Judicial Protection of Intellectual Property Rights and Innovation, Evidence from China

Abstract

This paper empirically investigates how China's judicial protection of IPR affects corporate innovation both in the short run and long run. We show that IPR protection immediately enhances innovation mainly by increasing corporate transparency and social trust. We further explore the development patterns of IPR protection using continuous exposure methods, and find that sustained and long-term judicial protection of IPR is essential for better promoting corporate innovation.

Introduction

Research in law and finance posits that a solid and effective legal infrastructure is indispensable for fostering the growth of corporate and financial market domains (La Porta et al., 1997). Innovation is the core driver of economic development (Solow, 1957), playing an essential role in enabling companies to secure a competitive edge (Lengnick-Hall, 1992; McGrath et al., 1996). The burgeoning literature in corporate finance shed light on theoretical and empirical studies to examine the impact of firm-level characteristics (Fang et al., 2014; Balsmeier et al.,2017; Lu and Wang, 2018), external legal rules (Brown and Petersen, 2013) and stock market liberalization (Moshirian et al., 2021) on corporate innovation (Brown and Petersen, 2013). The judiciary serves as an important institutional arrangement, upholding justice, enforcing laws and facilitates better intellectual property right (IPR) protection (Lai et al., 2023).

Despite the importance of the topic, the question of how judicial protection on IPR affects corporate innovation has not been well examined, particularly in countries where IPR protection is not as robust. Moreover, current research has not adequately explored the long-term relationship between judicial protection and innovation, highlighting the need for continuous governmental commitment to safeguarding IPR.

Our study seeks to examine the causal impact of judicial protection of IPR corporate innovation. It explores whether judicial protection is a long-term process that needs to be carried out to promote innovation in firms effectively. The research focuses on China for two main reasons. First, despite China generally has a poor record on IPR protection (Fang et al., 2017, Lai et al., 2023), It has experienced robust and continuous economic growth (Allen et al., 2005), which provides an interesting setting to examine our research question. China's IPR regime has historically faced challenges that include inadequate legal frameworks, enforcement deficiencies, and a cultural landscape where respect for intellectual property is not as deeply ingrained as in other regions. As a result, the innovation ecosystem in China has had to navigate a complex terrain where the fruits of creativity and invention are not always adequately protected. Second, China has seen a dramatic increase in patent innovation. Yet, amidst this impressive influx of patents, concerns and critiques have been widely directed towards the overall quality of these intellectual property filings (Cui et al., 2023). Third, innovation has gradually become the driving force behind high-quality China’s economy (Fang et al., 2017), understanding how the long-term effect of institutions on promoting corporate innovation within China can offer valuable insights to other nations that are in transition

or are emerging economies.

To investigate the effects of judicial protection of IPR and corporate innovation, we use the closing rate of intellectual property cases as a proxy of judicial protection of IPR. We then examine the possible mechanisms on how judicial protection of IPR affects corporate innovation. In addition, we follow the method of Takatsu and Westling (2024), we examine the long-term effects of the judicial protection system to assess whether there is a need to continue implementing strong intellectual property rights judicial protection policies. By employing the debiased estimator and taking into account the long-term and dynamic nature of firms' exposure to judicial environments, we are capable of capturing the cumulative effects of judicial protection on innovation. This approach effectively mitigates the influence of omitted variable biases typically present in static models. Moreover, it reduces the bias stemming from endogeneity, allowing for a more precise measurement of how intellectual property judicial protection influences innovative activities.

Using a sample of Chinese A-share listed firms from 2008 to 2022, our finding shows that firms located in cities with stronger judicial protection of IPR have higher innovation outputs. A one-unit standard deviation increase in judicial protection of IPR leads to a 2.6% increase in patent innovation and a 5.2% increase in firm R&D investment. The mechanism tests indicate that stronger judicial protection of IPR increases corporate innovation by increasing social trust, information transparency, and firm governance. The positive effects of judicial protection of IPR are more pronounced for non-SOE firms and cities with a higher GDP. We further examine the long-term

effect of judicial protection of IPR on corporate innovation and our results indicate that the long-term process of IPR protection needs to be carried out to promote innovation in firms effectively.

