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Judicial institution and innovation: Evidence from China's intellectual property courts reform

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ABSTRACT

This paper examines the impact of intellectual property judicial institutions on innovation, focusing on the intellectual property courts (IPCs) reform in China. We find that IPCs reform leads to a significant 22.6 % increase in the number of invention patents at the city level, equating to an average rise of 215 annually. Notably, we rule out the possibility of inter-region and intra-conglomerate transfer of patents, indicating that the effect of the IPCs reform on innovation is not a zero-sum game among regions. Furthermore, we find that the IPCs reform alters the patent structure by shifting the focus from utility and design patents to invention patents; however, it does not appear to significantly improve invention patent quality. Mechanism analyses suggest that the IPCs reform increases social satisfaction with judicial protection of intellectual property, shorter case duration and higher plaintiff winning rates in intellectual property cases.

1. Introduction

Innovation is widely acknowledged as a key driver of economic growth (Aghion and Howitt, 1992; Romer, 1990; Solow, 1957).[1] However, investing in innovation is inherently uncertain and risky, and successful inventions can often attract "free riders" when intellectual property protection is inadequate (Coase, 1960). Intellectual property legal system, encompassing legislation and judicial enforcement (i.e., courts and precedents), provides legal protection for intellectual property by explicitly stating the penalties for patent infringement, thereby sustaining inventors' incentives and reducing the risks associated with innovation. While the impact of specialized intellectual property laws legislation on innovation has been extensively studied (Ash et al., 2024; Moser, 2005, 2013; Qian, 2007), less attention has been paid to the enhancement of judicial enforcement.[2] Leveraging China's Intellectual Property Courts (IPCs) reform started in 2014, this paper shifts the focus from legislation to judicial enforcement and investigates the effect of IPCs reform on innovation and its mechanism.

China's IPCs reform offers an excellent setting for examining the causal relationship between judicial enforcement and innovation. Firstly, the majority of intellectual property laws in China remained stable and unchanged during the early period of the IPCs reform (2011–2020), which helps eliminate potential confounding factors such as the introduction of new intellectual property laws or major revisions. Secondly, unlike the U.S., where plaintiffs can choose the court for litigation, in China, judicial cases are mainly under the jurisdiction of

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[1] A large body of literature has studied the various determinants of innovation. Table A1 shows a brief summary.

[2] Ang et al. (2014) discovered that the intellectual property protection, as indicated by the success rate of intellectual property infringement cases at the provincial level and the number of articles promoting intellectual property protection in the official newspaper of the provincial Communist Party of China, positively influenced innovation in high-tech firms. Building on the work of Ang et al. (2014) which focused on the level of intellectual property protection, our study takes a different approach. Firstly, by leveraging a judicial institution reform in China (the establishment of IPCs) as a quasi-natural experiment, we identify the casual effects of enhanced judicial enforcement on innovation. Secondly, we extend our analysis beyond a specific group of high-tech firms to examine the impact of judicial enforcement on overall innovation output among all inventors at the city level. Lastly, we delve into the mechanisms in greater detail by utilizing multidimensional data, including China Intellectual Property Protection Social Satisfaction Survey and China's judgment documents. In brief, our research offers a more comprehensive understanding on how judicial reforms can shape innovation development.

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the court where the defendant resides and 80 % intellectual property cases involve parties from the same province, which limits forum shopping and underscores the importance and benefits of strengthening local judicial institutions for local innovators (Fang et al., 2017). Lastly, China has experienced a patent surge over the past decade, which provides a crucial opportunity window for our identification.

This paper argues that the IPCs reform spurred innovation by enhancing intellectual property judicial protection and thereby increasing the expected returns from patenting. Using invention patents as our measure of innovation, we argue that the shift in incentives drives the overall increase in invention patents through two distinct channels: a "general effect" and a "transformation effect".

The general effect captures the growth in patents resulting from new innovative activities. As stronger intellectual property protection makes patenting more attractive, firms or inventors are incentivized to boost their innovation input, such as R&D expenditure, leading to the creation of more patentable technologies. The transformation effect, by contrast, describes the patent growth resulting from a shift in how firms manage knowledge. The reform encourages firms to convert technologies, previously held as trade secrets, into publicly registered patents. This conversion is socially valuable, as the public disclosure of technology promotes knowledge spillovers from which society and other inventors can benefit (Comin and Mestieri, 2014; Stoneman and Battisti, 2010). Therefore, this effect is significant even if it primarily reflects a change in disclosure strategy rather than the creation of new innovations. Overall, both effects ultimately stem from the same foundational driving force: a more effective judicial system for intellectual property protection.

Our analysis finds compelling evidence supporting the above framework. We find that the IPCs reform led to a significant 22.6 % increase in the number of invention patents at the city level, equating to an average increase of 215 patents per year. This conclusion is corroborated by micro-level evidence from listed firms. Building on these findings, we then establish causality by utilizing geographical variations. During this process, it is crucial to consider the geographic relocation of innovators, as this could otherwise lead to overestimated or even spurious effects. Importantly, our study found no significant spatial transfer of patents across regions or within the listed companies' equity network, indicating that the innovation growth is net positive rather than a zero-sum game. Robustness checks also confirm that potential biases induced by omitted variables, public subsidies and tax credit, and other concurrent intellectual property related policies are minor. Heterogeneity analysis shows that the IPCs reform's impact on innovation is greater in cities with a higher share of highly educated population, suggesting an interaction between the reform and local "smart brains". Moreover, the empirical results indicate that the IPCs reform shifted the patent structure from utility and design patents toward invention patents, which have the highest innovation content, as evidenced by an increased proportion of invention patent applications. However, we do not observe a significant improvement in the patent quality, as measured by the approval rate of invention patents and the number of citations per invention patent.

Having established the significant impact of the IPCs reform on innovation, our mechanism analysis then delves into how this improvement is achieved, and identifies two primary pathways through which the judicial environment for intellectual property is enhanced. First, initial evidence from a province-level social satisfaction survey since 2012 indicates increased public satisfaction with intellectual property judicial protection. This includes significant improvements in perceptions of litigation processes, costs, and compensation reasonableness following the IPCs reform. These findings suggest that IPCs primarily boost innovation by improving the efficiency of intellectual property judicial protection, notably by reducing case duration, a critical innovator opportunity cost, and ensuring equitable judgments. Second, leveraging a unique dataset from the China Judgments Document website, which provides comprehensive case information for almost all judgments made after 2014, we directly observe that the IPCs reform significantly shortened first-instance intellectual property case duration by 111 days and increased plaintiff winning rates.

Further, we find that IPCs reform promotes the R&D investment for the listed firms in manufacturing and information technology industry. And at city level, the empirical results show that the IPCs reform increases the intensity of science and technology expenditure measured by the ratio of science and technology expenditure to GDP. Hence, we provide strong evidence for the general effect that IPCs reform increases innovation input and boosts invention patents through improving the intellectual property judicial protection. However, since the trade secrets are fundamentally hidden and the inventor's choice between patenting and secrecy usually unobservable, the transformation effect remains inconclusive in this paper.

Our paper delivers the following primary contributions. First, this paper explores the strand of literature studying the determinants of innovation from the perspective of intellectual property protection. The effect of intellectual property protection on innovation is complex, as some studies suggest that strict intellectual property protection may hinder subsequent innovation by restricting the diffusion of scientific knowledge and encouraging the emergence of nonpracticing entities, commonly known as "patent trolls," in the market (Murray et al., 2016; Williams, 2013). Indeed, a series of studies also proposed an inverted U-shaped or non-linear relationship between intellectual property protection and innovation (Chen and Puttitanun, 2005; Fang et al., 2020; Lerner, 2009; Murray and Stern, 2007; Sweet and Maggio, 2015). Using a survey-based prefecture-level intellectual property protection index from a research institute in China, Fang et al. (2017) discovered that intellectual property protection has a positive impact on firm innovation when studying the effects of privatization in China. This finding is also supported by Ang et al. (2014). However, the intellectual property protection index in previous literature functions as a *de facto* black box, obscuring which components are effective and which are not, thereby complicating the understanding of the underlying mechanism. We employ IPCs reform to target and isolate the causal effect of strengthening judicial protection on innovation from the composite indicator of intellectual property protection. Our examination of the underlying mechanisms enriches the relevant literature and further clarify the relationship between intellectual property protection and innovation. Additionally, while previous literature has extensively explored the impact of establishing and updating intellectual property laws on innovation development (Anderlini et al., 2013; Gilbert and Shapiro, 1990; Klemperer, 1990; Png, 2017; Moser, 2005; Tong et al., 2014), there is limited research on the role of judicial enforcement and this article provides some instructive empirical results.

Second, our paper contributes to the extensive body of theoretical and empirical research in the field of *law and finance*, which broadly investigates the impact of judicial institutions on economic performance across various countries (Atkinson et al., 2009; Chemin, 2012; Hay and Shleifer, 1998; La Porta et al., 1998, 2004; Sakakibara and Branstetter, 2001; Visaria, 2009). Particularly, the role of courts is also discussed (Colonnello and Herpfer, 2021; Djankov et al., 2003; Gillman, 2002; Landes, 1971; Shahshahani, 2018). Our results further reinforce findings in the existing literature regarding the effectiveness of specialized courts, such as Courts of International Trade (Hansen et al., 1995), Bankruptcy Courts (Li and Ponticelli, 2022; Ponticelli and Alencar, 2016; Müller, 2022), Environmental Courts (Zhang et al., 2019), and Federal Circuit Courts (Atkinson et al., 2009), collectively revealing that specialized courts improve judicial efficiency or promote economic performance.

Moving from the broader context of specialized courts, this paper specifically engages with the literature examining the impact of China's IPCs reform on innovation (Cao et al., 2024; Chen and Chen, 2024; Genin et al., 2022; Li et al., 2021; Nie et al., 2024; Zhang et al., 2024). While valuable, these existing studies often present inconsistent conclusions due to inherent limitations in sample representativeness, measurement approaches, and empirical methodologies. To directly address these challenges and advance the literature, our research incorporates several key features. First, we employ a comprehensive nationwide sample with an extended research period and a more reliable, unified identification strategy. Second, our mainly focus on innovation output (invention patents), rather than intermediate inputs such as R&D expenditure, provides a distinct perspective on the reform's effects. Third, we mitigate potential biases through the application of a robust estimator within a staggered Difference-in-Differences (DID) design (Callaway and Sant'Anna, 2021). Finally, and critically, our paper uniquely investigates the various channels through which IPCs reform influences the local judicial environment. This allows us to unravel the drivers behind these effects, deepen our understanding of the underlying mechanisms, and offer more precise policy recommendations.

Thirdly, our paper presents compelling evidence on China's remarkable surge in patent applications from a judicial institutional perspective. Previous studies have explored various factors that may drive this surge, including firm productivity (Fang et al., 2020), ownership structure of firms (Fang et al., 2017; Hu and Jefferson, 2009), foreign direct investment (Hu and Jefferson, 2009), pro-patent legislation (Hu and Jefferson, 2009; Li, 2012), and patent subsidy programs by the Chinese government (Li, 2012). By placing emphasis on judicial institutions, our results align with Hu et al. (2017), who underscored the role of non-innovation-related forces such as government economic incentives to explain China's patent explosion compared to innovation-related motives such as R&D intensity or labor productivity. Additionally, considering the increasing dynamic impact of the IPCs reform on innovation over time, we argue that establishing a more efficient formal (judicial) institution is likely to foster long-term innovation development, in contrast to financial incentives such as patent subsidies and government tax credits which may result in superficial surges in innovation (Chen et al., 2021; Cheng et al., 2019; König et al., 2022). Therefore, our findings also support the notion that China's patent explosion represents a significant advancement in innovation (Fang et al., 2020; Wei et al., 2017).

Finally, our findings provide policymakers with valuable insights into leveraging judicial institutions to stimulate innovation, particularly relevant for developing nations. As the world's largest developing and transitional economy, China is shifting from a traditionally input-driven approach to an innovation-driven one in its economic development model, and high-quality innovation development is key to this transition. Several developing countries such as Brazil and Russia, which share similarities with China in terms of intellectual property laws, have not experienced significant growth in innovation over the past two decades. The findings presented in this paper highlight the crucial role of judicial enforcement in fostering innovation.

The remainder of the paper is structured as follows. Section 2 describes the background of China's intellectual property protection and innovation development. Section 3 introduces the empirical strategy and displays our data. Section 4 presents our primary results. Section 5 shows the mechanism analyses. Section 6 is the conclusion.

2. Background

2.1. China's judicial protection of intellectual Property After 2012

The year 2012 marked a significant milestone in China's innovation capability, as the Chinese government officially introduced the innovation-driven development strategy at the 18th National Congress of the Communist Party of China.[3] With the establishment of a relatively comprehensive legal framework, China focused on refining judicial practices to address deficiencies in the judicial adjudication process (refer to the *Report of the Supreme People's Court on the Work of the Intellectual Property Courts*, 2017).[4] The Chinese government initiated the establishment of specialized IPCs institution in 2014, marking the beginning of the "Specialized Patent Courts" era. This development signifies a new phase in China's judicial protection of intellectual property, with a focus on enhancing judicial enforcement.

China's IPCs reform progressed in two distinct phases. Initially, dedicated Intellectual Property Courts (IPCs) were established in Beijing, Shanghai, and Guangzhou by the end of 2014. Subsequently, specialized Intellectual Property Tribunals (IPTs) were introduced across numerous cities from 2017 to 2020. In reality, IPCs and IPTs serve similar functions and objectives under this judicial reform, with only slight differences in the types of cases they govern.[5] Thus, for consistency and conciseness, this paper collectively refers to these entities as "IPCs" and the reform as "IPCs reform".

Judicial protection generally offers several advantages over administrative protection, including terminality, stronger deterrence through public judgment documents, and comprehensive protection encompassing criminal rulings and financial compensation.[6] However, judicial processes also present drawbacks such as a longer litigation cycle, higher economic costs, and a heavier burden of proof. Consequently, the specialized IPCs in China introduced key measures aimed at improving court efficiency and trial quality in intellectual property cases, as compared to the traditional general courts.

First, one significant change is the consolidation of first-instance civil and administrative intellectual property cases under the jurisdiction of IPCs, streamlining trial standards and litigation procedures through a "two trials in one" approach.

Second, the local judicial sector has deployed young elite judges with strong academic backgrounds in intellectual property to IPCs specifically dedicated to handling intellectual property cases. These judges were previously handling a variety of civil, administrative, and criminal cases in traditional courts, making this a strategic reallocation of judicial resources.

Third, mainland China has implemented the technical investigator system for the first time in these newly established IPCs.[7] In China, technical investigators are judicial support personnel with professional technical backgrounds who possess a broad knowledge of advancements in different technical domains. Until 2019, China's IPCs has more than 360 technical investigators and technical consulting experts, 75 % of whom have a graduate degree or above, and have an average of 9 years of experience in relevant technical fields.[8] This arrangement indicates that technical investigators are less susceptible to political interference from local governments, a longstanding issue that has been criticized for contributing to inefficiencies in the judicial system in China (Cao et al.,

[3] Appendix A provides more details about China's judicial protection of intellectual property before 2012.

[4] Chinese government implements the double-track protection for intellectual property, consisting of judicial protection and administrative protection. Judicial protection is achieved through filing lawsuits against infringing parties in court, while administrative protection is achieved through filing administrative complaints with government agencies such as the Administration of Market Regulation or the Public Security Bureau.

[5] More precisely, IPCs handle civil and administrative intellectual property cases, while IPTs have jurisdiction over civil, administrative, and criminal intellectual property cases. Geographically, China's IPCs exercise jurisdiction across multi-municipal administrative (refer to Table A2 for more details).

[6] Decisions made by administrative agencies are not final and appealable in China.

[7] Technical investigator system is common in developed countries such as Japan and Korea, which is composed of technical reviewers who are responsible for reviewing technical implementation, providing professional advice and assisting judges in trials when facing some technological disputes.

[8] Information source: https://www.chinanews.com.cn/gn/2019/12-05/9025277.shtml. For more information, please refer to China's Technical Investigator's Manual (2019).

2023; Li and Ponticelli, 2022), as they are employed by the IPCs without holding any administrative roles.

