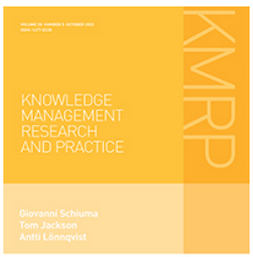

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ORIGINAL ARTICLE

New knowledge and regional entrepreneurship: the role of intellectual property protection in China

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ABSTRACT

This research examines the relationship between intellectual property protection (IPP), new knowledge and regional entrepreneurship development in transition China. Using provincial-level panel data collected over China from 2000 to 2017, consistent with conventional wisdom, we find that more investment in new knowledge is the key to encouraging regional entrepreneurship. IPP and entrepreneurship present a U-shaped relationship, that is, IPP first promotes entrepreneurship but impedes entrepreneurship when it exceeds a certain point. IPP negatively moderates the positive effect of new knowledge on entrepreneurship and there are heterogeneous effects in different industries and geographical clusters at different levels of entrepreneurship. New knowledge has a significant incentive effect on necessity-driven entrepreneurship, but not on opportunity-driven entrepreneurship. The moderating effects of IPP on the relationship between new knowledge and necessity-driven entrepreneurship and opportunity-driven entrepreneurship are negative and positive, respectively. These findings contribute to understanding the impact of IPP on entrepreneurial activities in emerging economies.

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KEYWORDS
New knowledge; intellectual property protection; entrepreneurship; China; inverted U-shaped

1. Introduction

Given the benefits of entrepreneurship for economic development, employment, and poverty alleviation (Hou et al., 2021; Mueller, 2006), this paper aims to study how IPP affects the role of new knowledge in regional entrepreneurship and contributes to the ongoing debate on the relationship between IPP and entrepreneurship. Continuous knowledge creation makes knowledge accumulate and then spill over, providing potential entrepreneurs with the possibility of realising business opportunities with diffused and filtered knowledge, which is exactly what the knowledge spillover theory of entrepreneurship (KSTE) describes (Audretsch & Keilbach, 2007; Plummer & Acs, 2014). In this spirit, the governments of many countries regard the strengthening of IPP legislation, enforcement, and publicity as a sensible option to promote innovation investment and knowledge spillover and encourage the formation of entrepreneurial opportunities, especially in developed countries (Van Stel et al., 2019). However, stringent IPP may undermine the motivation to innovate, knowledge spillover and entrepreneurial motivation of transition countries with a low level of knowledge base and innovation, so that transition countries are relatively cautious in strengthening IPP measures, even under the great external pressure from their developed counterparts (Cao, 2014; Kim et al., 2012; Liu, 2005).

One the one hand, a large proportion of the background of existing research on the relationship between IPP and entrepreneurship is compared between countries and examining the impact of national-level IPP on entrepreneur performance involves cross-levels that neglect regional or industrial heterogeneity of IPP regime within a country. In general, as a formal institution, IPP, which relies on complete laws and strict enforcement, can effectively compensate entrepreneurs for their positive effects on society because there will be a risk of infringement that will reduce market's investment for new knowledge and the entrepreneurial opportunities it derives if intellectual property rights are not well protected. This popular view has been validated by evidence from many developed countries (Fuentelsaz et al., 2015; Van Stel et al., 2019). Some scholars have pointed out that emerging economies lack a broad technological knowledge base and rely more on knowledge spillover, so strict IPP may limit the potential for knowledge reverse engineering and regeneration by impeding spillover effect, and the resulting reduction in opportunities may stifle entrepreneurial intentions by lowering expectations of net income from starting new firms (Pathak et al., 2013). As far as the political system is concerned, compared with autocracy, democracy is considered to be complementary to IPP to stimulate the use of technology in entrepreneurial activities (Laplume et al., 2014).

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On the other hand, studies on IPP and entrepreneurship from a linear perspective still dominate, although some scholars point out that the impact of IPP on entrepreneurship should not be monotonic. The absence of IPP does not mean that there is no entrepreneurial activity, and many entrepreneurs' pirated copyrighted products will still be profitable in the short term, even at the expense of the country's long-term growth rate (Rushing & Thompson, 1996). Both positive and negative even non-significant relationships have been found in different contexts (Burke & Fraser, 2012; Carbonara et al., 2016; Estrin et al., 2013), and inconsistent conclusions have caused confusion in our understanding of the relationship between them. Under this circumstance, some scholars explore some boundary conditions, or use IPP as a boundary condition for relationships between entrepreneurship and its determinants (Yeganegi et al., 2021; Zhou, 2014, 2018). Other scholars distinguish the reactions of different types of entrepreneurial activities to IPP and find that innovative start-ups benefit from the strengthening of IPP due to the protection of the potential benefits of innovation activities while general entrepreneurship or low-innovation entrepreneurial activities are inhibited by strict IPP, and opportunity entrepreneurship will benefit more from strong IPP than necessity entrepreneurship (i.e., Carbonara et al., 2016; Fuentelsaz et al., 2015).