The study makes several important contributions to the existing literature and policy discussion. First, our research contributes to the literature linking legal system and innovation. Previous literature primarily adopts a cross-country comparative perspective to examine the impact of the level of IPR in various countries on corporate innovation (Branstetter et al., 2006; Sweet and Maggio, 2014). However, there are differences in both the legal provisions and the enforcement levels of intellectual property protection across countries, making it difficult to clearly discern which factor plays a role. Other studies typically examine a single law within a country (Lerner, 2009; Brown, 2013; Lin et al., 2021; Acharya et al., 2014). For example, Brown (2013) and Lin et al. (2021) explore how innovation is affected by shareholder protection and litigation. Acharya et al. (2014) examine the effect of labor law on corporate innovation. Our research complements these studies using constructing cross-city comparative IPR judicial protection index. Since there are only differences in the judicial strength of IPR protection among cities in our country, without any legislative differences, allows us to focus more on examining the impact of the judicial protection of IPR judicial protection of IPR on corporate innovation.

Second, the study contributes to the literature on the long-term effect of institutional policy. The core viewpoint of legal system and finance holds that a robust and efficient legal system is a crucial factor in safeguarding financial development and

economic growth (La Porta et al., 1997). However, Allen et al. (2005) have pointed out that China's development over the past 30 years has diverged from this theory. Despite the underdeveloped legal system, China has achieved sustained and robust economic growth. Sweet and Maggio, (2014) argue that stronger protection of IPR is positively related to corporate innovation in countries that are more developed and complex, but non-significant effect on developing countries. Our research first provide evidence that China and other developed countries also need a strong judicial IPR protection system to protect corporate innovation. In addition, our study delves into the long-term implications of institutional policies. We have analyzed the specific implementation of policies regarding judicial protection of intellectual property rights in cities at different stages of development, offering valuable insights for policymakers. Our findings indicate that for regions with weak intellectual property judicial protection, increasing investment to refine the intellectual property protection system can provide enterprises with robust legal assurance, thereby encouraging innovative activities. In areas where the level of innovation is relatively stable, governments and relevant institutions should enhance corporate confidence in innovation and foster a positive interaction between intellectual property protection and innovative activities through policy guidance, financial support, and legal services, with the aim of achieving a steady increase in innovation levels in the long term.

2. Institutional background and hypothesis development

2.1 Chinese judicial IPR protection

The institutional background of China's intellectual property judicial protection is closely linked to the development of China's intellectual property protection legal system. Since the reform and opening up, China's intellectual property legal system has gone through a process of starting from scratch and gradually improving. After China joined the World Trade Organization (WTO), to comply with the requirements of the Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPs) and further strengthen the legal protection of intellectual property rights, relevant laws such as the Patent Law, Trademark Law, and Copyright Law were revised. The judicial protection system for intellectual property in China is constantly strengthening, including the establishment of specialized intellectual property courts such as those in Beijing, Shanghai, and Guangzhou, as well as the establishment of the Intellectual Property Court of the Supreme People's Court, all of which mark the improvement of China's intellectual property judicial protection level.

China began formal recognition and protection of IPR in 1980, when it became a member of World Intellectual Property Organization, the IPR protection is important at a local level for reasons below. In the United States, the judicial system is more decentralized, and each state has significant autonomy. In China, defendants cannot arbitrarily choose their jurisdiction, which helps to prevent forum shopping and ensures a more uniform application of justice. Secondly, with the surge in patent applications in China, there is an urgent need for an enhanced IP judicial protection system. The increase in patent filings highlights the importance of a robust legal framework that can effectively protect and enforce IPR. Ang et al. (2014) has revealed significant

disparities in the protection of IPR across different regions in China, underscoring the critical importance of employing municipal-level indicators for assessment. Moreover, China's emphasis on strengthening IP judicial protection at the local level is not only about safeguarding innovation but also about promoting economic development and competitiveness.

2.2 Chinese judicial IPR protection and innovation

Existing literature has studied the impact of firm-level characteristics (Mukherjee et al., 2017; Balsmeier et al., 2017) and formal institutions on innovation (Brown et al., 2013; Cerqueiro et al., 2016). Earlier studies have indicated that the legal framework significantly influences the motivation for corporate innovation. (La Porta et al., 1998; Hassan et al., 2021).

In this section, we suggest that stronger judicial protection of IPR affects corporate innovation. First, from the internal perspective of firm, a stronger judicial protection of IPR restrains insiders' opportunistic behaviors, improves firms' information transparency and better protects shareholders' interests (Moshirian et al., 2021). Consequently, managers are incentivized to direct resources more efficiently towards innovative endeavors with long-term potential, rather than misappropriating these assets for personal gain. Second, from the perspective of legal and financing environment, strong judicial protection of IPR enhances investor trust and confidence within the capital markets, thereby improving companies' ability to secure external funding. (Brown et al., 2009). Innovation of firm is regarded as a risky long-term

investment. In scenarios where there is legal uncertainty, corporate leaders tend to reduce these investment activities. (Julio and Yook, 2012). A strong judicial protection of IPR ensures the effort in investing in innovative projects are protected, which in turn motivates firms to engage in innovative activities.