The establishment process of IPCs across provinces in China is depicted in Fig. 1. The first batch of IPCs was established in Beijing, Shanghai, and Guangzhou in 2014. Subsequently, from 2015 to 2020, other provinces such as Jiangsu, Zhejiang, and Jiangxi successively established IPC institutions. By the end of 2020, China had set up 26 IPCs, including one under the Supreme People's Court, in 19 provinces or municipalities directly under the central government. These IPCs cover over half of China's provincial-level administrative regions.

2.2. The effectiveness of China's IPCs in practice

Before conducting empirical testing, we present some stylized facts and anecdotal evidence of the effectiveness of China's IPCs in practice. First, inventors gravitate towards utilizing legal avenues to enhance the protection of their intellectual property, especially with the advancement of the justice system in China, exemplified by the establishment of specialized IPCs. This transition is also evident in the shift in the total number of intellectual property cases depicted in Fig. 2. The graph illustrates a significant increase in the total number of intellectual property cases since 2014, contrasting with the relatively modest growth observed before 2014.

Second, the personnel characteristics of IPCs show obvious characteristics of youth, professionalism and a high level of education in practice. Although we cannot obtain detailed information about each IPC's personnel, we show a representative example by searching the official news. For instance, Hangzhou IPC released that:

> "The average age of the Hangzhou IPC trial team is only 37 years old, and 95 % of the people have a master's or above degree in law. Among them are many specialized talents who graduated from professional intellectual property, as well as compound talents with dual-disciplinary backgrounds in science engineering, and law. The Hangzhou IPC was the first in China to introduce 47 full-time and part-time technical investigators. In addition, none of the 1,403 technical cases in which the technical investigators participated were remanded by the higher courts due to problems in ascertaining technical facts."[9]

Finally, there is also a lot of anecdotal evidence about the role of China's IPCs in protecting the interests of innovative product owners efficiently, especially greatly shortening the litigation duration. For instance, Guangzhou IPC documented an interview with an innovative company in the city of Dongguan:

> "Lawyer Song, the litigation agent of Qianfangbao Technology Company, said gratefully, 'I didn't expect the court to stop the infringement in such a short time. We can now devote ourselves to production and research and development.'"[10]

2.3. China's Innovation development in the past 30 years

Here, we display some stylized patterns of China's past innovation development. Fig. 3 illustrates the growth trend of domestic granted (invention) patents in China from 1994 onwards. The red line represents the year 2012, while the blue line signifies 2014. Before 2012, there was a steady increase in the number of domestic (invention) patents granted in China. Following a period of relative stability between 2012 and 2014, a notable surge in patents occurred after the establishment of the IPCs institution in 2014, which aimed to enhance judicial enforcement. To illustrate, the State Intellectual Property Office (SIPO) in China authorized and maintained a total of 0.9 million domestic patents in 2011, including 0.11 million domestic invention patents. In contrast, by 2020, over 3 million domestic patents were granted, with 0.44 million being domestic invention patents, marking a significant increase compared to a decade ago.

Additionally, according to World Intellectual Property Organization (WIPO), China has demonstrated remarkable progress in the Global Innovation Index, climbing from 29th in 2011 to 14th in 2020.[11] This advancement is mirrored in China's institution index, a measure of political, regulatory, and business environments, which substantially improved from 98th to 62nd over the same period.

China's progress is particularly notable among developing countries over the last decade. Fig. 4 clearly illustrates these trends, charting both the comprehensive innovation index and the institution index for "BRICS" countries (Brazil, Russia, India, China, and South Africa). The figure's vertical axis indicates the percentage by which a country outperforms others in the WIPO report each year. China consistently leads the BRICS nations in both the absolute level and growth rate of its comprehensive innovation index, and also demonstrates a strong growth rate in its separate institution index. Notably, the data reveals a sharp increase in both indices for China after 2014.

3. Empirical strategy and data

3.1. Empirical strategy

We investigate the effect of IPCs reform on innovation using a staggered DID methodology. A prevalent method for assessing the effectiveness of IPCs is to estimate a two-way fixed effects model:

$$Innovation_{ct} = \alpha_1 IPC_{ct} + (\boldsymbol{X}_c \times \gamma_t)\boldsymbol{\beta} + \delta_c + \gamma_t + \varepsilon_{ct} \quad (1)$$

Where c is the city, t is the year. To directly capture the impact of IPC reforms on inventors' innovation output and account for patent approval time lags, we define $Innovation_{ct}$ as the number of invention patents applied for and granted within a three-year window period in city c in year t (hereinafter 3-year-window invention patents). This 3-year window period aligns with the typical three-year span, from application to final authorization, for invention patents in China, as per the National Intellectual Property Administration.[12] Our approach of setting a window period is also consistent with Kelly et al. (2021) and Moretti (2021).

IPC_{ct} is a dummy indicating whether IPCs were available in city c during year t. The availability is defined as follows: if the establishment month of an IPC is before July, we considered that year as the first year of IPC treatment; otherwise, we defined the following year as the first year of IPCs treatment.[13]

$\boldsymbol{X}_c$ is a vector of baseline city characteristics from 2010 that may influence local innovation performance, the timing of establishment of IPCs, or both. These city characteristics consist of four groups: macroeconomic development variables including GDP per capita (logged), total resident population (logged), and the proportion of the highly educated population; external inputs for innovation including total foreign direct investment (logged) and the number of universities per 10,000 people; public service characteristics including the number of hospitals per 10,000 people and total expenditure on educational institutions (logged); initial innovation intensity and accumulation of

[9] Information source: https://ipc.court.gov.cn/zh-cn/news/view-2042.html.

[10] Information source: https://www.gdzf.org.cn/xbsy/fzgd/content/post_131551.html.

[11] For additional information, please refer to: https://www.wipo.int/publications/en/search.jsp.

[12] Information source: https://www.cnipa.gov.cn/jact/front/mailpubdetail.do?transactId=340384&sysid=6. We also examine the 2-year-window invention patents, 4-year-window invention patents and unlimited window invention patents in the in the section of *Robustness Checks*.

[13] We examine the sensitivity of the establishment year in the section of *Robustness Checks*.

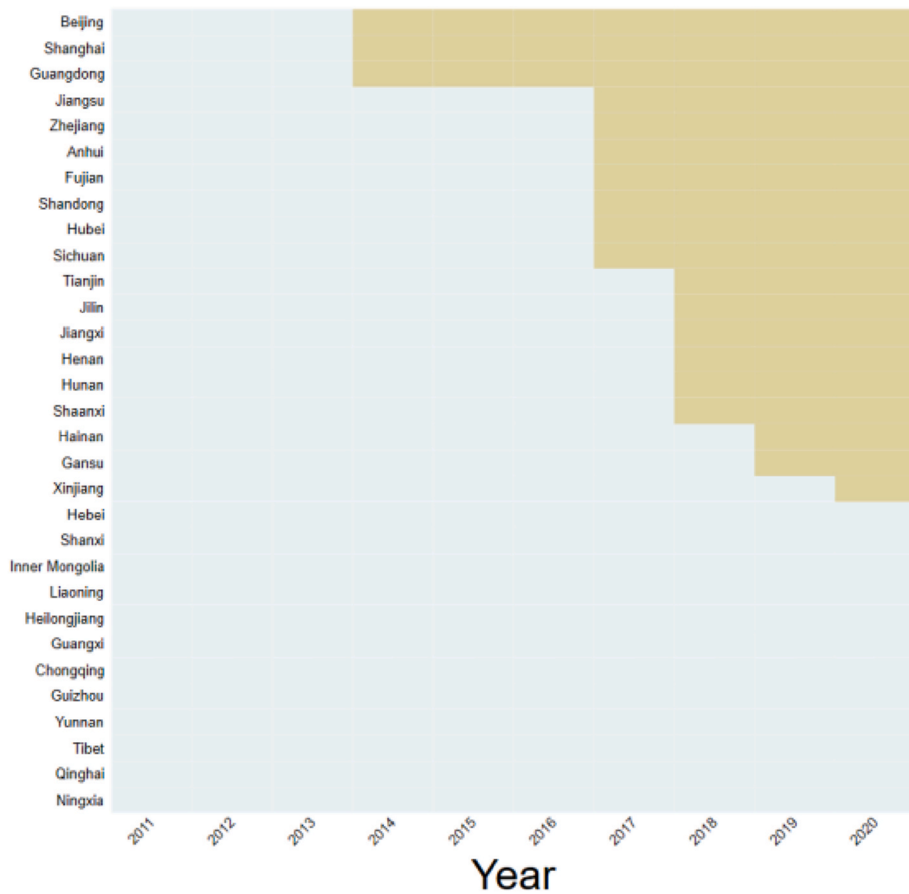

Fig. 1. Establishment Year of IPCs in China. *Notes*: This figure shows the year of establishment of IPCs in China.

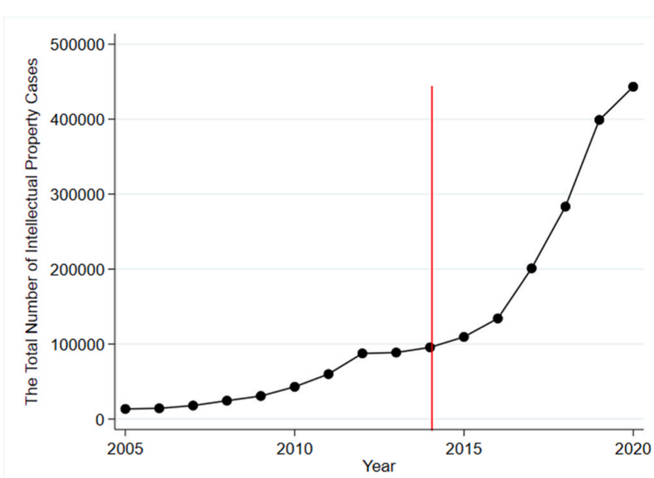

Fig. 2. The Total Number of Intellectual Property Cases in China. *Notes*: This figure shows the time trend of the total number of intellectual property cases from 2000 to 2020 in China. The data source is China Statistical Yearbook (2006–2021).

innovation capacity including the logged number of invention applications in 2010, the logged number of utility patents applications in 2010, logged cumulative number of granted invention and logged cumulative number of granted utility patents from 1990 to 2010. City fixed effects (δ_c) account for time-invariant city attributes that affect innovation performance, and year fixed effects (γ_t) capture common time shocks affecting innovation outcomes. Following Lu et al. (2019), we interact city control variables ($\boldsymbol{X}_c$) with γ_t to control for the non-linear relationship between socio-economic development trends and innovation. Standard errors are clustered at the city level.

The coefficient of interest (α_1) represents the average increase in the number of invention patents following the establishment of IPCs at the city level, compared to pre-reform averages, in cities with and without an IPC institution. A positive and statistically significant α_1 indicates that IPCs strengthen innovation activities.

However, recent research suggests that traditional two-way fixed effects estimators in a staggered DID specification may be biased due to the “negative weighting” issue caused by heterogeneous treatment effects over time and individuals, potentially leading to violate the parallel trend assumption and even an opposite causal effect (Baker et al., 2022; Goodman-Bacon, 2021). To address this, we present the weights of four different groups based on Goodman-Bacon (2021) and adopt the staggered DID estimator proposed by Callaway and Sant’ Anna (2021), which is robust to treatment effect heterogeneity, in the subsequent sections of this paper.[14]

3.2. Data

3.2.1. Patents

The patent data at the city level is sourced from the CnOpenData

[14] *Never Treated Group v.s. Timing Groups* include *Never Treated Group v.s. Early Treated Group* and *Never Treated Group v.s. Late Treated Group*. In a staggered DID model, the source of bias in the two-way fixed effects model originates from the forbidden comparison (*Late Treatment Group v.s. Early Treatment Group*) based on Goodman-Bacon (2021), which weights for 11.5 % in our paper (see Table A3 for detail).

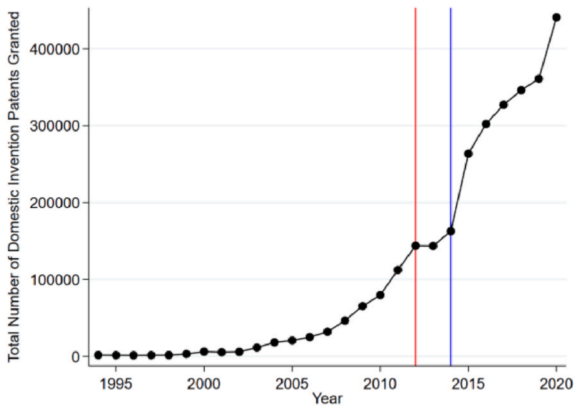

Fig. 3. The Number of Granted Patents in China. *Notes:* This figure shows the time trend of granted patent development from 1994 to 2020 in China. The data source is the China Patent Statistics Annual Report (1994–2020).

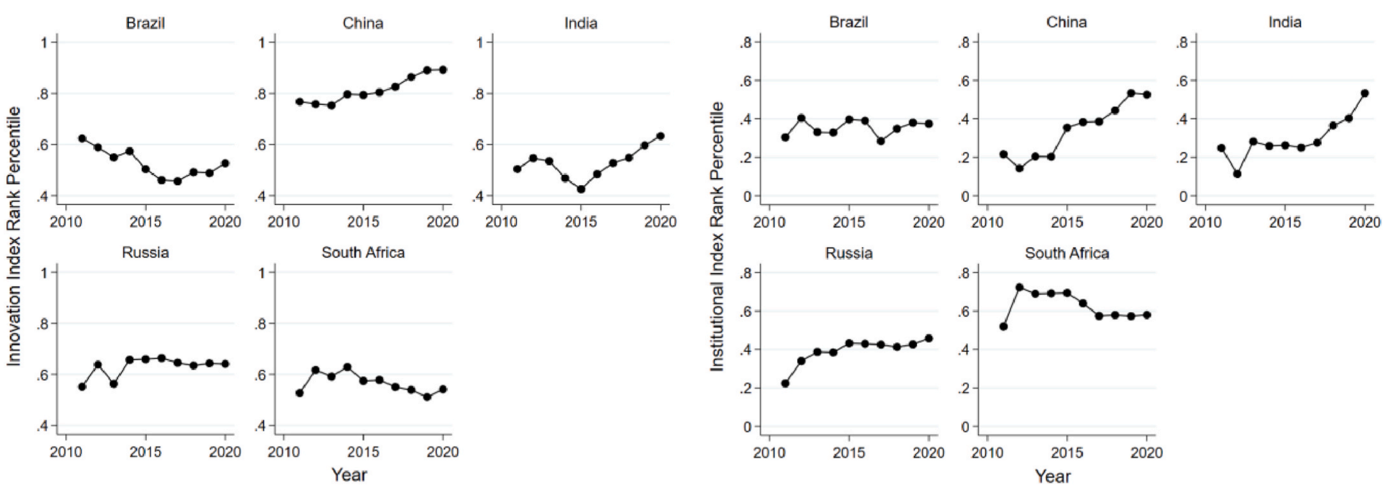

Fig. 4. The "BRICS" Countries' Comprehensive Innovation Index and Institution Index. *Notes*: This figure shows the yearly trend of "BRICS" countries' Comprehensive Innovation Index and Institution Index from 2011 to 2020. The data source is the World Intellectual Property Organization publications from 2011 to 2020.

platform's patent database, which gathers yearly information on patents granted and applications from the SIPO. Since 1985, the SIPO has provided detailed data on inventors, including their names, addresses, year of patent grant and application, patent type (invention, utility, or design model), and number of citations. This data from the SIPO has been extensively utilized in various studies on innovation in China (De Rassenfosse and Raiteri, 2022; Fang et al., 2017; Hu et al., 2017; Liegsalz and Wagner, 2013; Liu et al., 2021). Initially, we identify the city-level addresses of the first patentee of each patent holder and then aggregate the number of patents of each type based on geographical information.[15] In our primary analysis, we focus solely on the number of invention patents as they are considered to have the highest level of novelty and technological inventiveness (Fang et al., 2020; Rong et al., 2017; Wei et al., 2017).[16]

3.2.2. IPCs and judgment documents

The information on IPCs, the establishment time and detailed addresses, was collected manually from the website of the Intellectual Property Office at the provincial level and from local official news reports spanning from 2014 to 2020.