In summary, the existing research conclusions, which are mainly based on transnational comparisons or the backgrounds of developed countries, do not necessarily guide the IPP and entrepreneurship policies of transition countries with imperfect institutions. Z. J. Acs and Sanders (2012) developed an endogenous growth model that theoretically distinguishes inventors from innovators and proposed that strengthening IPP will increase the incentives for R&D and the generation of new knowledge, thereby providing more opportunities for potential entrepreneurs; however, further strengthening IPP beyond a certain point will lead to a reduction in the return to entrepreneurship. Despite the lack of empirical evidence, their work provides an enlightenment for our investigation. To fill the above-mentioned research gap, this paper aims to empirically examine the nonlinear influence of IPP on entrepreneurship and the moderation role of IPP between new knowledge and entrepreneurship. As an economy in transition, China has more than 30 provinces with uneven distribution of entrepreneurial activities, resource endowments, and fragmented governance system that is reflected in the large differences in the legislation and implementation of IPP across provinces (Brander et al., 2017), which provides a competitive background for the study of this topic.

This paper contributes to the literature by investigating the relationship between new knowledge and entrepreneurship from the perspective of IPP. Firstly, we empirically reveal that IPP motivates entrepreneurship and then counteracts entrepreneurship when it reaches a certain level, that is, their relationship is inverted U-shaped. As expected, IPP significantly attenuates the positive effect of new knowledge on entrepreneurship. Robustness test results are consistent with the above. Secondly, industrial heterogeneity is revealed through the comparative analysis of four industries, which allows us to better understand why the incentive effect of IPP on entrepreneurial activities in some industries is more obvious than in other industries. Thirdly, the heterogeneity of entrepreneurial clusters and entrepreneurial types is explored. The results of the high-entrepreneurship regional cluster are consistent with those of the full sample, while the impact of new knowledge and IPP in their low-entrepreneurship counterpart is not significant. New knowledge significantly activates necessity-driven entrepreneurship but has no apparent effect on opportunity-driven entrepreneurship; IPP reversely moderates the relationship between new knowledge and necessity-driven entrepreneurship but presents a positive moderation role in the relationship between new knowledge and opportunity-driven entrepreneurship. Our findings inspire policymakers to design the policies of knowledge creation and IPP contingently to promote regional entrepreneurship based on the industrial distribution and scale of local entrepreneurship.

2. Theory and hypotheses development

2.1. Knowledge and the formation of entrepreneurial opportunities

Knowledge is an economic good characterised by uncertainty and non-excludability. More knowledge spillovers due to knowledge's inappropriability and non-rival provide market with more entrepreneurial opportunities as a wealth of knowledge creates a higher degree of uncertainty (Audretsch & Keilbach, 2007). And in the case of a high degree of uncertainty, the organisational form of new firm can provide entrepreneurs with a competitive advantage due to the incumbents' disregard, rejection, or inability to commercialise unexploited knowledge, and substitute for relatively weak external institutional environment (Zhao, 2006). Knowledge non-excludability determines that knowledge is more likely to spill over than material and capital goods, thus providing low-cost or cost-free opportunities for potential entrepreneurs (Audretsch & Keilbach, 2007). KSTE holds that knowledge cannot be fully utilised and commercialised because of the uncertainty of knowledge (Acs et al., 2009). This proposition reveals that there exists a barrier between knowledge investment and commercialisation, that is knowledge

filter (Z.J. Acs & Plummer, 2005). The uncommercialised knowledge created by incumbent firms, higher education institutions (HES), or research institutes provides entrepreneurs with opportunities to gain potential competitive advantage (Z. J. Acs & Sanders, 2012; Mueller, 2006).