Hence,

H1: A strong judicial IPR protection will increase firm's innovation.

2.3 The mechanisms between judicial IPR protection and innovation

2.3.1 Information transparency

In this section, we suggest that stronger judicial IPR protection leads to better information transparency of firms and in turn promotes corporate innovation. The strengthening of judicial protection for intellectual property rights creates a fair and legally safeguarded environment for innovation for businesses. The increased transparency brought about by strong IPR judicial protection allows firms to better assess the risks and potential rewards associated with their innovation efforts. Investors and partners are also more inclined to engage with firms operating in such a transparent environment, as they can trust in the legal framework to safeguard their contributions and investments. This environment encourages companies to disclose their research and development outcomes and innovative information because they trust that such information will not be illegally copied or misused. The establishment of this trust promotes cooperation between enterprises, as they know that their partners are less likely to steal or misuse their intellectual property. Moreover, a robust intellectual

property protection mechanism reduces the legal risks that businesses face due to lack of transparency, enhances their competitiveness, and drives the improvement of corporate transparency through regulatory requirements and international standards.

2.3.2 Social trust

Firms located in a better judicial IPR protection city increase its social trust to investors, thereby increasing firms' access to external financing and motivating firms to engage in innovative resource activities. Good judicial protection can ensure that the innovative achievements of enterprises are fully safeguarded by law, thereby enhancing the confidence of market participants, including investors, partners, and consumers, who believe that innovative achievements will not be easily infringed upon. At the same time, this protection motivates enterprises to make more R&D investments and innovative attempts, as they know they can gain economic returns from innovation, and this economic incentive is an important driving force for continuous innovation in enterprises. The good reputation of a city's intellectual property protection can attract foreign investors and multinational companies, and the inflow of these external resources (such as R&D cooperation) helps to enhance the innovative capabilities and global competitiveness of local enterprises, jointly promoting the development of enterprise innovation (Becker and Dietz, 2004; Kondo et al., 2021).

Hence:

H2: A strong judicial IPR protection will increase firm's innovation by increasing firms' information transparency and social trust.

3 Data and methods

3.1 Data

Our data is obtained from several sources. First, we obtain firm-level patent data from IncoPat database. Patent data serves as one of the innovation proxies because they capture the output of innovation activities (Lai et al., 2023). Firm-level financial data are obtained from China Stock Market and Accounting Research (CSMAR) database. Our sample includes Chinese A-share firms listed between 2008-2021. We exclude financial industries and ST firms. To mitigate the potential estimation bias caused by outliers, we winsorize all continuous variables at the 1st and 99th percentiles.

3.2 Variables

3.2.1 Innovation measurements

Following existing literature on economics of innovation indicates that a company's patenting activities are reflective of the quality and scope of its innovation efforts. Consequently, patent data are widely used for assessing the level of innovation within a firm. (Chava et al., 2013; Bernstein, 2015). Dosi et al. (2006), Hall and Harhoff (2012) points out the innovation behavior of enterprises measured by patent applications sometimes manifests as a strategic behavior, whose purpose is not to substantially improve the technological competitiveness of enterprises, but to obtain certain benefits. Often, it manifests as catering to government policies and regulations. the patent system categorizes patents into three main types: invention patents, utility model patents, and design patents. Invention patents represent the most innovative

category, as they are granted for new technical solutions that pertain to products, reflecting a high level of ingenuity and creativity. Hence, we follow Tian and Wang, using patents as the proxy of firm innovation. We use the proportion of invention patents over total patents as the innovation measure of a firm. The financing of R&D is essential for fostering innovation and driving economic growth in today's economy. (Brown et al., 2009). Our second proxy for firm innovation is R&D investment following existing literature (Hirshleifer et al., 2012; Brown et al., 2009). We take the natural logarithm of one plus the R&D investment.