In 2013, the Supreme People's Court established China Judgments Online Institution, a unified platform for disclosing judicial documents, and has called for mandatory disclosure of all judgments made after 2014. Hence, China Judgments Online Institution provides access to almost all judgments and rulings in China.[17] As part of our mechanism analysis, we gathered data on first-instance cases related to intellectual property from China Judgments Online. These case documents include details such as the court locations, case types, submission and judgment dates, legislation fees of plaintiff and defendant and case serial numbers.

3.2.3. Summary statistics

The data are matched at the city-year level to create a balanced panel, resulting in a final baseline sample of 259 cities spanning from 2011 to 2020, and 2590 city-year observations in total. We gather the 2010 socioeconomic data from the 2011 China City Statistical Yearbook.

[15] We use the total number of patents at the city level, rather than at the firm level, because we are aimed to provide a more comprehensive representation of innovative activities across different inventors. The impact of judicial reform extends to all local inventors, encompassing individual inventors, universities, research institutions, and firms. Notably, firms account for approximately 60 % of the total patents, as highlighted in the 2020 China Patent Statistical Analysis Report. This percentage is expected to be much lower for listed firms. This is evident from the fact that top three ranking entities in terms of invention patents granted, such as Huawei Technologies Co., Ltd., State Grid Corporation of China Co., Ltd., and Guangdong OPPO Mobile Communications Co., Ltd., are all not listed companies.

[16] More details are presented in Appendix B.

[17] We provide a brief introduction of China Judgment Online in Appendix C.

The information on the population's education levels was sourced from the 2010 census data in China. Table A5 provides detailed definitions for all main variables.

Table 1 presents summary statistics across three panels: city-year level, city (in 2010), and firm-year level. The average number of 3-year-window invention patents granted per year across all cities during the sample period is approximately 952. Additionally, around 24 % of cities in the sample were under the jurisdiction of the new IPCs institution annually. City-level control variables, such as GDP per capita in 2010 (approximately CNY 33,777 or USD 5196) and the average resident population of 4.5 million in a Chinese city in 2010, are also reported. Since we also conduct the study utilizing the listed firms in Subsection 4.2, Table 1 also includes statistical characteristics for variable at firm level.

Table 1
Summary statistics.

Variables	All Sample			
	Obs.	Mean	S.D.	Median
Panel A: City-Year Level				
3-year Window Invention Patents	2590	952.279	2778.440	152
2-year Window Invention Patents	2590	443.854	1318.166	76
4-year Window Invention Patents	2590	1191.871	3727.309	176
Total Invention Patents Granted	2590	1332.259	4258.441	191
Invention Patents Applications	2590	3453.228	9454.612	600.500
The Proportion of 3-year Window Invention Patents	2590	0.109	0.074	0.090
The Proportion of Invention Patent Applications	2590	0.300	0.144	0.274
The Proportion of 3-year Window Invention Patents in the Number of Invention Patents Applications	2590	0.295	0.139	0.284
The Proportion of the Number of 3-year Window Invention Patents with Citations	2590	0.767	0.134	0.797
The Average Citations per 3-year Window Invention Patent	2590	3.440	1.686	3.330
3-year Window Utility Patents	2590	4667.318	10664.240	1241.500
3-year Window Design Patents	2590	1822.974	4847.666	368
IPC	2590	0.242	0.428	0
Panel B: City in 2010				
GDP per Capita	259	33777.230	22252.910	27,545
Population	259	452.610	316.569	379.562
FDI	259	107.852	308.774	16.694
Proportion of the Highly Educated Population	259	0.088	0.051	0.072
Education Expenditures	259	39.669	181.570	6.306
Hospital	259	0.606	0.599	0.468
University	259	0.018	0.019	0.010
Invention Patent Applications	259	841.429	2735.905	120
Utility Patent Applications	259	1242.996	2556.676	291
Cumulative Invention Patents from 1990 to 2010	259 259	1082.116	4089.573	165
Cumulative Utility Patents from 1990 to 2010	259	5396.892	10850.430	1637
Panel C: Firm-Year Level				
3-year Window Invention Patents	16,090	10.205	60.434	1
Indicators of 3-year Window Invention Patents	16,090	0.569	0.495	1
Return of Assets	16,090	0.056	0.050	0.049
Firm Size	16,090	21.807	1.431	21.549
Cash Flow	16,090	0.038	0.082	0.041
Leverage Rate	16,090	0.440	0.236	0.440

Notes: Table A5 provides detailed definitions of the main variables. Summary statistics for the treatment and control groups are presented in Table A6.

4. Results

4.1. Baseline results

We begin by presenting the regression results for the coefficient of interest without control variables in Column 1 of Table 2. As shown in Column 1, the establishment of IPCs, on average, increases the number of 3-year window invention patents by 16.5 %.[18] Subsequent columns (2–5) progressively incorporate control variables, with the coefficients of interest demonstrating robust consistency across all specifications. Specifically, the DID estimator in Column 5 shows that the IPCs reform results in a statistically and economically significant average increase of 215 invention patents per city (0.226 × 952 = 215), relative to the overall mean value of invention patents.[19] Meanwhile, supplementary analyses, documented in Table A8, confirm these findings when invention patents are alternatively measured by the locations of the first three patent signatories.[20]

4.2. Robustness checks

4.2.1. Parallel trend assumption

Our baseline results are contingent upon the assumption that cities designed to establish an IPC did not exhibit a different time trend before the treatment. To validate this assumption, we employ a dynamic DID

Table 2
The impact of IPCs reform on Innovation.

	Ln (Invention Patents)				
	(1)	(2)	(3)	(4)	(5)
IPC	0.165*** (0.050)	0.201*** (0.050)	0.197*** (0.054)	0.237*** (0.056)	0.226*** (0.070)
Public Service Controls	No	Yes	Yes	Yes	Yes
External Input Controls	No	No	Yes	Yes	Yes
Innovation Ability Controls	No	No	No	Yes	Yes
Economic Development Controls	No	No	No	No	Yes
City FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Observations	2590	2590	2590	2590	2590

Notes: This table presents the baseline estimates on the effect of IPCs reform on innovation at the city level. The dependent variable is the natural logarithm of 3-year window invention patents in city *c* in year *t*. *IPC* is a dummy for whether the IPC institution was available at the city level. Public service controls include number of hospitals per 10,000 people and total expenditure on educational institutions (logged). External input controls include total foreign direct investment (logged) and the number of universities per 10,000 people. Innovation capability controls include the logged number of invention applications in 2010, the logged number of utility patents applications in 2010, logged cumulative number of granted invention patents and logged cumulative number of granted utility patents from 1990 to 2010. Economic development controls include GDP per capita (logged), total resident population (logged), and the proportion of the highly educated population. Standard errors are clustered at the city level. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

[18] Unless otherwise specified, invention patents mentioned below refer to 3-year-window invention patents.

[19] We display the results employing the conventional two-way fixed effects model in Table A7.

[20] For example, if the first three patent signatories are located in three different cities, the three cities will simultaneously be regarded as having one invention patent. Meanwhile, if the first three patent signatories are located in a same city, the city will also be regarded as having one invention patent.

design:

$$Innovation_{ct} = \sum_{k=-7}^{5}\left[\beta_k \times D_{k(ct)}\right] + (\boldsymbol{X}_c \times \gamma_t)\boldsymbol{\varphi} + \delta_c + \gamma_t + \varepsilon_{ct} \quad (2)$$

where $D_{k(ct)}$ is a vector of dummy variables that equal to 1 if the IPC institution was k years away for city c in year t and $\boldsymbol{\beta_k}$ represents the vector of corresponding estimators. The $k = -8$ period is omitted as the reference group. These estimators measure the difference in innovation outcomes between cities with and without IPCs institution before and after the reform. The control variables and fixed effects used are consistent with those in the baseline regression model. To allow for heterogeneity in treatment effects, we also present the dynamic figure generated by the estimator that is robust to treatment effect heterogeneity in Callaway and Sant' Anna (2021).

Fig. 5 illustrates that the difference in outcomes between cities with and without IPCs institution remains consistently close to zero and not statistically significant before the implementation of IPCs reform. This robustly supports the parallel trend assumption in our empirical setting. Meanwhile, following the introduction of IPCs, treated cities demonstrate a notable and continuous increase in invention patents compared to their untreated counterparts.

The immediate increase observed in Fig. 5, which exhibits no significant time lag, cannot be fully accounted for by the general effect, as innovation investments typically require time to yield patentable technologies. We therefore propose that this immediate increase may be attributed to the transformation effect, which enhances the likelihood of converting existing trade secrets into public invention patents. A comprehensive analysis of these two effects will be presented in Section 5.

4.2.2. Firm-level results

We also gather data on invention patents granted to listed firms in China from the SIPO spanning the years 2011–2020 and adopt a similar staggered DID methodology to identify the effect of IPCs reform on innovation at firm level.[21] The results are presented in Table 3.

Columns 1–4 explore the impact of IPCs reform on innovation performance in China by analyzing data from listed firms across various industries. Following Chen and Roth (2024), we examine both the extensive and intensive margins of innovation to tackle the challenge that numerous firms in our sample have no invention patent applications within a 3-year window. Consistent with Fang et al. (2018), we then conduct a sub-sample analysis focusing on the manufacturing and information technology sectors, given their high level of technological intensity.[22]

Our analysis yields two main findings: First, the positive effect of IPCs reform on firm-level innovation is primarily driven by the extensive margins, aligning with Fang et al. (2018). Second, sub-sample results in Columns 3 show this positive effect is even more pronounced in manufacturing and information technology (IT) industries. This intensified effect is attributed to the fact that listed firms in these sectors are more responsive to improvements in the judicial environment for intellectual property. Their greater involvement in patent filing often leads to more frequent engagement in patent-related legal disputes, making them particularly sensitive to intellectual property protection enhancements. Overall, these firm-level findings further support the conclusion that IPCs reform promotes innovation.[23]

[21] The details of the data processing and regression model are presented in Appendix D.

[22] In our listed firm sample, 65 % of firm-years observations in the Manufacturing & IT industries hold at least one invention patents, almost twice as much as in non-Manufacturing & IT industries (36 %).

[23] We present the parallel trend checks at the firm level in Figure A1 and find an insignificant coefficient of interest which is stable at zero before the IPCs reform.

4.2.3. Other robustness checks

This section presents additional robustness checks on our baseline results. First, we examine the sensitivity of our findings to different invention patent window periods. Specifically, we calculate the number of invention patents granted within 2-year, 4-year and unlimited window periods. The results, as shown in Table A9, remain highly consistent, indicating that our finding is not sensitive to the window period selection. Corresponding parallel trends are also plotted in Figure A2.

Second, we conduct several robustness checks related to sample composition and alternative policy influences. We utilize an unbalanced sample, exclude cities with important economic and political status, such as municipalities, provincial capitals, sub-provincial cities and special economic zones; and account for potential effects induced by other related policies during the sample period. These policies include the Pilot Construction of Innovation-oriented Cities, the National Intellectual Property Demonstration Cities policy, and the anti-corruption campaign, all of which could potentially promote the innovation environment and increase government funding to support innovation; additionally, we adjust the definitions of our independent and dependent variable. The results are presented in Table A10 and consistently support our baseline findings.

Furthermore, we carefully consider the potential confounding effects of policies that directly alter innovating behavior through patent subsidies and government tax credits. Following Li and Branstetter (2024), we consider “Made in China (2025)” (MIC2025) as a major policy supporting industrial innovation, given its aim to achieve an innovation-driven development model in China via public innovation policy. We collect the city list and approval times for the 30 cities designated as national demonstration areas under the MIC2025 policy in 2016 and 2017, incorporating this information as an additional control variable in our empirical examination. Additionally, we use data from listed firms to further investigate the effect of subsidies and tax credits, using non-operating income as the proxy for subsidies. As our previous analysis only finds a significantly positive effect of the IPCs reform on innovation at the extensive margin, we focused solely on this margin here for simplicity. The results are presented in Table A15. We find that innovation support policy such as MIC2025 did not undermine our primary finding: the coefficient of interest remains significantly positive at the 1 % level and intact in economic magnitude. Firm-level evidence also supports the conclusion of a limited effect of subsidies and tax credits on innovation. The findings are consistent with Li and Branstetter (2024) that innovation-focused industrial policies may prove to be inefficient in fostering innovation due to the distortions caused by the policies themselves.[24]

Lastly, we employ various estimation methods to validate the primary results. As shown in Table A11, we apply the framework provided by Callaway and Sant' Anna (2021) (Columns 1–3) and other two-stage estimators based on Borusyak et al. (2024) and Gardner (2022) (Columns 4–5), all of which confirm our initial findings.

Overall, our coefficient of interest remains stable across various samples, estimation methods and measures of independent and dependent variables. The primary effect of the IPCs reform remains robust and highly significant, undiminished by other related policies, patent subsidies, government tax credits.

[24] However, it is worthy to note that we should interpret the firm-level results with caution, primarily for two reasons. First, the amount of tax credit is for all purposes, not solely for patent application. Similarly, using non-operating income as a proxy for subsidy faces the same measurement challenge. Second, recent research has shown that Chinese firms may relabel R&D to comply with government regulations for tax benefits or subsidy (Chen et al., 2021; König et al., 2022).

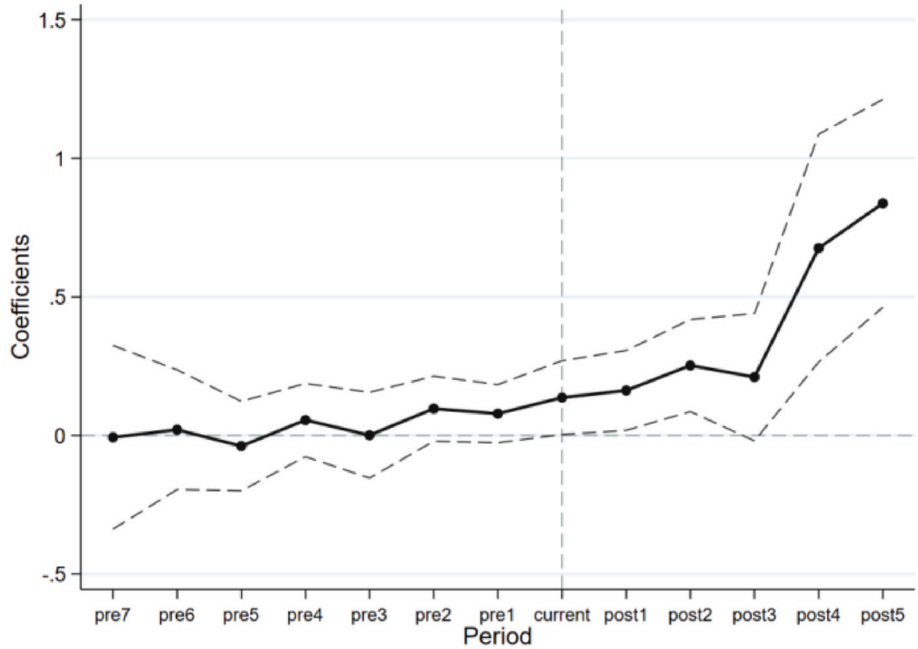

Fig. 5. Parallel Trend Test. *Notes*: This figure shows the parallel trend test for 3-year-window invention patents during our sample period (2011–2020) based on Callaway and Sant' Anna (2021).

Table 3
The impact of IPCs reform on Innovation at the firm level.

