables maintain continuous continuity at the breakpoints, but none are observed at  $e=5$ .

**Table no. 8. Parameter estimates for control variables at  $e=5$**

	B	Std	Sig
<i>GPR</i>	0.139	0.041	0.580
<i>ROA</i>	0.020	0.012	0.893
<i>ART</i>	-0.209	0.033	0.125
<i>TAT</i>	0.508	0.042	0.380
<i>EPS</i>	0.020	0.001	0.481
<i>PSC</i>	0.412	0.091	0.460
<i>NAPS</i>	0.302	0.240	0.542
<i>Year</i>	0.110	0.173	0.182

4. Discussion

All the empirical results in this study support the proposed hypotheses. In the context of China's vigorous construction of free trade pilot zones, institutional innovation brings policy dividends, while intellectual property protection, equity incentives, and government subsidies have positive effects on the innovation output of service industry companies. The policy dividend is brought by the system innovation.

First, Table no. 5 reports the regression results of the effect of intellectual property protection on enterprise innovation capability. The level term of intellectual property protection has a significant negative effect while its squared term has a significant positive effect on patent applications and grants, which verifies Hypothesis 1 that intellectual property protection has a U-shaped relationship with enterprise innovation capability. When intellectual property protection is weak, firms benefit more from knowledge and technology spillovers. Due to the emergence of competing products flooding the market, market competitiveness increases, and innovators invest more in R&D due to the fear of being overtaken by imitators and reducing their profits (Jeng and Pak, 2016). As intellectual property protection strengthens, corporate innovation efforts are likely to decline. However, the further increase of intellectual property protection promotes corporate innovation investment, protects investment monopoly rents and profits, reduces information asymmetry, frees up the industry base for firms to build, and again stimulates enterprises to innovate (Li, 2020).

Second, Models 1-5 in table no. 5 report a significant negative effect of the intra-equity incentive level gap with enterprise innovation capability. As the level of equity incentives for executives becomes higher than that for core employees, the corporate R&D expenditure in the year after the implementation of the equity incentive also increases. However, the number of corporate patent applications in the one and two years after the implementation of the equity incentive decreases, supporting Hypothesis 2 that the increase in the internal gap in the level of equity incentives increases corporate R&D expenditure, but reduces corporate innovation output (Pan et al., 2020). Core employees are the real implementers and direct participants in innovation programs, and may feel unfairly rewarded when the level of equity incentive has a large internal gap. The role of equity incentive weakens, thereby reducing their motivation to innovate (Vuksanović et al., 2022).

Third, government subsidies in Table no. 5 have a significant positive effect on both patent applications and grants, supporting Hypothesis 3. That is, government subsidies send innovation recognition signals to the market, reduce the business risk of service industry companies, promote innovation capability, and corporate innovation performance has a strong dependence on R&D funds. Government subsidies can thus stimulate the innovation enthusiasm of companies (Yang et al., 2019).

Fourth, the coefficients of patent applications and grants are further analysed. For patent applications, the coefficient shows that the effect of Free Trade Area implementation is positively significant, and the number of patent applications by firms shows a clear jump at the end of 2015. However, for patent grants, the coefficient is insignificant, indicating that the policy effect of the Free Trade Area is not effective and may have a certain lag (Song and Guo, 2019).

Fifth, the different levels of patent applications are further subdivided into new utility and design patents. The results for utility patent applications are consistent with those for general patent applications. That is, the establishment of the Free Trade Area Policy has a positive effect on utility patent applications (Albort-Morant et al., 2018), but shows no similar effect on design applications (Schilke, 2014).

## Conclusion and insights

### Main findings

This study adopts secondary data of firm dimension, combined with panel data of service industry companies listed in Shanghai and Shenzhen A-shares in the Guangdong Free Trade Area. A parametric Regression Discontinuity model is used to analyse the mechanism of influence of policies such as Free Trade Area intellectual property protection, equity incentives, and government subsidies on the innovation capability of service industry companies. The main conclusions obtained in this study are as follows: First, intellectual property protection and the innovation capability of service industry companies show a U-shaped relationship; as the strength of intellectual property protection increases, the innovation capability of service industry companies first decreases and then increases. Second, expanding the gap within the level of equity incentives increases the R&D expenditures but reduces the innovation capacity of service industry companies. Third, government subsidies send innovation recognition signals to the market, reduce the business risks of service industry companies, and promote innovation capacity. Moreover, the Free Trade Area Policy affects the innovation of service industry companies in terms of their patent applications, with a significant increase before and after the policy implementation. Moreover, in different patent dimensions, the Free Trade Area Policy significantly affects the number of utility model patents, but shows no similar effect on the number of design patents.

### Management insights

The findings imply the need for the following:

- Strengthen intellectual property protection, further improve and revise intellectual property protection-related laws and regulations, and improve the applicability of legislation; improve the functions of intellectual property legislation, judicial, and administrative protection, and their articulation mechanisms; clearly define property rights, protect the intellectual property rights of Free Trade Area enterprises, and give full play to the incentive effect of property rights on enterprises; adopt new-age information technology to realise the effective connection of isolated information such as patents, trademarks, and trade to open up intellectual property information silos, and improve the efficiency of service industry companies in carrying out IPR transactions.

- Promote equity incentive policy; accelerate the improvement of the performance allocation system that encourages innovation and creativity of talents; create a system that encourages the participation of intellectual property production factors such as knowledge, patents, technology, and management in the distribution to motivate talents to innovate; utilise the leverage of financial policies to improve the Free Trade Area “government-oriented rewards, the main unit rewards, supplemental social rewards” talent reward system, the formation of talent selection criteria and rewards, and the distribution of innovation incentives for talent.

- Optimise the structure of financial support; Establish a screening and selection mechanism for target enterprises with substantive innovation as the main focus and overall innovation as a supplement, then precisely support R&D funds to ease the pressure on

enterprises and achieve high-quality innovation output; Perfect the tax policy system of the GSP to support corporate innovation and appropriately increase the tax incentives for regions with low marketization. The comprehensive use of “pre-support” and “post-subsidy” means optimising the combination of policy instruments.

- At the corporate level, shares or equity interests are granted to incentive recipients in the form of a contract to promote their positive value from the perspective of property rights. Thus, the purpose of enhancing the firm value and improving the governance structure can be achieved, and thereby reflect the characteristics of Free Trade Area equity incentive.

### Research shortcomings and prospects

This paper reveals the influence mechanism between the Free Trade Area Policy and the innovation capability of service industry companies, but several questions remain to be solved. First, the strong promotion of China’s Free Trade Area occurred in 2015, and the policy effect interval is relatively short, which may cause bias in the estimation results. Second, the selection of Guangdong, a representative region, as the sample for the empirical study is appropriate for the service industry, although corporate innovation in other industries is ignored. Third, the construction of the Free Trade Area itself has an enhancing effect on the output level of corporate innovation, perhaps not only limited to intellectual property protection, equity incentive, and government subsidies, but also to a strong relationship with the nature and size of enterprises. For example, the above effect differs between state-owned and non-state-owned. The lack of an analysis of property rights and enterprise size in this study may provide a direction for future research.

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