3.2.2 Measure of judicial IPR protection

The strength of judicial protection available to patent owners when their rights are infringed upon is an important aspect of the patent system (WIPO, 2018). Therefore, we use the number of intellectual property cases closed by the People's Court at the city level ($IPPCourt_{jt}$) to measure the intensity of IPR protection at the city level. The data on the number of intellectual property cases closed in this paper comes from the Peking University Treasure Law Judicial Case Database. We select the number of intellectual property cases closed by the People's Courts of various cities included in the Peking University Treasure Law Judicial Case Database as a proxy variable for the number of intellectual property cases closed in that city. Taking into account the impact of city size, we use the city's GDP to scale the proxy followed WIPO (2018). In addition, the research constructs judicial IPR protection index at the city level using RCA, the equation is as follows.

$$IP\_Level = \frac{IPPCourt_{jt}/GDP_{jt}}{IPPCourt_{ct}/GDP_{ct}}$$

Where IP_Level is judicial IPR protection index at the city level based on the number of intellectual property trials concluded in city j in year t. The larger the index, indicating a stronger judicial IPR protection. $IPPCourt_{jt}$ and GDP_{jt} represent the number of intellectual property trial cases and GDP of city j in year t, respectively. $IPPCourt_{ct}$ and GDP_{ct} represents the number of intellectual property trial cases and GDP of China in year t.

3.2.3 Empirical model

The research exploits the relationship between judicial IPR protection and innovation. Specifically, we construct the following OLS regression model as follows:

$$Innovation_{it} = \alpha + \beta IP\_Level_{i,t} + \theta Controls_{i,t} + Year + Industry + \varepsilon_{i,t}$$

Where $Innovation_{it}$ is the measurement for firm's innovation. The core explanatory variable is $IP\_Level_{i,t}$, which is judicial IPR protection index at the city level based on the number of intellectual property trials concluded in city j in year t. We then match this index to the firms based on their location. We include a set of firm characteristics as control variables to explain innovation: Return on Asset (ROA), FirmSize, TobinQ and leverage.

4 Results and discussion

4.1 Summary statistics

Table 1 presents the summary statistics of our research. Our measurements for

innovation are Inv_patent and R&D (log). The mean of Inv_patent and R&D (log) are 0.475 and 18.013 respectively. The mean of IP_Level is 0.566, and the maximum value of IP_Level is 3.751. This indicates that the judicial IPR protection is relatively low in most places.

Table 1 Summary statistics and variable descriptions

Panel A Summary statistic					
Variable	Observations	Mean	Std. Dev.	Min	Max
Inv_patent	23117	0.475	0.344	0.000	1.000
R&D (log)	23117	18.013	1.434	8.854	25.025
IP level	15239	0.566	0.540	0.000	3.751
ROA	23117	0.03	0.043	-2.505	0.635
FirmSize	23117	9.490	0.529	7.620	12.371
TOBINQ	23109	2.076	1.367	0.629	57.324
Leverage	22355	2.349	16.839	-38.190	2105.598

Panel B Variable description	
Inv_patent	The proportion of invention patents over total patents as the innovation measure of a firm.
R&D (log)	The natural logarithm of one plus the R&D investment.
IP level	Judicial IPR protection index at the city level based on the number of intellectual property trials concluded in city j in year t.
ROA	Return to total asset.
FirmSize	Firm size variable defined as the total asset of a firm.
TOBINQ	The market value of a company relative to its replacement cost.
Leverage	Leverage of firm, defined as total debt divided by total asset amount.

4.2 Judicial IPR protection and corporate innovation: Baseline result

The paper first investigates how judicial IPR protection affects corporate innovation. Table 2 provides the baseline results. Standard errors, clustered at the firm level, are shown in the parenthesis. Columns (1) to (4) report the OLS regression results. Columns (1) and (2) use *Inv_patent* as the dependent variable, which is measured as the proportion of invention patents over total patents as the innovation measure of a firm.

Columns (3) and (4) use *R&D* as the dependent variable. The coefficients in all four columns are statistically positive at the 1% level, supporting the idea that a strong judicial IPR protection will increase firm's innovation's level. When companies know that their inventions, designs, and creative works are safeguarded by a strong legal framework, they are more likely to invest in research and development, as they can be confident that their intellectual assets will not be easily copied or stolen. Taking the results from Column (2) and Column (4), the estimated coefficients of *IP_protection* are 0.026 and 0.052 respectively. The results find that one unit increase in *IP_protection* level leads to a 2.6% increase in *Inv_patent* and a 5.2% increase in *R&D*.

Table 2 Baseline regression

	Inv_patent	Inv_patent	R&D	R&D
VARIABLES	（1）	（2）	(3)	(4)
IP level	0.027***	0.026***	0.048**	0.052***
	（0.006）	(0.006)		(0.017)
ROA		-0.032		3.131***
		(0.099)		(0.281)
Firmsize		0.025**		1.894***
		(0.010)		(0.040)
TobinQ		0.001		-0.002***
		(0.002)		(0.000)
Leverage		-0.000		-0.000
		(0.000)		(0.000)
Year	YES	YES	YES	YES
Industry	YES	YES	YES	YES
N	16,897	16,362	22,688	21,845
R2	0.012	0.013	0.421	0.546

Note: The table reports the baseline regression results. The dependent variables are High_inno and RD_INVEST. Year and industry fixed effects are included. Heteroscedasticity-consistent standard errors are clustered at the firm level. Robust standard errors are used and reported in parentheses. R squared values are given in the table. *, ** and *** represents statistical significance at the 10%, 5% and 1% levels, respectively.