	Indicator of Invention Patents	Ln (Invention Patents)	Indicator of Invention Patents	Ln (Invention Patents)
	All Industries		Manufacturing & IT	
	(1)	(2)	(3)	(4)
IPC	0.200*	0.215	0.334***	0.065
	(0.111)	(0.391)	(0.128)	(0.418)
City Controls	Yes	Yes	Yes	Yes
Firm Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	16,090	7736	11,260	6394

Notes: This table reports the robustness results of the impact of the IPCs reform on the innovation performance of the listed firms. The dependent variable is the indicator of 3-year window invention patents of firm i in city c in year t in the odd columns. The dependent variable is the logged 3-year window invention patents of firm i in city c in year t in the even columns. *IPC* is a dummy for whether the IPC institution was available at the city level. Firm controls include total assets, firm size, leverage rate and net cash flow. City controls are the same as the preferred specification in baseline regression. Standard errors are clustered at the city level. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

4.3. Displacement effects

A plausible concern regarding the baseline results is that inventors (or innovative firms) in cities without IPCs institutions might relocate to cities with IPCs institution for better protection, especially in neighboring provinces.[25] Therefore, our baseline estimator could be influenced by the competing explanation, potentially capturing the inter-regional transfer effect of innovation output. Additionally, examining the "beggar-thy-neighbor effect" is important to evaluate the overall effect of the IPCs reform on innovation development. Therefore, we use two specifications to verify it. The econometric model is as follows:

$$Innovation_{ct} = \alpha_1 Exploited\_IPC_{ct} + (\boldsymbol{X}_c \times \gamma_t)\boldsymbol{\beta} + \delta_c + \gamma_t + \varepsilon_{ct} \tag{3}$$

Where c is the city, t is the year. First, we classify cities into two categories: exploited cities are those without IPCs institution throughout the entire sample period, while treated cities are those where IPCs institution are available. Next, we conceptualize a series of circles with radii ranging from 200 km to 600 km at intervals of 100 km around each IPC city where an IPC actually is located. Then, we define the exploited treatment variable ($Exploited\_IPC_{ct}$) to be 1 if an exploited city falls within the circle of a certain geographical distance (200 km–600 km) of a city that becomes an IPC city after year t; otherwise it takes the value 0.[26] We design a schematic diagram and a table to further describe the measurement of Variable $Exploited\_IPC_{ct}$ and show them in Appendix Figure A3 and Table A12. Additionally, we also control the true IPCs reform to separate the net potential transfer effect. The remaining variables are consistent with those in our baseline specification. We would observe a significant geographical displacement effect among provinces in our results if the estimated coefficient of interest is statistically significant. Conversely, an insignificant coefficient would suggest the absence of an alarming trans-regional displacement effect. The results, presented in Columns 1–5 of Table 4, are both insignificant and trivial, demonstrating that displacement effect is limited in our study. This finding is intuitively supported by the high costs typically involved in the migration of firms or individual innovators to another city or province.

Second, we shift our focus to provincial borders to specifically capture trans-regional displacement effects. For this analysis, we restrict the sample of exploited cities to only those located on provincial borders, as their inventors are most likely to relocate across provinces. In this context, $Exploited\_IPC_{ct}$ is defined as 1 if an exploited city is located on

[25] Beijing established an IPC by the end of 2014, while Shijiazhuang, the capital of Hebei province adjacent to Beijing, did not establish an IPC during the entire sample period. If innovative firms or individual inventors in Shijiazhuang seek better judicial protection for their intellectual property, they may consider migrating to Beijing.

[26] In our sample, the 99th percentile of the geographical distance from an exploited city to an IPC city is 500 km.

Table 4
Examination of inter-region patent transfers.

	Ln (Invention Patents)					
	(1)	(2)	(3)	(4)	(5)	(6)
	200 km	300 km	400 km	500 km	600 km	Border
Exploited_IPC	−0.155	−0.030	−0.025	−0.011	0.054	−0.012
	(0.110)	(0.065)	(0.054)	(0.077)	(0.070)	(0.056)
City Controls	Yes	Yes	Yes	Yes	Yes	Yes
City FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2590	2590	2590	2588	2580	2560

Notes: This table reports the displacement effect analysis of IPCs reform at the city level. The dependent variable is the logged 3-year window invention patents of city c in year t. In Columns 1–5, we define the $Exploited\_IPC_{jt}$ to be 1 if an exploited city falls within the circle of a certain geographical distance (200 km–600 km) of a city that becomes an IPC city after year t; otherwise it takes the value 0. In Column 6, the $Exploited\_IPC_{jt}$ is defined as 1 if an exploited city is located on the border of a province where an IPC institution was established in year t. We drop Hainan Province in Column because Hainan Province is an island and has no border with any other province. City controls are the same as the preferred specification in baseline regression. We also control the IPC institution based on the firms' own location. Standard errors are clustered at the city level. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

the border of a province where an IPCs institution was established in year t. Should the exploited city be adjacent to multiple bordering provinces with IPCs, year t is designated as the year the IPC became operational in the first exploiting city within those provinces. Otherwise, the variable takes the value 0. Thus, $Exploited\_IPC_{jt}$ refers to the trans-regional displacement effects caused by IPCs reform. The estimated coefficient reported in Columns 6 of Table 4 is statistically insignificant and close to zero, suggesting that the trans-regional displacement effect of IPCs is negligible.

Third, from the perspective of enterprise network, patent transfer between firms within the same conglomerate represents another possible pattern of patent displacement. To account for this, we construct the regression model as follows:

$$Innovation_{igct} = \alpha_1 IPC\_Transfer_{gt}^{-i} + (\boldsymbol{Z}_{ig} \times \gamma_t)\boldsymbol{\rho} + (\boldsymbol{X}_c \times \gamma_t)\boldsymbol{\beta} + \delta_i + \gamma_t + \varepsilon_{igct} \quad (4)$$

Where c is the city, t is the year, g is the conglomerate and i is the firm. In specific, $Innovation_{igct}$ refers to the indicator (or the number of patents in log format) of 2-year/3-year/4-year/unlimited window invention patents of firm i (including subsidiaries and their parent companies) within conglomerate g in city c in year t. $IPC\_Transfer_{gt}^{-i}$ equals 1 if firm i is *never* directly affected by IPCs reform but, at year t, at least one other firms within the same conglomerate g is located under the jurisdiction of an IPC institution; otherwise, it equals 0.[27]

In Equation (4), $\boldsymbol{X}_c$ is consistent with those in the baseline model and $\boldsymbol{Z}_{ig}$ is also consistent with the specification at the listed firm level. In addition, we also control the IPCs institution based on the firms' *own* location to separate the net potential transfer effect. δ_i represents the firm fixed effects to account for any time-invariant features of firms. γ_t is the year fixed effects, capturing common time shocks that affects innovation outcomes. Standard errors are clustered at the city level to maintain consistency with the baseline specification. The coefficient α_1 captures the potential transfer effects within a same conglomerate.

The results are shown in Table 5. We do not observe any significant coefficients of transfer effect, regardless of all industries or manufacturing & IT industries. In summary, this subsection's analysis robustly rules out inter-region and intra-conglomerate patent transfers, thereby affirming that our observed innovation growth represents a net increase.

[27] Th variable $IPC\_Transfer_{gt}^{-i}$ is constructed using a jackknife-like method. To facilitate a better understating of this measurement, we present a demonstrative conglomerate as shown in Table A14.

Table 5
Examination of intra-conglomerate patent transfers.

	Indicator of Invention Patents	Ln (Invention Patents)	Indicator of Invention Patents	Ln (Invention Patents)
	All Industries		Manufacturing & IT	
	(1)	(2)	(3)	(4)
IPC_Transfer	−0.012	−0.057	−0.008	−0.036
	(0.010)	(0.056)	(0.011)	(0.062)
City Controls	Yes	Yes	Yes	Yes
Firm Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	98,327	16,638	76,872	13,603

Notes: This table excludes the intra-conglomerate patent transfers. The dependent variable is the indicator of 3-year-window invention patents of firm i in city c in year t in the odd columns. The dependent variable is the logged 3-year window invention patents of firm i in city c in year t in the even columns. *IPC_Transfer* equals 1 if firm i is *never* directly affected by IPCs reform but, at time t, at least one other firms within the same conglomerate g is located under the jurisdiction of an IPC institution; otherwise, it equals 0. Firm controls include total assets, firm size, leverage rate and net cash flow of the conglomerate, and the IPC institution based on its own location. City controls include public service controls (number of hospitals per 10,000 people and logged total expenditure on educational institutions), external input controls (logged total foreign direct investment and the number of universities per 10,000 people), innovation capability controls (the logged number of invention applications in 2010, the logged number of utility patents applications in 2010, logged cumulative number of granted invention patents and logged cumulative number of granted utility patents from 1990 to 2010), and economic development controls (logged GDP per capita, logged total resident population, and the proportion of the highly educated population). Standard errors are clustered at the city level. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

4.4. Heterogeneity analysis

Human capital has long been viewed as an indispensable factor in innovative activities (Hunt and Gauthier-Loiselle, 2010; Kerr and Lincoln, 2010). In this subsection, we investigate the interaction effect of human capital and IPCs reform on innovation development. We measure city-level human capital using two indicators from 2010: the total

Table 6
Heterogeneity analysis.

	Ln (Invention Patents)		
	(1)	(2)	(3)
*IPC * Indicators*	0.126**	0.024	0.229**
	(0.061)	(0.058)	(0.095)
City Controls	Yes	Yes	Yes
City FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	2590	2590	2590

Notes: This table presents the heterogeneous effect of IPCs reform on innovation at the city level with respect to human capital. The dependent variable is the natural logarithm of 3-year-window invention patents in city c in year t. *Indicators* is the dummy variable equals one if cities' total number of people with a college degree or higher and the number of universities per 10,000 people exceeds the median value of all cities in the sample in Columns 1 and Columns 2. The indicator equals one Beijing, Shanghai and Guangdong province and otherwise zero in Columns 3. City controls are the same as the preferred specification in the baseline regression. Standard errors are clustered at the city level. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

number of higher education population and the number of universities per 10,000 people, assuming these variables are positively associated with the presence of "smart brains".

To analyze this heterogeneity, we divided the cities in our sample into two groups: high and low human capital. A city is categorized as having high human capital if: (1) the number of residents with a college degree or higher exceeds the sample median, or (2) the number of universities per 10,000 people in 2010 exceeds the sample median. Since the method proposed by Callaway and Sant'Anna (2021) only applies to a DID setting, we modify our triple-difference model into a DID specification according to Yang et al. (2024). Columns 1 and 2 of Table 6 present the respective results. These findings suggest a consistent pattern: cities with higher human capital in the pre-IPCs period benefits more from the IPCs reform, regardless of the specific human capital measurement. However, it is worth noting that the results for human capital intensity, as measured by the number of universities per 10,000 people, lack statistical significance.

Moreover, we also explore the potential heterogeneity on the IPCs and IPTs, as suggested in the background. Specially, we define an indicator of Beijing, Shanghai and Guangdong province, which is interacted with the variable of interest (*IPC*). In Column 3, we find that the establishment of IPCs has a larger effect on innovation compared to IPTs. However, this result should be interpreted cautiously: heterogeneous results on human capital indicate that cities with higher human capital benefit more from IPCs reform, and Beijing, Shanghai, and Guangdong happen to also be the regions with the most "smart brains" in China.

4.5. Patent applications, structure and quality

After investigating the improvement in innovation performance represented by the quantity of granted patents, we now turn to examining patent applications, structure and quality using different independent variables, as reported in Table 7.[28] In Column 1, the estimated coefficient indicates that the establishment of IPCs boosts the number of invention patent applications by 31 %, with a statistically significant coefficient at the 1 % level.

Second, since invention patents are inherently more innovative and valuable than utility or design patents, the effect of IPCs reform on the structure of patent authorization reflects the impact of IPCs on *overall* patent quality. In Column 2, after the IPCs reform, we observe a 7 percent points increase in the proportion of invention patent applications to the total number of patent applications at the city level, equaling to 23 % of the sample average. In Column 3, we find that the establishment of IPCs increases the proportion of invention patents to the total 3-year-window patents at the city level by 2.3 percent points, equivalent to a 21 % increase compared to the sample mean. Overall, we observe a significant improvement in patent structure, shifting from relatively low innovation-value utility and design patents to invention patents.

Furthermore, we investigate the effect of IPCs reform on the patent quality. We first examine the proportion of invention patents approved in their own applications since the authorization of invention patents requires strict quality review during the approval process, as discussed in Section 3.2.1. A higher approval rate means higher quality of overall invention patent. Nevertheless, the coefficient of interest turns out to be significantly negative coefficient of interest at the 10 % level. Then, we further utilize the number of citations as a proxy for measure patent quality, a method previously employed in previous studies like Arora et al. (2022) and Derrien et al. (2023). Specifically, we measure invention patent quality in Columns 5 and 6 by examining the proportion of invention patents with at least one citation and the average number of citations per invention patent, respectively. The results in Column 5 demonstrates that the IPCs reform results in an insignificant 0.7 percent points decrease in the proportion of the cited invention patents. The result of average citations per invention patent is presented in Column 6, indicating that IPCs reform significantly decreases the average citations per invention patent by 6.7 %, given that the average citations per invention patent is 3.44 at city level. Hence, we consider that IPCs reform enhances the quantity of invention patent and the structure of patent application and authorization. However, it might fail to improve the quality of invention patent to some extent.

5. Mechanisms

This section delves into the positive impact of IPCs reform on innovation development by examining the specialized courts' role in enhancing judicial enforcement. We then connect these judicial improvements to innovation outcomes through two specific channels: the general effect, which we assess by analyzing the reform's impact on innovation input, and the transformation effect, which we examine through the propensity to register innovations as public patents.

Previous literature has shown that the specialized courts contribute to improving local judicial environment, particularly reflected in judicial enforcement including, for example, reducing case congestion (Müller, 2022) and selecting better-educated and professional judges who are graduated from the top law schools or have previously worked in the law practice in China (Li and Ponticelli, 2022). Therefore, we argue that the IPCs reform helps to alleviate inefficiencies in the court system and shape better judicial environment, particularly concerning enforcement. This is largely due to more professional judicial teams handling specialized trial matters, which, in turn, increases infringement costs and provides innovators with greater economic incentives. As the returns to patents increase, we propose that innovators will respond by increasing innovation inputs, such as R&D (the general effect) or by registering more technologies previously held as trade secrets as public patents (the transformation effect).

5.1. The Public's subjective satisfaction with the judicial environment

We begin our analysis of the judicial environment by examining survey data on the public's subjective satisfaction with intellectual property protection. The China Patent Protection Association (CPPA), a department under SIPO, has been conducting the "China Intellectual Property Protection Social Satisfaction Survey" at the province level since 2012. This survey serves as a proxy to reflect the local judicial environment. Specifically, the CPPA conducts annual surveys on three categories of individuals across all provinces in China, namely intellectual property holders, professionals, and the general public. These groups collectively exceed 10,000 individuals each year. The assessment project evaluating subjective satisfaction with judicial protection of intellectual property primarily focuses on four key aspects: litigation duration, litigation costs, fairness of trial, and reasonableness of compensation. Answers are divided into five levels: very satisfied, satisfied, basically satisfied, not very satisfied and dissatisfied, corresponding to 100 points, 80 points, 60 points, 30 points and 0 points. The final sample includes 16 provinces across China's key economic regions.[29]

We examine the relationship between subjective social satisfaction scores and the IPCs reform, with results presented in Table 8. The coefficient of interest in Column 1 indicates that the establishment of IPCs

[28] We show the empirical results of the effect of IPCs on utility and design patents in Table A13 in Appendix and find that the coefficients of interest are statistically insignificant.

[29] The official survey file shows that "if a province does not receive valid questionnaire responses, the province's score in that year will be a missing value". The 16 provinces are Hebei, Shanxi, Liaoning, Heilongjiang, Zhejiang, Jiangsu, Anhui, Fujian, Jiangxi, Shandong, Henan, Hubei, Hunan, Sichuan, Yunnan, and Shaanxi.

Table 7
The impacts of IPCs reform on patent applications, structure and quality.

	Patent Application	Patent Structure		Patent Quality		
	Ln *(Invention Patent Applications)*	*The Proportion of the Number of Invention Patent Applications*	*The Proportion of Invention Patents Granted*	*The Proportion of Invention Patents Granted in the Number of Applications*	*The Proportion of the Invention Patents with Citations*	*The Average Citations per Invention Patent*
	(1)	(2)	(3)	(4)	(5)	(6)
IPC	0.313***	0.070***	0.023***	−0.021*	−0.007	−0.232**
	(0.068)	(0.017)	(0.008)	(0.011)	(0.015)	(0.111)
City Controls	Yes	Yes	Yes	Yes	Yes	Yes
City FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2590	2590	2590	2590	2590	2590

Notes: This table presents the effect of IPCs reform on patent applications, patent structure and patent quality at the city level. In Column 1, the dependent variable is the natural logarithm of 3-year-window invention patents application of city *c* in year *t*. In Column 2, the dependent variable is defined as the proportion of the number of invention patent applications to the total number of patent applications in city *c* in year *t*. In Column 3, the dependent variable is the proportion of 3-year-window invention patents to the total 3-year-window patents in city *c* in year *t*. In Column 4, the dependent variable is defined as the proportion of the number of 3-year-window invention patents to the number of invention patent applications in city *c* in year *t*. In Column 5, the dependent variable is the proportion of the number of 3-year-window invention patents with at least one citation to the total number of 3-year window invention patent in city *c* in year *t*. In Column 6, the dependent variable is the number of citations per 3-year-window invention patent. *IPC* is a dummy for whether the IPCs institution was available at the city level. City controls are the same as the preferred specification in the baseline regression. Standard errors are clustered at the city level. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

institution significantly enhances social satisfaction scores related to litigation duration at the 1 % level, resulting in a 0.4 standard deviation increase. This improvement is comparable to a province transitioning from the 50th percentile to the 75th percentile in satisfaction. Additionally, we find that the social satisfaction scores on litigation costs and reasonability of compensation also improved after the IPCs reform at the 1 % level, showing economic significance with increases of 0.5 and 0.2 standard deviations, respectively. In conclusion, our findings suggest a positive correlation between the establishment of IPCs institution and improved subjective social satisfaction with judicial trial.