4.3 Endogeneity concerns

In addition, the result might lead to endogeneity concerns. The paper therefore exploits an instrumental variable (IV) strategy to address such concerns. Specifically, we followed the research of Fisman and Svensson (2007), we use the average judicial IPR protection level as the instrument variable. Firstly, the average level of judicial IPR protection is related to the strength of IPR protection in the region where the enterprise is located. If a region's judicial system is stronger and more effective, then businesses in that region may enjoy higher levels of IP protection. Therefore, this instrumental variable is related to the endogenous variable (strength of intellectual property protection). Secondly, Fisman and Svensson (2007) indicate that using the regional average level as an instrumental variable can reduce endogeneity issues, as it takes advantage of region-specific factors that may affect firms across the region but are not related to individual firms' innovation decisions.

Table 3 reports the results. *IP_mean* is the average of judicial IPR protection level. The KP F-statistics is 42.722, which are sufficiently large to reject the null hypothesis of a weak instrument. We then examine how the instrument variable corelates with judicial IPR protection level. The first column of Table 3 reports the results of the relationship between the instrumental variable and the *IP_protection*. The coefficient is positive and statistically significant at the 1% level. In addition, the coefficient of *IP_protection* is also positive and significant with innovation level as shown in the second column of Table 3.

Table 3 Two- stage least squares regression

	（1）	（2）
	IP level	Inv_patent
IP_mean	0.985***	
	(0.008)	
IP level		0.084***
		(0.011)
Control	YES	YES
Year	YES	YES
Industry	YES	YES
N	16,362	16,362

Note: The table reports the regression results of the two-stage least squares. Year and industry fixed effects are included. Heteroscedasticity-consistent standard errors are clustered at the firm level. Robust standard errors are used and reported in parentheses. *, ** and *** represents statistical significance at the 10%, 5% and 1% levels, respectively.

4.4 Mechanisms analysis

In this section, we systematically explore the potential mechanisms through which a stronger judicial IPR protection level may encourage innovation.

4.4.1 Information transparency

The first potential mechanism is information transparency. We posit that a robust judicial protection of IPR can exert a positive influence on a firm's innovation level, as it enhances the informational transparency of the enterprise. When the judicial system effectively safeguards IPR, it sends a clear message to the market about the value and protection of intangible assets. This clarity fosters an environment where firms can confidently invest in research and development, knowing that their innovations will be protected from infringement.

Our paper constructs an information transparency index followed Lang et al. (2012).

It equals the average of the percentage rank five commonly used information transparency index in the literature, which are the earnings quality indicators (DD) (Dechow and Dichev, 2002); analyst tracking number and accuracy of analyst earnings forecasts (Lang et al., 2012), Scoring value of information disclosure assessment for listed companies on the Shenzhen Stock Exchange and Big4 audit. Table 4 reports the results. In Column (1) and Column (3) of the table, the judicial IPR protection level positively related with information transparency index. In Column (2) and Column (4), the coefficients of information transparency index and judicial IPR protection level are positively related to the innovation proxies. The results indicate that judicial IPR protection increases the innovation level by increasing the information transparency of firms. This is driven primarily by a better judicial IPR protection environment, which encourages knowledge sharing and collaboration without the fear of them being misused or stolen. The increased transparency brought about by strong IPR judicial protection allows firms to better assess the risks and potential rewards associated with their innovation efforts.

Table 4 Mechanism test for information transparency

	(1) Transparency	(2) Inv_patent	(3) Transparency	(4) R&D
IP level	0.018***	0.059***	0.020***	0.173***
	(0.003)	(0.005)	(0.002)	(0.015)
Transparency		0.128***		1.169***
		(0.016)		(0.045)
Control	YES	YES	YES	YES
Year	YES	YES	YES	YES
Industry	YES	YES	YES	YES
R2	0.390	0.226	0.355	0.626
N	16,042	16,042	21,356	21,356

Note: The table reports the mechanism test for information transparency. Year and industry fixed effects are included. Heteroscedasticity-consistent standard errors are clustered at the firm level. Robust standard errors are used and reported in parentheses. *, ** and *** represents statistical significance at the 10%, 5% and 1% levels, respectively.

4.4.2 Social trust

The second mechanism is social trust. We argue that when a firm operates in a stronger judicial IPR protection city, it can cultivate a greater sense of trust among various stakeholders. The variable "Social trust" is from a survey from "China Entrepreneur Survey System". The survey distributed questionnaires to over 15000 companies and received over 5000 valid responses. The survey covers 31 provinces, autonomous regions, and municipalities directly under the central government in China. The survey mainly targets some enterprises and enterprise leaders, of which at least 60% are current general managers. The question is "Based on your experience, which five regions of enterprises do you think are more trustworthy (in order)?" In our paper, we take the natural logarithm of the scores and construct the social trust index.

Table 5 presents the results. In Column (1) and Column (3) of the table, the judicial IPR protection level is positively related to social trust. In Column (2) and Column (4), the coefficients of social trust and judicial IPR protection level are positively related to the innovation proxies. The results indicate that judicial IPR protection increases the innovation level by increasing the social trust of firms.

Table 5 Mechanism test for social trust

	(1)	(2)	(3)	(4)
	Trust	Inv_patent	Trust	R&D
IP level	0.923***	0.035***	0.986***	0.129***
	(0.016)	(0.006)	(0.014)	(0.016)

Trust		0.027***		0.082***
		(0.003)		(0.007)
Control	YES	YES	YES	YES
Year	YES	YES	YES	YES
Industry	YES	YES	YES	YES
R2	0.258	0.226	0.274	0.613
N	16,361	16,361	21,844	21,844

Note: The table reports the mechanism test for information transparency. Year and industry fixed effects are included. Heteroscedasticity-consistent standard errors are clustered at the firm level. Robust standard errors are used and reported in parentheses. *, ** and *** represents statistical significance at the 10%, 5% and 1% levels, respectively.

4.5 Robustness check

To test the stability of the baseline results, the paper performs a series of robustness checks, including using alternative measurements of the dependent variable and the independent variable, as well as different exposure windows of our dataset. Table 6 presents additional tests on robustness check.

In our baseline model, we use the judicial IPR protection index at the city level based on the number of intellectual property trials as the judicial IPR protection proxy. An alternative measure can be obtained by using the finished IP trials as a proxy. The result is shown in Column 1 of Table 6, we obtain a similar estimate to the baseline finding. In addition, we change the measurement for the dependent variable. We use RD_PERSON_RATIO as an alternative measurement for the dependent variable. As shown in Column (2) in Table 6, the result is still robust.

To further validate the robustness of the relationship between the strength of IPR protection and the level of corporate innovation, we use a different time window of our dataset. Considering the implementation of the intellectual property demonstration city

policy in China in 2012, which marked a significant strengthening of the IP protection system, we selected data from 2012 and beyond as samples for regression analysis. This strategy allows us to assess its potential impact on corporate innovation in an environment with stronger intellectual property protection. Through this method of shortening the time window, we aim to eliminate other possible confounding factors, thereby providing a clearer and more accurate assessment, ensuring that our research results remain robust in the context of policy changes. As shown in Column (3) in Table 6, we obtain the similar estimate to the baseline regression, which further confirms the importance of increasing the strength of intellectual property protection in stimulating innovation vitality in enterprises.

Table 6 Robustness check

	(1) Innovation	(2) RDPERSON_RATIO	(3) Shorten time period
Closed_case_num	0.014***		
	(0.002)		
IP level		0.334**	0.019***
		(0.159)	(0.006)
Control	YES	YES	YES
Year	YES	YES	YES
Industry	YES	YES	YES
R2	0.013	0.046	0.005
N	16,363	15,350	13,568

Note: The table reports the robustness check of the main regression results. Year and industry fixed effects are included. Heteroscedasticity-consistent standard errors are clustered at the firm level. Robust standard errors are used and reported in parentheses. R squared values are given in the table. *, ** and *** represents statistical significance at the 10%, 5% and 1% levels, respectively.

5. Further analysis

5.1 Heterogeneity analysis of ownership

Firstly, non-state-owned enterprises often rely more on innovation to gain competitive advantages due to facing more intense market competition. Therefore, strong intellectual property protection provides them with necessary incentives to protect their innovative achievements and encourages more research and development investment. Secondly, non-state-owned enterprises have more limited access to resources and therefore rely more on intellectual property protection to ensure their return on their innovative investments (Gong et al., 2023). In addition, non-state-owned enterprises usually have more flexible management and decision-making mechanisms, which can respond faster to market changes and the need to protect intellectual property rights. In contrast, SOE enterprises may not be as sensitive to intellectual property protection needs and responses as non-state-owned enterprises due to their more complex decision-making processes and management levels. Meanwhile, state-owned enterprises may benefit more from direct government support and subsidies (Schweizer et al., 2019), which may to some extent replace the role of intellectual property protection. These factors work together to result in differences in the relationship between the strength of intellectual property protection and the level of innovation in different types of enterprises.