5.2. The judicial enforcement of intellectual property

We further verify the enhancement in local judicial environment using the lawsuit documents from the China Judgment Online. Prior research has indicated that many developing nations face challenges with low judicial efficiency due to a lack of specialized courts or judges (Djankov et al., 2008). We mainly focus on three indicators that are widely explored to reflect the judicial enforcement or environment including the judgment duration, the plaintiff winning rate and the appeal rate of cases. Note that we only exploit the first-instance cases since instead of retaining in the local IPCs, the second-instance cases will be sent to the Provincial High People's Court or the Supreme People's Court for trial based on the legislation law in China.

The duration of processing an intellectual property case serves as a crucial indicator of judicial efficiency. Given the specialized nature of IPCs, it is anticipated that the trial duration of the cases related with intellectual property issue will decrease, thereby reducing the economic cost of intellectual property protection for potential infringed parties. Specifically, we take the days between the filing date and the final judgment date as the trial duration of the case and then measure the judgment efficiency by averaging the number of days for complete trial of individual first-instance cases at the city level.[30]

The estimated coefficient is presented in Column 1 of Table 9, showing that IPCs reform significantly reduces the average trial duration of intellectual property cases by 111 days, equivalent to around 4 months. Economically, this 111-day reduction represents a 57 % decrease compared to the average judgment duration of 195 days. We emphasize the importance of reducing case duration in our study, particularly due to the significant opportunity cost of time for innovators. The positive impact of IPCs on judgment efficiency aligns with existing literature on specialized courts in China. For example, Li and Ponticelli (2022) observed a 36 % decrease in bankruptcy-related cases duration for China's bankrupt courts.

Next, we would like to explore the plaintiff winning rate of first-

Table 8
Social satisfaction with judicial protection of intellectual property.

	Litigation Duration	Litigation Costs	Fairness of Trial	Reasonability of Compensation
	(1)	(2)	(3)	(4)
IPC	2.186***	2.858***	0.159	1.174***
	(0.513)	(1.109)	(0.225)	(0.002)
Province Controls	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Mean of Dependent Variable	74.135	73.47	74.179	72.130
S.D. of Dependent Variable	5.552	5.894	4.492	6.429
Observations	112	112	112	112

Notes: This table presents the mechanism analyses of the effect of IPCs reform on innovation based on China Intellectual Property Protection Social Satisfaction Survey. In Columns 1–4, the dependent variable is the subjective social satisfaction with litigation duration of province *p* in year *t*, respectively. The subjective social satisfaction with litigation duration reflects respondents' opinions on trial deadlines and the timely resolution of intellectual property cases; the subjective social satisfaction with litigation costs reflects respondents' opinions on whether protecting rights through judicial means is perceived as "highly costly"; the subjective social satisfaction with the fairness of trials reflects respondents' opinions on the severity of judicial punishments and the reasonableness of damages in intellectual property infringement cases; the subjective social satisfaction with the reasonableness of compensation reflects respondents' opinions on the transparency of the trial process in intellectual property cases and the strict adherence to the law. *IPC* is a dummy for whether the IPC was available at province *p* in year *t*. Control variables include public service controls, external input controls and economic development controls at the province level. Standard errors are clustered at the province level. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

[30] Our unbalanced sample covers 91 cities, distributed in all economic regions of China, including east, central, south, southwest, northeast, northwest and north China. We winsorize this indicator at the 1–99 % to deal with the unusually long duration of cases caused by some uncontrollable factors in legislation process like missing evidentiary documents. However, the result is consistent without winsorizing (unreported and available upon request).

instance intellectual property cases, a metric widely used in previous Chinese literature to assess the quality of judicial protection for infringed parties (Cao et al., 2023; Lu et al., 2015; Zhang, 2023). However, accurately measuring the plaintiff winning rate of cases can be challenging, as both plaintiffs and defendants often bear some degree of legal responsibility in most of cases. Therefore, following Liu et al. (2025), we define the proportion of plaintiffs' success in litigation cases by one minus the proportion of litigation fees paid by the plaintiffs. The higher the value, the greater the plaintiff's success rate. We also use two alternative approaches, defining plaintiff success when the defendant paid either the whole and more than half of legislation fees. The results are presented in the Columns 2–4 of Table 9. We find that IPCs reform holds a significantly positive effect on protecting the plaintiff. Taking the result in Column 2 as an example, on average, the plaintiff winning rate significantly increases by 0.26 percentage points after the IPCs reform at the city level, equivalent to 45 % of the sample mean. In summary, our analysis indicates that the enhanced protection for intellectual property following the IPCs reform encourages inventors to invest more in innovative activities and produce more innovative products with less concern about infringement.

Lastly, according to China's Civil (Administrative) procedural Law, the trial of intellectual property follows a system where the second instance serves as the final stage in civil and administrative litigation. If either the plaintiff or defendant choose to appeal the first-instance judgment, the overall trial duration for the cases related with intellectual property issue will be further extended. Hence, we determine the annual average appeal rate of first-instance the cases related with intellectual property issue at the city level by dividing the total number of the cases related with intellectual property issue with second-instance records by the total number of the cases related with intellectual property issue. Around 26 % of all first-instance the cases related with intellectual property issue appeal in our sample period (2011–2020). The findings in Column 5 of Table 9 reveal an insignificant decrease in the appeal rate of first-instance cases related with intellectual property issue.

Overall, these findings in Table 9 align with what we observed in social satisfaction survey (Table 8). More significantly, they provide empirical support for the key features of China's IPCs reform discussed in the Introduction part, including the recruitment of a specialized team of judges, the focus on the cases related with intellectual property issue, and the implementation of the technical investigator system.

5.3. The general effect and the transformation effect

Having established that the IPCs reform improved the judicial environment for intellectual property protection, we now test for the two channels through which this improvement is expected to have influenced innovator behavior: the general effect and the transformation effect.

5.3.1. The general effect

The general effect proposes that stronger judicial protection incentivizes new innovative activity. To test this, we employ firm-level and city-level R&D expenditure intensity as proxies to measure the intensity of innovation activities. The R&D intensity at the firm level is calculated by dividing total R&D expenditure by total assets. To account for the incompleteness of listed firm data, we also collect total science and technology expenditures at the city level from the China City Statistical Yearbooks (2011–2020). Data is normalized using 2010 city-level GDP and the results are presented in Table 10.

Column 1 of Table 10, focusing on listed firms across all industries, shows a positive coefficient of interest with economic significance (though lacking statistical significance). Further analysis is conducted by narrowing down to manufacturing and information technology industries. We find that the coefficient of interest is significantly positive at the 10 % level, indicating a 21 % increase in R&D intensity in firms following the IPCs reform, with the mean outcome variable being 0.02. Column 3 further shows a significantly positive impact of IPCs reform on science and technology expenditure intensity at the 5 % level. Specifically, the intensity of science and technology expenditure is shown to increase by 33 % at the city level after the IPCs reform. This larger effect observed at the city level can be attributed to the fact that the listed firms represent only a portion of the innovative groups within a city. Overall, the results in Table 10 suggest that IPCs reform significantly alters innovation input.

While our data do not allow us to distinguish whether this new R&D is directed toward invention, utility, or design patents, our other findings (see Table A13 in the Appendix) show that the reform did not increase utility or design patents. Therefore, we interpret the positive effect on R&D as evidence that the IPCs reform successfully stimulated the innovative activity underlying new invention patents.

5.3.2. The transformation effect

The transformation effect suggests that improved intellectual property protection encourages firms to convert existing trade secrets into public patents, and further facilitates overall innovation through knowledge spillover. Since knowledge spillover is widely existed and the effect of knowledge spillover on innovation has been well documented, we focus here on testing the crucial first step: whether the IPCs reform increased the likelihood of this conversion.[31]

Directly measuring the transformation of trade secrets into publicly disclosed patents is challenging, as trade secrets are inherently unobservable (Png, 2017). We therefore use a proxy: the ratio of R&D investment to the number of invention patents. Theoretically, if firms are patenting existing knowledge without new R&D, this ratio should decrease.[32] We examine the effect of IPCs reform on the ratio of R&D investment on the number of invention patents at the firm level and the empirical results are presented in Table A16 in the Appendix. Further, we investigate the dynamic effects on both the full industry sample and a targeted Manufacturing & IT industry subsample, showing them in Figure A4 and Figure A5 in the Appendix.

Our empirical results for the transformation effect are inconclusive. The estimated coefficients in Table A16 in the Appendix are statistically insignificant. Furthermore, the results, presented in Figure A4 and Figure A5 in the Appendix, confirm this finding, showing no significant decline in the ratio of innovation investment to patents for either group. While our statistical tests are inconclusive, the immediate increase in patents shown in our dynamic analysis (Fig. 5) suggests the transformation effect is plausible. This inconclusive result is likely due to the profound difficulty in measuring the conversion of hidden trade secrets. Our proxy, while theoretically grounded, may be too rough to capture this subtle mechanism.

In summary, our analysis provides solid empirical evidence for the general effect: the IPCs reform spurs innovation by encouraging new R&D investment. However, we do not find statistically significant evidence for the transformation effect.

[31] Comin and Mestieri (2014) and Stoneman and Battisti (2010) have given a comprehensive review for the play of knowledge spillover played in the technology diffusion. Cai et al. (2022) discussed the cross-country and cross-sector knowledge spillover and Ganguli et al. (2020) shown evidence of localized knowledge spillovers using a new database of US patent interferences terminated between 1998 and 2014. Hence, knowledge spillover is a universal phenomenon.

[32] This inference is based on the assumptions that the efficiency of innovation investment and the patent quality are unchanged. Therefore, an increase of the likelihood of converting trade secrets into patents maybe implies that the ratio of innovation investment on the number of patent decreases.

Table 9
The effects of IPCs reform on judicial enforcement.

	Days for Judgment of First-instance Intellectual Property Cases	The Plaintiff Wining Rate of First-instance Intellectual Property Cases	The Plaintiff Wining Rate of First-instance Intellectual Property Cases (100 %)	The Plaintiff Wining Rate of First-instance Intellectual Property Cases (>50 %)	Appeal Rate of First-instance Intellectual Property Cases
	(1)	(2)	(3)	(4)	(5)
IPC	−111.030***	0.264**	0.311***	0.366***	−0.103
	(33.344)	(0.103)	(0.119)	(0.127)	(0.124)
City Controls	Yes	Yes	Yes	Yes	Yes
City FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Mean of Dependent Variable	194.140	0.583	0.282	0.645	0.256
S.D. of Dependent Variable	121.161	0.270	0.345	0.340	0.279
Observations	440	440	440	440	440

Notes: This table presents the mechanism analyses of the effect of IPCs reform on innovation based on judicial enforcement. In Columns 1–5, the dependent variable is the average number of days for judgment of first-instance intellectual property cases at city *c* in year *t*, the plaintiff wining rate of the average first-instance intellectual property cases at city *c* in year *t*, the plaintiff wining rate by defining a plaintiff success in a lawsuit when the defendant paid the whole, the plaintiff wining rate by defining a plaintiff success in a lawsuit when the defendant paid the more than half of legislation fees and appeal rate of first-instance intellectual property cases at city *c* in year *t*, respectively. *IPC* is a dummy for whether the IPC institution was available at city *c* in year *t*. Control variables include public service controls, external input controls and economic development controls at the city level. Standard errors are clustered at the city level. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table 10
The effects of IPCs reform on R&D (science and technology) expenditure.

	R&D Intensity		Science and Technology Expenditure Intensity
	All Industries	Manufacturing & IT Industry	
	(1)	(2)	(3)
IPC	0.002	0.005*	0.003**
	(0.002)	(0.003)	(0.001)
City Controls	Yes	Yes	Yes
Firm Controls	Yes	Yes	/
Firm FE	Yes	Yes	/
City FE	/	/	Yes
Year FE	Yes	Yes	Yes
Mean of Dependent Variable	0.022	0.024	0.009
Observations	12,092	10,056	2551

Notes: This table reports the impact of the IPCs reform on innovation R&D (science and technology) expenditure at the firm (city) level. In Columns 1–2, the dependent variable is the total R&D expenditure scaled by the total assets at the firm level. In Column 3, the dependent variable is total science and technology expenditure scaled by the GDP at the city level. *IPC* is a dummy for whether the IPC institution was available at the city level. Firm controls include total assets, firm size, leverage rate and net cash flow. City controls are the same as the preferred specification in baseline regression. Standard errors are clustered at the city level. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

5.4. Discussion on two possible alternative explanations

In this section, we address two possible alternative explanations for the observed effect of China's IPCs reform on innovation. One important competing explanation is that our findings represent a zero-sum game effect rather than genuine innovation development. However, as detailed in Section 4.3, we have demonstrated the absence of inter-region and intra-conglomerate transfer of invention patents, thereby refuting the zero-sum game concern as a driver of our primary results.

Another potential concern is that the local government in cities with IPCs reform may over-report patent number to inflate the success of the central government's IPCs reform. While over-reporting may exist in China due to its top-down official promotion assessment system (De Janvry et al., 2023), this explanation is not applicable to our study. Patent authorizations are recorded and managed by the SIPO, a body under the central government's jurisdiction, not local governments.

6. Conclusion

In the past decade, many developing countries have aimed to transit from a traditional input-driven economic development model to one centered around innovation. However, some countries have encountered challenges during this transition, even with well-established intellectual property laws in place. This paper highlights the crucial role of judicial enforcement, providing compelling evidence that China's IPC reform significantly spurred innovation. Our research shows the reform led to a 22.6 % increase in invention patents, a growth that represents a net positive for the economy and not merely a relocation of existing innovation.

The mechanism behind this success was a tangible improvement in the judicial environment. The IPCs fostered a more efficient and reliable system, as reflected in increased public satisfaction, shortened case durations, and higher plaintiff success rates. This enhanced protection led to a clear increase in R&D expenditure, providing strong evidence for the "general effect" where new innovative activity is stimulated. In contrast, our results for the "transformation effect"—the conversion of trade secrets into patents—are inconclusive. When trade secrets are converted into public patents, they expand the public knowledge base and can drive broader innovation through knowledge spillovers. Therefore, identifying and measuring the transformation effect remains an important and challenging question for future research.

Our study enhances the understanding of the diverse factors influencing innovation outcomes through the lens of judicial institutions. The remarkable growth of Chinese innovation can be attributed not only to direct inputs such as human capital and public subsidies, but also to the institutional reforms implemented for intellectual property protection, particularly *within* the judicial system. Furthermore, while informal institutions have been crucial substitutes for formal ones in promoting China's past economic growth (Allen et al., 2005), our results underscore the vital role that formal institutional reform will play in the country's future innovation.

CRediT authorship contribution statement

Liyang Wan: Writing – review & editing, Writing – original draft, Software, Project administration, Methodology, Data curation, Conceptualization. **Qian Wan:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Funding acquisition, Data curation, Conceptualization. **Zichao Yang:** Writing – review & editing, Writing – original draft, Software, Methodology, Data curation, Conceptualization. **Ying Zhao:** Methodology, Data curation, Conceptualization.

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Appendix

A. China's Judicial Protection of Intellectual Property Before 2012

In 1950, Chinese government formulated and promulgated the laws (or regulations) called "Provisional Regulations on the Protection of Invention Rights and Patent Rights" and "Provisional Regulations on Trademark Registration". However, the development of intellectual property institutions remained at a basic and underdeveloped stage, stagnating before 1978 due to the challenging political environment.