Table 7 presents the results. Columns (1) and (3) present results for SOE firms, and Column (3) and (4) present results for non-SOE firms. As shown in Table 7, the coefficients in Column (1) and (3) are not significant, while the coefficients in Column (2) and (4) are statistically significant at the 1% level. The result meets our expectations.

Table 7 Heterogeneity analysis

	(1)SOE Inv_patent	(2)NON-SOE Inv_patent	(3)SOE R&D	(4)NON-SOE R&D
IP level	0.026	0.027***	-0.011	0.051***
	（0.019）	(0.007)	(0.069)	(0.017)

Control	YES	YES	YES	YES
Year	YES	YES	YES	YES
Industry	YES	YES	YES	YES
R2	0.052	0.007	0.565	0.543
N	2,010	14,027	2,466	18,938

Note: The table reports the heterogeneity regression results of different types of ownership. Year and industry fixed effects are included. Heteroscedasticity-consistent standard errors are clustered at the firm level. Robust standard errors are used and reported in parentheses. *, ** and *** represents statistical significance at the 10%, 5% and 1% levels, respectively.

5.2 Heterogeneity analysis of City GDP

In this section, the paper discusses the heterogeneity of GDP levels in the cities where companies are located. Firstly, high GDP cities typically have a more comprehensive intellectual property protection system and stronger protection measures. Changsha City has established a "1+N" full chain protection system for intellectual property rights and a "three in one" administrative and judicial protection mechanism. It has also established a "prevention+monitoring+crackdown" three in one digital protection system and a new model of "full process certification+judicial verification" for IPR. These measures have effectively stimulated the innovative vitality of business entities. This environment provides stronger innovation incentives for enterprises, as they know that innovative achievements can be effectively protected and are more willing to invest in research and development. Secondly, enterprises in high GDP cities often face more intense market competition, which drives them to rely more on innovation to gain a competitive advantage. Strong intellectual property protection provides necessary guarantees for these enterprises to ensure that their innovative achievements are not easily imitated or stolen by competitors. In addition, high GDP cities often have richer resources, including capital, talent, and technology, which

provide more innovative opportunities for enterprises (Hsu et al., 2014). Enterprises are more capable of investing in research and development, and the demand for intellectual property protection is more urgent to ensure that their innovative achievements can be transformed into market competitiveness.

We split our data into two groups by the median of the GDP level. Table 8 presents the results. Columns (1) and (3) present results for firms located in city with higher level of GDP, and Column (3) and (4) present results for firms located in city with lower level of GDP. As shown in Table 8, the coefficient in Column (1) and (3) are significant and positive, while the coefficient in Column (2) and (4) are not significant. The result meets our expectations.

Table 8 Heterogeneity analysis

	(1)high_gdp Inv_patent	(2)low_gdp Inv_patent	(3)high_gdp R&D	(4)low_gdp R&D
IP level	0.024**	0.006	0.047*	0.029
	（0.010）	(0.007)	(0.025)	(0.024)
Control	YES	YES	YES	YES
Year	YES	YES	YES	YES
Industry	YES	YES	YES	YES
R2	0.052	0.018	0.588	0.517
N	8,091	8,271	10,987	10,858

Note: The table reports the heterogeneity regression results of city GDP. Year and industry fixed effects are included. Heteroscedasticity-consistent standard errors are clustered at the firm level. Robust standard errors are used and reported in parentheses. *, ** and *** represents statistical significance at the 10%, 5% and 1% levels, respectively.

6. Long term effect of judicial protection of IPR

In our study, we use a nonparametric inference method for estimating the covariate-

adjusted regression function introduced by Takatsu and Westling (2024). Utilizing the approach, we have constructed a graph (Figure 1) that illustrates the impact of continuous exposure to the intellectual property judiciary environment on corporate innovation activities. In this graph, the x-axis represents the continuous exposure levels of companies to the intellectual property judiciary environment, while the y-axis displays the innovation outcome indicators adjusted for covariates. The point estimates on the graph, along with their corresponding pointwise confidence intervals, reveal the variation in innovative outcomes at different levels of exposure, and the uniform confidence band provides an overall perspective on the trend of outcomes across the entire range of exposure.

The impact of IP judicial protection on corporate innovation is not immediate but evolves over time. Initially, during the early stages of judicial protection, strict IP protection provides a stable expectation for businesses, significantly enhancing their confidence to engage in innovative activities. In this period, companies perceive the positive signals of judicial protection and are more willing to invest resources in research and development, leading to a notable increase in innovation levels. As the graph demonstrated, the covariate-adjusted outcome starts from negative and shows an increasing trend as continuous judicial IPR protection.

However, as time progresses and IP judicial protection enters a relatively stable phase, we observe that the pace of innovation level enhancement begins to slow down. Despite the continuous strengthening of judicial protection, the marginal effect on innovation starts to diminish, meaning that each additional increment of judicial

protection investment yields less significant innovation level improvement compared to the initial phase. Nevertheless, sustained judicial protection remains essential as it provides a stable environment for innovation, helping to maintain corporate innovation momentum and long-term innovation activities. For regions with weak IP judicial protection, we believe that their innovation potential is yet to be fully tapped. In these areas, strengthening the judicial protection of IP rights can stimulate corporate innovation potential and promote local economic development. Therefore, substantial investment is needed in these regions to establish and improve the IP protection system, thereby providing a solid legal foundation for corporate innovation.

In addition, for regions where innovation levels remain relatively flat, we believe that businesses need sufficient confidence and support. IP judicial protection is a long-term process that requires persistent effort and investment. In these areas, governments and relevant institutions should enhance corporate innovation confidence and foster a positive interaction between IP judicial protection and innovation activities through policy guidance, financial support, and legal services. With such efforts, we can expect a steady improvement in innovation levels over the long term.

Lastly, when the judicial protection of IP becomes excessively strong, there is a corresponding decline in the level of innovation. This inverse relationship can be attributed to the fact that overly robust protection mechanisms might have a stifling effect on innovation. While strong intellectual property rights are essential for incentivizing innovation by ensuring inventors can capture the benefits of their creations, an overemphasis on protection could potentially hinder the free flow of ideas

and knowledge, which are crucial for innovation. Thus, the balance between providing adequate intellectual property protection and fostering an environment conducive to innovation is critical, as there is an inherent trade-off.

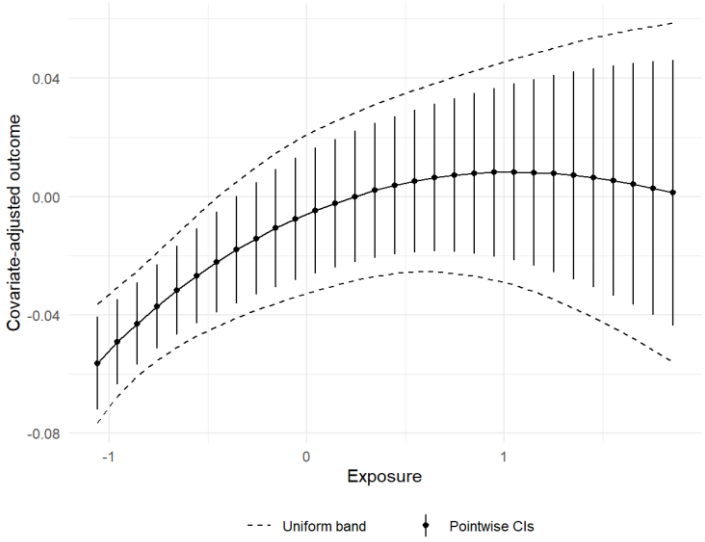

Figure 1. Continuous exposure of judicial IPR protection on innovation

7. Conclusion

In this paper, we study how judicial IPR protection environment affects innovation in China. Our finding shows that firms located in cities with stronger judicial protection of IPR have higher innovation outputs. Furthermore, we have elucidated two possible mechanisms through which judicial IPR protection influences a firm's innovation. The first is the enhancement of information transparency. Our analysis reveals that an effective judicial system in safeguarding IPRs encourages firm to be more transparent. The second mechanism is the cultivation of social trust. A robust judicial IPR protection system engendering trust among market participants can lead to increased collaboration and the sharing of knowledge, both of which are indispensable for propelling innovation.

Expanding upon these insights, the paper investigates the long-term effects of judicial IPR protection. Our analysis suggests that the impact of a strong judicial IPR protection system extends beyond immediate gains, shaping a firm's innovation trajectory over an extended period. By scrutinizing these enduring effects, we aim to offer a more comprehensive view of how judicial IPR protection can sculpt the innovation landscape in the long run. This exploration is vital for policymakers and corporate strategists, as it underscores the enduring strategic value of investing in and upholding a robust judicial IPR protection framework.

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