Following the implementation of the reform and opening policy under the leadership of Chinese political figure Deng Xiaoping, the Chinese government began to gradually re-establish the institution for judicial protection of intellectual property in 1978. The China Patent Office, which later evolved into the State Intellectual Property Office (SIPO), was established in 1980, coinciding with China's membership in the World Intellectual Property Organization (WIPO). Subsequently, the Chinese government enacted the trademark law in 1982, marking the first formal intellectual property law in mainland China. However, the process of enacting patent and copyright laws faced challenges due to limited legislative experience and ideological considerations.[33]

The turning point occurred in 1984 when Deng Xiaoping stated, "The earlier passage of the patent law is advisable", which laid the groundwork for the future re-establishment and development of Chinese intellectual property protection institutions. Subsequently, the Chinese government enacted the first patent law in 1984, signifying the official establishment of a patent institution in China. The first copyright law was issued in 1990. It is noteworthy that the Chinese government passed the "General Principles of the Civil Law of China" in 1986, which clarified intellectual property in China's basic civil law and recognized citizens' rights for the first time. Subsequently, the anti-unfair competition law was formulated in 1993 to complement the intellectual property legal framework. In 1997, the Chinese government promulgated the "Regulations of China on the Protection of New Varieties of Plants", granting new plant variety rights to those meeting the requirements. Additionally, the SIPO issued the "Regulations on the Protection of Layout Designs of Integrated Circuits" in 2001. Later on, the Chinese government enacted the "Technology Contract Law of China" and the "Scientific and Technological Progress Law of China", and made necessary revisions to laws to comply with the "Agreement on Trade-Related Aspects of Intellectual Property" as per the World Trade Organization's request.

So far, China has already established a comprehensive system of intellectual property laws that align with international standards and has joined nearly all major international intellectual property conventions. In terms of the court system, at the time, only Intermediate People's Courts in provincial capital cities, municipalities directly under the Chinese central government, special economic zone cities, and other Intermediate People's Courts authorized by the Supreme People's Court had jurisdiction over patent cases at the initial stage. The Higher People's Courts of provinces, autonomous regions, and municipalities directly under the Chinese central government served as appellate courts for first-instance cases.[34] The era when patent cases were governed by traditional courts was called the "General Patent Courts" stage in China. However, this era faced various challenges. For example, issues like rule-breaking judicial authorization in local government,[35] inconsistent trial standards (as highlighted in the

[33] The former Chinese Ministry of Industry raised objections to the establishment of the patent law. See the Interview with Zhao Yuanguo, the member of the patent law drafting group and former deputy director of the Patent Reexamination Board at that time.

[34] China's court system consists of the Supreme People's Court (directly under the jurisdiction of Central Government), Local People's Courts at all levels and Specialized Courts. Local People's Courts at all levels include: (1) Basic People's Courts which are located at the seat of government of the counties (2) Intermediate People's Courts which are which are located at the seat of government of cities (prefectures, provincial capital cities and municipalities) (3) Higher People's Courts which are located at the seat of government of provinces, autonomous regions and municipalities. Specialized Courts include Military Courts, Maritime Courts, etc.

[35] For instance, Yiwu and Kunshan (both are at the county administrative level in China) are granted jurisdiction over patent cases in 2009. Information source: https://www.cnipa.gov.cn/art/2018/11/14/art_700_47994.html.

Report of the Supreme People's Court on the Work of the Intellectual Property Courts, 2017), and low judgment efficiency due to factors like lack of professionalism and specialization in the judgment procedure. These weaknesses in the judicial trial process significantly limit inventors' options to resolve intellectual property disputes through legal channels, given the substantial opportunity cost of time for inventors.

B. The Process of Application and Certification of Patents

We gathered official documents of requests for invention patents, utility patents, and design patent applications from the China National Intellectual Property Administration website. The application requirements for these three types of patents are detailed in Table A4. The application requirements for these three patent types vary significantly. Invention patents are subject to the most rigorous criteria: applicants must submit two additional critical materials—*a Request for Substantive Examination and a Substantive Examination Reference*—for review by the National Intellectual Property Administration. The substantive examination is conducted by the SIPO, assessing the substantive aspects of an invention patent: novelty, inventiveness, and practicality. Applicants are required to request this examination within 3 years of the filing date. Failure to do so, without valid reasons, will lead to the application being considered withdrawn. Importantly, Chinese patent law mandates the rigorous substantive examination process exclusively for invention patents. In contrast, utility model patents and design patents are only subject to a simplified examination to ensure that a similar application has not been previously granted. This may result in potential double patenting issues, as multiple distinct patents could be filed based on the same underlying invention (Rong et al., 2017).

To a certain extent, the patent approval timeframe also indicates variations in the quality and innovation content across different patent types. As per the National Intellectual Property Administration in China, the process of an invention patent typically spans three years from preparation to application to final authorization, compared to 1 year for utility patents and 0.5 year for design patents.[36] Hence, we opt to use the number of invention patents to assess the innovation performance at the city level in China, which is also aligns with previous studies (Fang et al., 2020; Rong et al., 2017; Wei et al., 2017).

C. The Scope of Disclosure of Judgment Documents

The following judgment documents made by the people's court shall be published on the Internet according to the Supreme People's Court: (1) Written criminal, civil and administrative judgments; (2) Criminal, civil, administrative and enforcement rulings; (3) payment order; (4) Notice of rejection of a complaint in criminal, civil, administrative or enforcement matters; (5) Written decision on state compensation; (6) A decision on compulsory medical treatment or a decision on rejecting an application for compulsory medical treatment; (7) Written decision on execution and alteration of criminal punishment; (8) Decisions on detention or fines for acts that interfere with litigation or enforcement, decisions on early release of detention, and decisions on reconsideration for refusing to accept sanctions such as detention or fines; (9) administrative mediation statement and civil public interest litigation mediation statement; (10) Other judgment documents that have the effect of suspending or ending the proceedings, or have an impact on the substantive rights and interests of the parties, or have a significant impact on the procedural rights and interests of the parties. The official website of China Judgments Online is: https://wenshu.court.gov.cn/. The total number of documents has exceeded 100 million until 2020, 7 years after its launch, with an average daily increase of more than 77,000.

D. The Empirical Analysis at Firm Level

Data Processing According to the Company Law of the People's Republic of China and Securities Law of the People's Republic of China, *ST* stand for Special Treatment and PT stands for Particular Transfer. Firms labeled with *ST*, and *PT* indicate that they have experienced consecutive years of financial losses. To ensure the reliability of our results, we exclude firms identified with *ST*, and *PT* labels to eliminate any potential outliers. We keep a balance sample because it excludes the abnormal impact of *Initial Public Offering* on firms' operation status discussed in the previous literature during our sample period (Sletten et al., 2018; Teoh et al., 1998a, 1998b). We employ the office addresses of the listed firms to match the geographical locations of IPCs in order to capture the locations of firms' substantial economic activities. We also exclude the firms which changed their office addresses during our sample period.[37]

Regression Model The econometric model employed is as follows:

$$Innovation_{ict} = \alpha_1 IPC_{ct} + (\boldsymbol{X}_C \times \gamma_t)\boldsymbol{\beta} + (\boldsymbol{Z}_i \times \gamma_t)\boldsymbol{\rho} + \delta_i + \gamma_t + \varepsilon_{ict} \quad (3a)$$

Where i refers to the firm, c is the city, t is the year, $Innovation_{ict}$ refers to the number of invention patents applied for in city c in year t and granted within a 3-year-window. In addition to the city controls employed in the baseline, we also consider various firm characteristics ($\boldsymbol{Z}_i$) that may impact the firms' innovation capabilities. These include return on assets, firm size, leverage rate, and net cash flow. Furthermore, we interact firm controls ($\boldsymbol{Z}_i$) with γ_t to enhance flexibility. To mitigate the influence of outliers, we winsorize the firm controls at the 1 %–99 % level. δ_i represents the firm fixed effects to account for any time-invariant features of firms, for example the location of the firms. The remaining variables remain consistent with the baseline regression. Standard errors are clustered at the city level to maintain consistency with the baseline specification.

[36] Information source: https://www.cnipa.gov.cn/jact/front/mailpubdetail.do?transactId=340384&sysid=6.
[37] The results are highly intact without removing the relocated firms (unreported and available upon request).

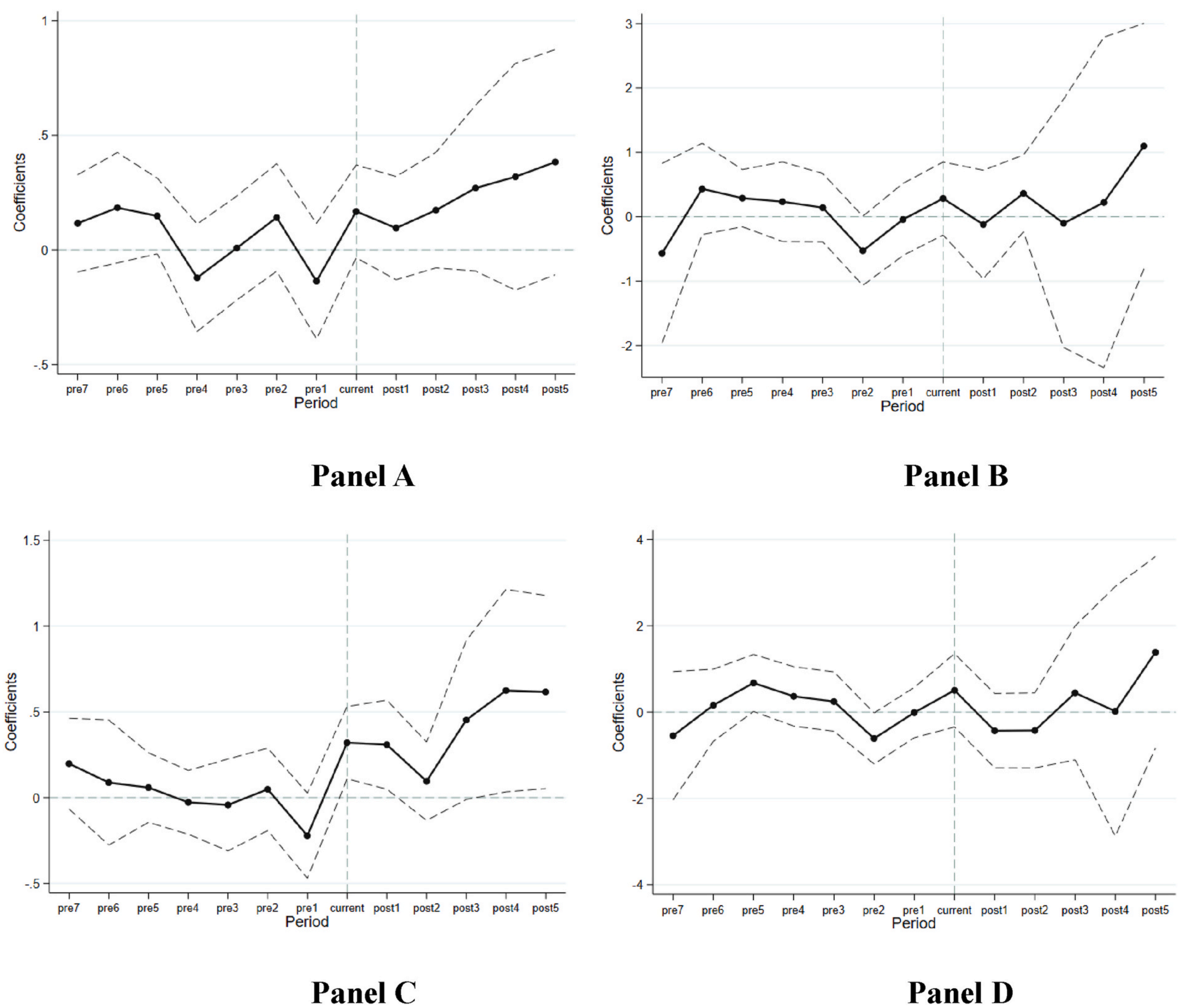
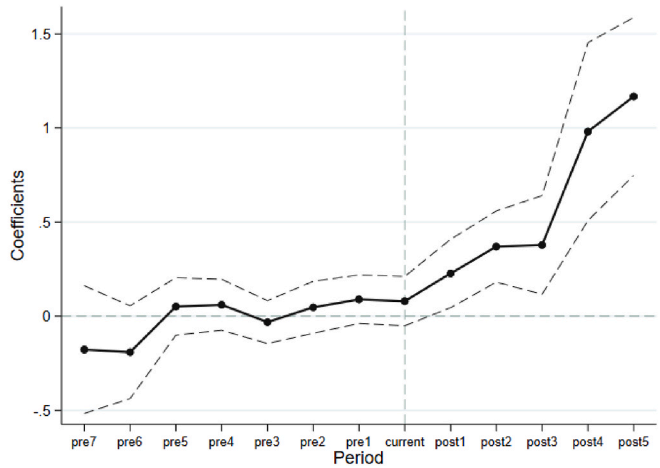
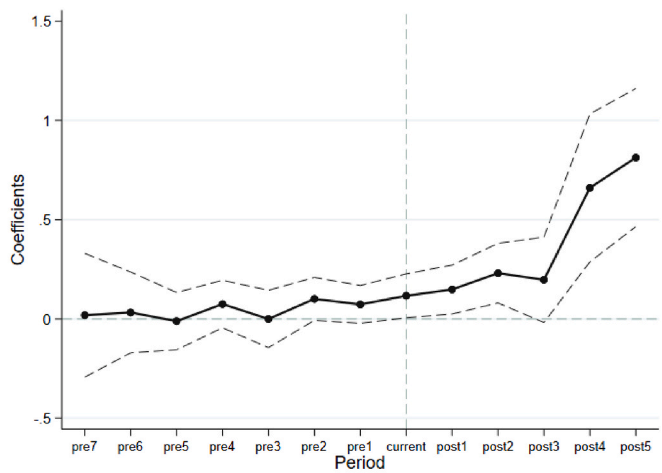


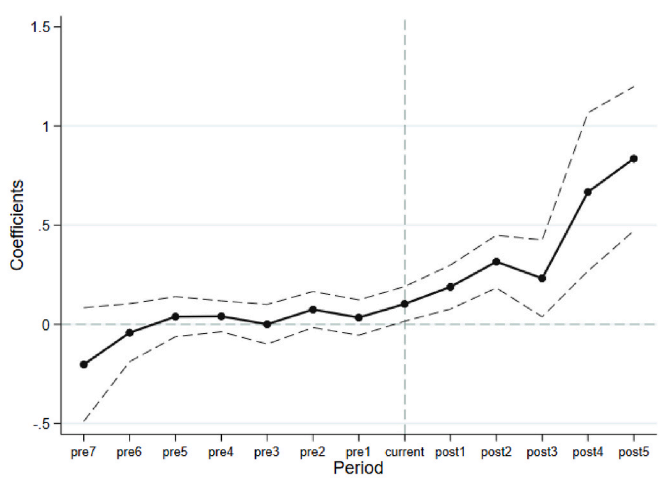
Fig. A1. Parallel Trend at the Listed Firm Level *Notes*: This figure shows the parallel trend for invention patents at the listed firm level during 2011–2020 for all industries and subsample of manufacturing and information technology industries, respectively. Panel A denotes the indicators of 3-year window invention patents of all industries. Panel B denotes the logged number of 3-year window invention patents of all industries. Panel C denotes the indicators of 3-year window invention patents of manufacturing and information technology industries. Panel D denotes the logged number of 3-year window invention patents of manufacturing and information technology industries.



Panel A: 2-year Window



Panel B: 4-year Window



Panel C: Total

Fig. A2. Parallel Trend for Invention Patent Granted within Different Windows *Notes*: This figure shows the parallel trend for invention patents granted within different windows during 2011–2020.

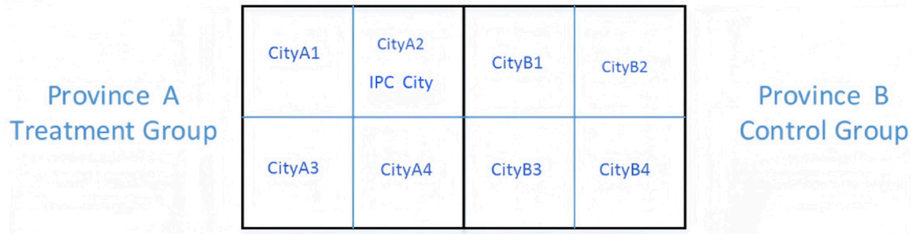


Fig. A3. The Schematic Diagram *Notes*: This figure describes the measurement of Variable $Exploited\_IPC_{jt}$.

Figure A3 is the schematic diagram to describe the measurement of Variable $Exploited\_IPC_{jt}$ in the regression model. According to Figure A3, we define that Province A implemented IPCs reform, representing the treatment group, with the court located in City A2. Province B did not implement IPCs reform, representing the control group. The distances between City A2 and the cities in Province B are as follows: The distance between City A2 and City B1 is 150 km; the distance between City A2 and City B2 is 350 km; the distance between City A2 and City B3 is 550 km; and the distance between City A2 and City B4 is 650 km.

According to the measurement of Variable $Exploited\_IPC_{jt}$, the values of Variable $Exploited\_IPC_{ct}$ for the cites in Province A (City A1-City A4) equal to 0 because Province A implemented IPCs reform. Then we can calculate the value of Variable $Exploited\_IPC_{jt}$ for the cites in Province B and show them in the Panel A of Table A12. For example, since the distance between City A2 and City B1 is 150 km and always below the thresholds, the Variable $Exploited\_IPC_{jt}$ for City B1 is one after Province A implemented IPCs reform. Similarly, since the distance between City A2 and City B4 is 650 km and always greater than the thresholds, the Variable $Exploited\_IPC_{jt}$ for City B4 is always zero even after Province A implemented IPCs reform. We show the measurement of Variable $Exploited\_IPC_{jt}$ from the perspective of boundaries in Panel B of Table A12. Since City B1 and City B3 are located on borders of Province A, the values of Variable $Exploited\_IPC_{jt}$ of City B1 and City B3 equals to one and other cities in Province B equals to zero.

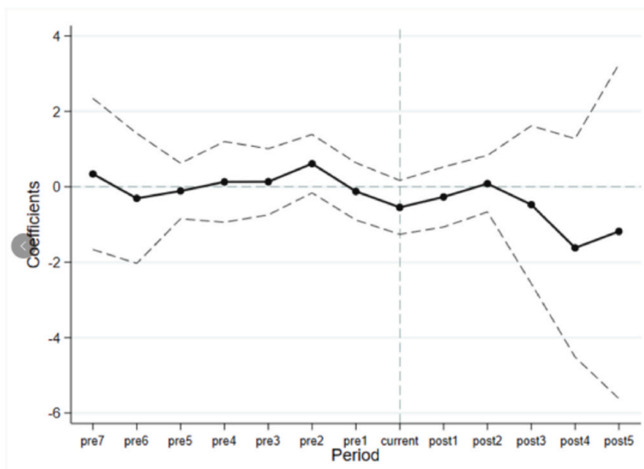


Fig. A4. The Dynamic Transformation Effect (All Industries).

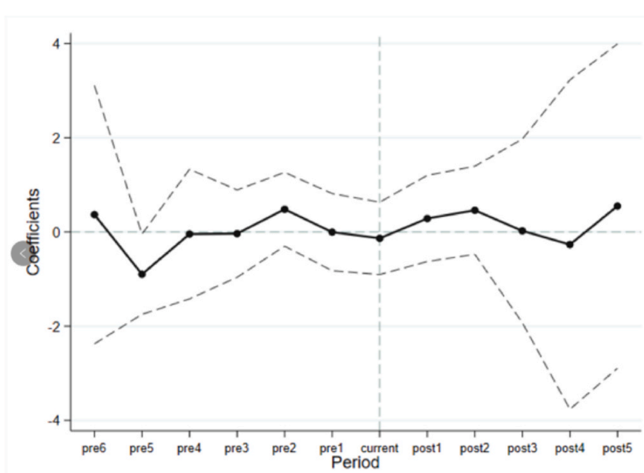


Fig. A5. The Dynamic Transformation Effect (Manufacturing & IT) *Notes:* The reason for the missing coefficient of the 7th period before the policy implementation is that the sample size has decreased.

Table A1
Relevant Literature on the Main Influence Factors of Innovation

Research	Research Object
Acharya and Subramanian (2009); Acharya et al. (2013); Acharya et al. (2014); Atanassov (2013)	Non-IP-related Laws
Alok and Subramanian (2023); Galasso et al. (2013); Lach and Schankerman (2008); Lerner and Malmendier (2010)	Property Rights
Furman et al. (2021); Hegde et al. (2023)	Patent Publication (Disclosure)
Bloom et al. (2002); Cheng et al. (2019); Howell (2017)	R&D Tax Credit and R&D Subsidies
Akcigit et al. (2022); Mukherjee et al. (2017)	Personal or Corporate Income Tax Rates
Azoulay et al. (2019); Jacob and Lefgren (2011)	Public Research Investment
Amore et al. (2013); Benfratello et al. (2008); Chava et al. (2013); Hsu et al. (2014)	Financial Sector Development
Hunt and Gauthier-Loiselle (2010); Kerr and Lincoln (2010)	Human Capital Cumulation
Jaffe and Palmer (1997); Nesta et al. (2014); Xue et al. (2021)	Environmental Factors (e.g., Air Pollution) and Regulations
Aghion et al. (2005); Yung (2016)	Market Factors (e.g., Product Market Competition)
Bustos (2011); Liu et al. (2021)	Trade (e.g., Import Competition and Export Behaviors)
Audretsch and Feldman. (1996); Jaffe et al. (1993); Moretti (2021)	Spatial Economic Agglomeration (e.g., High-technology Industries Clusters and Knowledge Spillover)
Dong et al. (2020)	Intercity Transportation Accessibility
Talhelm et al. (2014)	Informal Institution (e.g., Culture Characteristics)

Notes: This table summarizes the relevant literature on the main influencers of innovation.

Table A2
The Jurisdiction of the IPCs in China (2014–2020)

Designation	Location	Jurisdiction Regions
Beijing IPC	Beijing	Beijing
Shanghai IPC	Shanghai	Shanghai
Guangzhou IPC	Guangzhou, Guangdong Province	Guangdong Province (except Shenzhen)[a]
Chengdu IPC	Chengdu, Sichuan Province	Sichuan Province
Nanjing IPC	Nanjing, Jiangsu Province	Jiangsu Province: Nanjing, Zhenjiang, Yangzhou, Taizhou, Yancheng, Huai'an, Suqian, Xuzhou, Lianyungang
Suzhou IPC	Suzhou, Jiangsu Province	Jiangsu Province: Suzhou, Wuxi, Changzhou, Nantong
Wuhan IPC	Wuhan, Hubei Province	Hubei Province
Hefei IPC	Hefei, Anhui Province	Anhui Province
Hangzhou IPC	Hangzhou, Zhejiang Province	Zhejiang Province: Hangzhou, Jiaxing, Huzhou, Jinhua, Quzhou, Lishui
Ningbo IPC	Ningbo, Zhejiang Province	Zhejiang Province: Ningbo, Wenzhou, Shaoxing, Taizhou, Zhoushan
Fuzhou IPC	Fuzhou, Fujian Province	Fujian Province (except Xiamen, Zhangzhou, Quanzhou, Longyan)[b]
Jinan IPC	Jinan, Shandong Province	Shandong Province: Jinan, Zibo, Zaozhuang, Jining, Tai'an, Laiwu, Binzhou, Dezhou, Liaocheng, Linyi, Heze[c]
Qingdao IPC	Qingdao, Shandong Province	Shandong Province: Qingdao, Dongying, Yantai, Weifang, Weihai, Rizhao
Shenzhen IPC	Shenzhen, Guangdong Province	Guangdong Province: Shenzhen
Xi'an IPC	Xi'an, Shaanxi Province	Shaanxi Province
Tianjin IPC	Tianjin	Tianjin
Changsha IPC	Changsha, Hunan Province	Hunan Province
Zhengzhou IPC	Zhengzhou, Henan Province	Henan Province
Nanchang IPC	Nanchang, Jiangxi Province	Jiangxi Province
Changchun IPC	Changchun, Jilin Province	Jilin Province
Lanzhou IPC	Lanzhou, Gansu Province	Gansu Province
Xiamen IPC	Xiamen, Fujian Province	Fujian Province: Xiamen, Zhangzhou, Quanzhou, Longyan
Urumqi IPC	Urumqi, Xinjiang Uygur Autonomous Region	Xinjiang Uygur Autonomous Region

Notes: This table provides a detailed description of the jurisdiction of the IPCs in China.
[a] Shenzhen was under the jurisdiction of Guangzhou IPC before the establishment of Shenzhen IPC.
[b] Xiamen, Zhangzhou, Quanzhou and Longyan were under the jurisdiction of Fuzhou IPC before the establishment of Xiamen IPC.
[c] Laiwu was revoked in January 2019 and merged into Jinan.

Table A3
Different Groups' Weights in Staggered DID

	(1)
DID Comparison Groups	Weights
Early Treatment Group v.s. Late Control Group	0.221
Late Treatment Group v.s.Early Treatment Group	0.115
Never Treated Group v.s.Timing Group s	0.664

Notes: This table shows the weights of different groups in our staggered DID model based on Goodman-Bacon (2021). Timing groups include the early treatment group and the late treatment group.

Table A4
Materials Requirements for Applications of Three Types of Patents

	Basic List of Application Materials	Additional List of Application Materials
A: Invention Patent	1. Application Form 2. Abstract of the Patent's Description 3. Letter of Claim 4. Instruction Manual 5. Drawings Attached to Instructions 6. Nucleotide or Amino Acid Sequence Table (if necessary) 7. A Sequence Table in Computer-readable Form	**1. Request for Substantive Examination** **2. Substantive Examination Reference** 3. Certificate of Transfer of Priority 4. Certificate of Assignment of Priority in Chinese 5. Certificate of Confidentiality 6. Power of Attorney 7. Prior Application Documents Copy 8. Chinese Title List for Prior Application Documents Copy 9. Preservation and Survival of Biomaterial Samples (if necessary) 10. Sample Preservation and Survival Certification of biological materials in Chinese (if necessary) 11. Request for Patent Confidentiality Examination to a Foreign Country 12. Other Supporting Documents (Indicate Document Name)
B: Utility Patent	1. Application Form 2. Abstract of the Patent's Description 3. Letter of Claim 4. Instruction Manual 5. Drawings Attached to Instructions	1. Certificate of Transfer of Priority 2. Certificate of Assignment of Priority in Chinese 3. Certificate of Confidentiality 4. Power of Attorney 5. Prior Application Documents Copy 6. Chinese Title List for Prior Application Documents Copy 7. Request for Patent Confidentiality Examination to a Foreign Country 8. Other Supporting Documents (Indicate Document Name)
C: Design Patent	1. Application Form 2. A Picture or Photograph of the Patent 3. Brief Introduction of the Patent	1. Certificate of Transfer of Priority 2. Power of Attorney 3. Prior Application Documents Copy 4. Chinese Title List for Prior Application Documents Copy 5. Other Supporting Documents (Indicate Document Name)

Notes: This table shows the list of materials required for three types of patent applications in China.

Table A5
The Definitions of Main Variables

Variables	Definitions
City Level	
3-year Window Invention Patents	The number of invention patents applied for in a given year and granted within a three-year window at the city level
2-year Window Invention Patents	The number of invention patents applied for in a given year and granted within a two-year window at the city level
4-year Window Invention Patents	The number of invention patents applied for in a given year and granted within a four-year window at the city level
Total Invention Patents Granted	The total number of invention patents applied for in a given year and finally granted at the city level
Invention Patents Applications	The number of invention patents applied for in a given year at the city level
The Proportion of 3-year Window Invention Patents	The number of 3-year-window invention patents divided by the total number of 3-year-window patents in a given year at the city level
The Proportion of Invention Patent Applications	The number of invention patent applications divided by the total number of patent applications in a given year at the city level
The Proportion of 3-year Window Invention Patents in the Number of Invention Patents Applications	The number of 3-year-window invention patents divided by the number of invention patent applications in a given year at the city level
The Proportion of the Number of 3-year Window Invention Patents with Citations	The number of 3-year-window invention patents with at least one citation divided by the total number of 3-year-window invention patents in a given year at the city level
The Average Citations per *3-year Window Invention Patent*	The number of citations of 3-year-window invention patents divided by the number of 3-year-window invention patents in a given year at the city level
3-year Window Utility Patents	The number of utility patents applied for in a given year and granted within a three-year window at the city level
3-year Window Design Patents	The number of design patents applied for in a given year and granted within a three-year window at the city level
IPC	A dummy variable equals one after the establishment year and zero otherwise at the city level. The establishment year is defined as follows: if the establishment month of an IPC is between January and June, the year is set to the current year; If the establishment month of an IPC is between July and December, the year is set to the next year
GDP per *Capita*	GDP *per* capita at the city level in 2010 (Unit: CNY)
Population	Total resident population at the city level in 2010 (Unit: 10 Thousand)
FDI	Total foreign direct investment at the city level at the city level in 2010 (Unit: 10 Thousand USD)
Proportion of the Highly Educated Population	The number of people with a college degree and above divided by the total population at the city level in 2010
Education Expenditures	Total expenditure on educational institutions at the city level in 2010 (Unit: 10 Million CNY)
Hospital	The total number of hospitals per 10,000 people at the city level in 2010
University	The total number of universities per 10,000 people at the city level in 2010
Firm Level	
3-year Window Invention Patents (Firm)	The number of invention patents applied for in a given year and granted within a three-year window at the firm level
Indicators of 3-year Window Invention Patents	A dummy variable that equals one if a firm holds at least one 3-year invention patent in a given year
Return of Assets	The net profit divided by total assets at the firm level in 2010 (Unit: %)
Firm Size	The natural logarithm of total assets at the firm level in 2010 (Unit: CNY)
Cash Flow	The net cash flow divided by total assets at the firm level in 2010 (Unit: %)
Leverage Rate	The total liabilities divided by total assets at the firm level in 2010 (Unit: %)

Notes: This table shows the detailed variable definitions.

Table A6
Summary Statistics of Subsamples

Variables	Treatment Group				Control Group			
	Obs.	Mean	S.D.	Median	Obs.	Mean	S.D.	Median
Panel A: City Level								
3-year Window Invention Patents	1820	1205.502	3239.828	214.500	770	353.753	806.935	79.500
2-year Window Invention Patents	1820	557.882	1534.714	105.500	770	174.334	418.327	40
4-year Window Invention Patents	1820	1518.055	4362.177	244.500	770	420.892	956.939	94
Total Invention Patents Granted	1820	1704.101	4990.315	263.500	770	453.360	1022.701	99
Invention Patents Applications	1820	4377.477	11002.720	854.500	770	1268.638	2791.534	325.500
The Proportion of 3-year Window Invention Patents	1820	0.103	0.066	0.088	770	0.122	0.089	0.099
The Proportion of Invention Patent Applications	1820	0.289	0.133	0.267	770	0.327	0.165	0.291
The Proportion of 3-year Window Invention Patents in the Number of Invention Patents Applications	1820	0.299	0.139	0.287	770	0.285	0.140	0.271
The Proportion of the Number of 3-year Window Invention Patents with Citations	1820	0.769	0.129	0.798	770	0.761	0.145	0.794
The Average Citations per *3-year Window Invention Patent*	1820	3.488	1.689	3.372	770	3.327	1.674	3.167
3-year Window Utility Patents	1820	5859.678	12257.240	1619.500	770	1849.012	4023.111	620.500
3-year Window Design Patents	1820	2425.603	5649.140	527.500	770	398.578	859.874	138.500
IPC	1820	0.344	0.475	0	770	0	0	0
Panel B: City in 2010								
GDP per *Capita*	182	34092.340	21115.040	28037.500	77	33032.430	24868.290	26215
Population	182	471.667	293.658	425.536	77	407.565	363.187	311.862
FDI	182	115.205	315.710	19.967	77	90.473	292.991	10.052
Proportion of the Highly Educated Population	182	0.087	0.053	0.071	77	0.090	0.045	0.076
Education Expenditures	182	50.472	214.618	6.876	77	14.134	35.768	4.582
Hospital	182	0.507	0.325	0.428	77	0.840	0.942	0.530
University	182	0.017	0.019	0.009	77	0.020	0.020	0.012
Invention Patent Applications	182	1065.736	3208.162	151	77	311.247	702.133	89
Utility Patent Applications	182	1557.451	2913.479	379	77	499.740	1085.278	200
Cumulative Invention Patents from 1990 to 2010	182	1326.022	4817.595	164	77	505.610	1010.858	175
Cumulative Utility Patents from 1990 to 2010	182	6339.313	12381.110	1744.500	77	3169.351	5238.140	1456
Panel C: Firm Level								
3-year Window Invention Patents	13,990	10.999	64.526	1	2100	4.911	14.631	1
Indicators of 3-year Window Invention Patents	13,990	0.578	0.494	1	2100	0.504	0.500	1
Return of Assets	13,990	0.058	0.049	0.050	2100	0.044	0.055	0.036
Firm Size	13,990	21.772	1.449	21.485	2100	22.041	1.277	21.929
Cash Flow	13,990	0.038	0.082	0.041	2100	0.037	0.081	0.042
Leverage Rate	13,990	0.430	0.234	0.427	2100	0.508	0.235	0.514

Notes: This table shows the summary statistics of the main variables of subsamples in this paper.

Table A7
The Impact of IPCs Reform on Innovation (Two-way Fixed Effects Estimators)

	Ln (Invention Patents)				
	(1)	(2)	(3)	(4)	(5)
IPC	0.171***	0.165***	0.169***	0.171***	0.173***
	(0.046)	(0.048)	(0.049)	(0.053)	(0.053)
Public Service Controls	No	Yes	Yes	Yes	Yes
External Input Controls	No	No	Yes	Yes	Yes
Innovation Ability Controls	No	No	No	Yes	Yes
Economic Development Controls	No	No	No	No	Yes
City FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Observations	2590	2590	2590	2590	2590

Notes: This table presents the baseline estimates on the effect of IPCs reform on innovation at the city level using the conventional two-way fixed effect model. The dependent variable is the natural logarithm of 3-year window invention patents in city c in year t. *IPC* is a dummy for whether the IPC institution was available at the city level. Public service controls include number of hospitals per 10,000 people and total expenditure on educational institutions (logged). External input controls include total foreign direct investment (logged) and the number of universities per 10,000 people. Innovation ability controls include the logged number of invention applications in 2010, the logged number of utility patents applications in 2010, logged cumulative number of granted invention and logged cumulative number of granted utility patents from 1990 to 2010. Economic development controls include GDP per capita (logged), total resident population (logged), and the proportion of the highly educated population. Standard errors are clustered at the city level. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table A8
The Impact of IPCs Reform on Innovation (The First Three Patent Signatories)

	Ln (Invention Patents)				
	(1)	(2)	(3)	(4)	(5)
IPC	0.184***	0.210***	0.214***	0.214***	0.220***
	(0.046)	(0.047)	(0.049)	(0.052)	(0.064)
Public Service Controls	No	Yes	Yes	Yes	Yes
External Input Controls	No	No	Yes	Yes	Yes
Innovation Ability Controls	No	No	No	Yes	Yes
Economic Development Controls	No	No	No	No	Yes
City FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Observations	2590	2590	2590	2590	2590

Notes: This table reports the impact of IPCs reform on innovation using 3-year window invention patent calculated by the first three patent signatories at the city level. The dependent variable is the natural logarithm of 3-year window invention patents calculated by the first three patent signatories of city *c* in year *t*. *IPC* is a dummy for whether the IPC institution was available at the city level. Public service controls include number of hospitals per 10,000 people and total expenditure on educational institutions (logged). External input controls include total foreign direct investment (logged) and the number of universities per 10,000 people. Innovation ability controls include the logged number of invention applications in 2010, the logged number of utility patents applications in 2010, logged cumulative number of granted invention and logged cumulative number of granted utility patents from 1990 to 2010. Economic development controls include GDP per capita (logged), total resident population (logged), and the proportion of the highly educated population. Standard errors are clustered at the city level. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table A9
Robustness Checks I

	Ln (Invention Patents)		
	2-Year Window	4-Year Window	Unlimited Window
	(1)	(2)	(3)
IPC	0.297***	0.227***	0.224***
	(0.079)	(0.065)	(0.060)
City Controls	Yes	Yes	Yes
City FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	2510	2600	2600

Notes: This table presents the robustness results on the effect of IPCs reform on innovation at the city level using alternative authorization windows. The dependent variable is the natural logarithm of invention patents granted within 2-year, 4-year and unlimited window periods in city *c* in year *t*. *IPC* is a dummy for whether the IPC institution was available at the city level. City controls are the same as the preferred specification in baseline regression. Standard errors are clustered at the city level. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table A10
Robustness Checks II

	Ln (Invention Patents)								
	Unbalanced Data	Excluding Municipalities	Excluding Municipalities and Capital Cities	Excluding Municipalities, Capital Cities and Sub-provincial Cities	Excluding Municipalities, Capital Cities, Sub-provincial Cities and Special Economic Zones	Excluding other Policies			Adjusting the Definition of the Key Independent Variable
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
IPC	0.193***	0.254***	0.194**	0.180**	0.171**	0.145**	0.233***	0.226***	
	(0.060)	(0.071)	(0.084)	(0.082)	(0.079)	(0.074)	(0.076)	(0.070)	
IPC_2									0.250***
									(0.067)
City Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
City FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2607	2550	2280	2230	2210	2590	2590	2590	2580

Notes: This table reports the robustness test results of the impact of the IPCs reform on innovation performance at the city level. The dependent variable is the natural logarithm of 3-year window invention patents. City controls are the same as the preferred specification in baseline regression. *IPC* is a dummy for whether the IPC institution was available at the city level. In Columns 6–8, we include the *Pilot Construction of Innovation-oriented Cities* policy, the *National Intellectual Property Demonstration Cities* policy and the anticorruption campaign as an additional control, respectively. In Column 9, IPC_2 denotes that we define the current year of IPC establishment as the first year. Standard errors are clustered at the city level. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

In Column 1 of Table A10, we first utilize an unbalanced sample and observe a coefficient of interest that aligns closely with the baseline results.

Second, given that the IPCs are situated in key cities with significant economic and political influence, there is a potential concern with our baseline findings being influenced if the unobservable power varies over time and is correlated with both the establishment of IPCs and local innovation performance. To address this concern, we remove municipalities, capital cities, sub-provincial cities, and special economic zones in Columns 2–5. Despite these exclusions, the results continue to show a significant positive impact at the 1 % level, remaining consistent with our baseline findings.[38]

The results show a significantly positive impact at the 5 % level and are robust in magnitude with the baseline results. The findings from smaller cities suggest that the coefficient of interest in the baseline model is largely unbiased, as access to IPCs institution is considered an exogenous shock for non-key cities. This is due to their lack of political and economic influence in negotiating the creation of IPCs with the central government. Furthermore, non-key cities are under the jurisdiction of IPCs in key cities within their provinces, without undergoing structural changes in their local judicial administrative agencies post-IPCs establishment. Therefore, the results using non-key cities alleviate concerns that structural changes in judicial institutions where IPCs are located may spur innovation through efficiency improvements in other local judicial administrative bodies unrelated to intellectual property protection.

Third, we conducted robustness checks by controlling for the effects of other major policies implemented during the same period using the "horse race" method. The first policy examined was the *Pilot Construction of Innovation-oriented Cities* policy, initiated by the National Development and Reform Commission and the Ministry of Science and Technology of China in 2008, which included eight waves of cities by 2020. The second policy analyzed was the *National Intellectual Property Demonstration Cities* policy, introduced by the SIPO in 2012, encompassing six waves of demonstration and pilot cities by 2020. City lists for both policies are manually collected.[39] At last, previous studies have indicated that the anti-corruption campaign in China since 2012, which may be related to the local judicial environment, has a significant impact on innovation performance in affected regions. (Fang et al., 2018; Kong and Qin, 2021). Thus, we construct a variable to denote the anticorruption campaign following Kong and Qin (2021). These three policies were included as additional controls in Columns 6–8 to re-evaluate the coefficient of interest. The results demonstrate that the estimator of interest remains robust to the baseline, both in terms of magnitude and significance. Overall, these findings confirm that our primary result is not influenced by other potentially relevant policies.

Finally, to further test the robustness of different treatment statuses of cities with IPCs, we adjusted the definition of the variable of interest (IPC_{ct}) and the measurement of dependent variable. We define the current year of IPC establishment as the first year. The results are presented in Column 9, indicating a robust outcome.

Table A11
Robustness Checks III

	Ln (Invention Patents)				
	Based on Callaway and Sant'Anna (2021)			Based on Borusyak et al. (2024)	Based on Gardner (2022)
	(1)	(2)	(3)	(4)	(5)
IPC	0.171***	0.206***	0.211**	0.169***	0.269***
	(0.057)	(0.067)	(0.082)	(0.049)	(0.077)
City Controls	Yes	Yes	Yes	Yes	Yes
City FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Observations	2590	2590	2590	2590	2590

Notes: This table reports the robustness results of the impact of the establishment of IPCs on innovation at the city level. The dependent variable is the natural logarithm of 3-year window invention patents in city *c* in year *t*. *IPC* is a dummy for whether the IPC institution was available at the city level. Columns 1–2 alter different estimation methods of control variables: STIPW, IPW and REG. The *Help Files* in Stata present: STIPW refers to inverse probability weighting estimator with stabilized weights; IPW is inverse probability weighting estimator based on Abadie (2005).REG refers to outcome regression based on ordinary least squares. Column 4 uses the estimator based on Borusyak et al. (2024). Column 5 uses the estimator based on Gardner (2022). City controls are the same as the preferred specification in baseline regression. Standard errors are clustered at the city level. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Table A12
The Measurement of Exploited Cities

	Before Province A implemented IPCs Reform				After Province A implemented IPCs Reform			
Panel A: The Perspective of Distance								
$Exploited\_IPC_{jt}$	City B1	City B2	City B3	City B4	City B1	City B2	City B3	City B4
200 km	0	0	0	0	1	0	0	0
300 km	0	0	0	0	1	0	0	0
400 km	0	0	0	0	1	1	0	0
500 km	0	0	0	0	1	1	0	0
600 km	0	0	0	0	1	1	1	0
Panel B: The Perspective of Boundary								
$Exploited\_IPC_{jt}$	0	0	0	0	1	0	1	0

Notes: Since Province A actually implemented the IPCs reform, the value of Variable $Exploited\_IPC_{jt}$ of cities in Province A is always zero.

Table A13
The Impact of IPCs Reform on Utility and Design Patents

	Ln (Utility Patents)	Ln (Design Patents)
	(1)	(2)
IPC	0.063	−0.081
	(0.041)	(0.073)
Public Service Controls	Yes	Yes

(*continued on next page*)

Table A13 (*continued*)

	Ln (Utility Patents)	Ln (Design Patents)
	(1)	(2)
External Input Controls	Yes	Yes
Innovation Ability Controls	Yes	Yes
Economic Development Controls	Yes	Yes
City FE	Yes	Yes
Year FE	Yes	Yes
Observations	2590	2590

Notes: This table presents the baseline estimates on how the IPCs reform affects innovation at the city level. The dependent variable is the natural logarithm of 3-year window period utility patents and design patents in city *c* in year *t*. *IPC* is a dummy for whether the IPC institution was available at the city level. Public service controls include number of hospitals per 10,000 people and total expenditure on educational institutions (logged). External input controls include total foreign direct investment (logged) and the number of universities per 10,000 people. Innovation capability controls include the logged number of invention applications in 2010, the logged number of utility patents applications in 2010, logged cumulative number of granted invention patents and logged cumulative number of granted utility patents from 1990 to 2010. Economic development controls include GDP per capita (logged), total resident population (logged), and the proportion of the highly educated population. Standard errors are clustered at the city level. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table A14
The Measurement of IPC Potential Influence within the Same Conglomerate

Location	Year	Group_ID	Firm_ID	IPC_Year	IPC_Transfer_Year	IPC_Transfer
Province A	2014	G1	G1-F1	2015	0	0
Province B	2014	G1	G1-F2	2017	0	0
Province C	2014	G1	G1-F3	0	2015	0
Province A	2015	G1	G1-F1	2015	0	0
Province B	2015	G1	G1-F2	2017	0	0
Province C	2015	G1	G1-F3	0	2015	1

Notes: This tables presents the measurement of potential influence of IPC reform within the same conglomerate.

In Table A14, the conglomerate, labeled as G1, was composed by three firms in which the first firms (G1-F1) was affected by IPC reform in 2015, the second firm (G1-F2) was affected by IPC reform in 2017 and the last firm (G1-F3) was never affected by the IPC reform. For the last firm, we define the earliest year when it was indirectly affected by the IPC reform that was derived from other firms within the same conglomerate is 2015 in which Province A, where the first firm were located, implemented the IPC reform.

Table A15
Excluding the Effects of the Subsidy and Tax Credit

	City Level	Firm Level			
	Ln (Invention Patents)	Indicator of Invention Patents			
		All Industries		Manufacturing & IT Industries	
	(1)	(2)	(3)	(4)	(5)
IPC	0.284***	0.220*	0.136	0.364***	0.245**
	(0.067)	(0.114)	(0.148)	(0.128)	(0.121)
City Controls	Yes	Yes	Yes	Yes	Yes
MIC 2025 Policy	Yes	/	/	/	/
Subsidy	/	Yes	No	Yes	No
Tax Credit	/	No	Yes	No	Yes
City FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Observations	2590	16,043	11,014	11,223	8429

Notes: This table presents the robustness results on the effect of IPCs reform on innovation by excluding the effects of the relevant policies about subsidy and tax credit. In Column 1, the dependent variable is the natural logarithm of 3-year window invention patents in city c in year t. In Columns 2–5, the dependent variable is the indicator of 3-year window invention patents of firm i in city c in year t. IPC is a dummy for whether the IPC institution was available at the city level. City controls include public service controls, external input controls, innovation ability controls and economic development controls, which are consistent with the baseline model. Standard errors are clustered at the city level. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

[38] The special economic zones in China include Shenzhen, Shantou, Zhuhai, Xiamen and Hainan Province.

[39] Accounting for the two policies also contributes to relieve the concern about the confounding effects of innovation subsidy and tax credit. Specially, we further read the documents of the two policies in more detailed and find the government funding to support innovation has been mentioned many times. For example, the fourth key task in the document of *Pilot Construction of Innovation-oriented Cities* policy said "government needs to cultivate innovative leading enterprises with strong competitiveness" and the eighth key task said "government needs to further increase local fiscal investment in science and technology and promote steady growth in government-led investment". Additionally, the key task in the document of *National Intellectual Property Demonstration Cities* policy said "government needs to focus on cultivating the competitiveness of enterprises' intellectual property rights" and one of the application conditions for the policy is "city's patent funding policy emphasizes quality and efficiency". We also employ the data of the listed firms to further examine the effect of subsidy and tax credit by controlling the amount of tax credit and non-operating income of firms which is used to denote the subsidy and find a robust estimator of interest (See Table A15 for more details).

Table A16
R&D Investment and Invention Patents

	R&D Investment per Invention Patents	
	All Industries	Manufacturing & IT Industries
	(1)	(2)
IPC	−0.531	0.198
	(0.454)	(0.496)
City Controls	Yes	Yes
Firm Controls	Yes	Yes
Firm FE	Yes	Yes
Year FE	Yes	Yes
Observations	6759	5975

Notes: This table investigates the effect of IPCs reform on the ratio of logged R&D investment to invention patents. The dependent variable is the ratio of R&D Investment to invention patents of firm *i* for all industries in city *c* in year *t* in Column 1. The dependent variable is the ratio of R&D Investment to invention patents of firm *i* for manufacturing & IT Industries in city *c* in year *t* in Column 2. Therefore, if the number of patents is zero, the independent variable will be undefined, resulting in a reduction in the sample size. IPC is a dummy for whether the IPC institution was available at the city level. City controls include public service controls (number of hospitals per 10,000 people and logged total expenditure on educational institutions), external input controls (logged total foreign direct investment and the number of universities per 10,000 people), innovation capability controls (the logged number of invention applications in 2010, the logged number of utility patents applications in 2010, logged cumulative number of granted invention patents and logged cumulative number of granted utility patents from 1990 to 2010), and economic development controls (logged GDP per capita, logged total resident population, and the proportion of the highly educated population). Firm controls include total assets, firm size, leverage rate and net cash flow. Standard errors are clustered at the city level. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Data availability

Data will be made available on request.

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