Under the background of China's transformation, the lack of sound legal and financial institutions has led to large financing constraints for many small and medium-sized enterprises (Fu & Jian, 2018; Li et al., 2019). R&D investments only generate positive cash flows in the future, and they are extremely vulnerable to institutional risks, making many decision-makers of firms unwilling to risk commercialising new knowledge. Inadequate enforcement of China's IPP makes this knowledge easy to obtain by competitors or potential entrepreneurs at a lower cost (Cao, 2014). In other words, China's institutional voids and fragmented governance system cause a lot of knowledge to be filtered that will create new entrepreneurial opportunities for the market, as Shu et al. (2020) find empirically. New knowledge investment not only provides knowledge owners themselves but also other potential entrepreneurs with more entrepreneurial opportunities through knowledge creation and spillover, respectively. Thus, we expect new knowledge could provide incentives for regional entrepreneurship.

2.2. IPP and entrepreneurship

There is a dilemma for countries in transition such as China, where, on the one hand, stimulating innovation and entrepreneurship to promote employment and sustainable development requires strengthening IPP, combined with pressure from abroad, and on the other hand, intellectual property rights involve a lot of public interests, so the government will not simply take enhanced measures in implementing its IPP policy but will consider social welfare (Liu, 2005). As Liu (2005) puts it, China's economy has maintained a high growth rate in recent years, mainly dependent on investments and exports most of which are labour-intensive and have limited technological content, reflected in China's large reliance on imports to address the scarcity of technology, which makes the domestic appeal to strong IPP slightly inadequate. However, as China's economy continues to grow (now the world's second largest economy), maintaining a sustained competitive advantage forces it to master its core autonomous technology system, which externally requires stricter level of IPP, as is the case with China in the Sino-US trade dispute. In addition, China's major economic strategy of promoting industrial upgrading also endogenously requires improvement in the level of IPP.

We argue that, in transition economies, a modest degree of IPP attracts potential entrepreneurs to create new firms. Firstly, the gradual strengthening of IPP when it is below a certain level can inspire general entrepreneurs and their stakeholders to enter the market by stimulating new knowledge production that is key to entrepreneurial activities. Weak IPP enforcement system reduces the incentive for innovation, as it is common in China that plaintiffs usually give up before a case is completed, and "even in cases where plaintiffs win infringement lawsuits, the award is often too low to even cover the costs of bringing a case to court" (Brander et al., 2017, p. 911). China's Confucian culture and the government control of economic system tend to damage individual property rights, leading to frequent infringements (Cao, 2014). The generation of new knowledge will be inhibited under the weak IPP, which will reduce the formation of entrepreneurial opportunities. In this case, stronger IPP makes technology providers or knowledge producers more willing to invest more resources and energy in R&D and reduce their perceived risk of illegal use of knowledge acquired through R&D because infringements will cost more and face tougher legal sanctions. This availability of formal institution and legal process should encourage knowledge providers to implement fewer isolation mechanisms, which facilitates the diffusion of new knowledge to potential entrepreneurs (Zhou, 2014).

Secondly, stricter IPP can ease the financing constraints of start-ups and attract more potential entrepreneurs. Start-ups in China in transition are subject to more financial constraints due to an unsound corporate bond market and a weak institutional environment where weak IPP may allow their competitors to copy or steal their ideas but are less likely to face legal sanctions, and it further exacerbates the information asymmetry between start-ups and their potential investors, resulting in more severe financial constraints than in developed economies (Li et al., 2019). When IPP is strengthened, potential entrepreneurs are expected to be more willing to disclose their intellectual property information, which, based on effective legal protection and higher infringement costs, should relatively mitigate information asymmetry, thus facilitating entrepreneurs' access to financing.

Thirdly, combining the above two points, that is, moderately improving the level of IPP can stimulate the creation of new knowledge and ease the financial constraints of potential entrepreneurs, which will effectively reduce the amount of knowledge filtering and promote entrepreneurship by improving the commercialisation of knowledge (Z. J. Acs & Sanders, 2012). Strengthening IPP encourages innovation activities, while the stability of informal institutions represented by guanxi in China does not reduce knowledge exchange on the premise that the total

amount of knowledge increases (Cao, 2014). With the improvement of the IPP institutional environment and the consequent reduction of financial constraint, the owners or buyers of knowledge are more willing to commercialise through intrapreneurship or entrepreneurship, motivated by the greater expected benefits of innovation.

However, when the degree of IPP exceeds a certain level, it may work the other way to adversely affect potential entrepreneurs' tendency to create new firms. Strict IPP may deter entrepreneurship because of the higher costs for potential entrepreneurs who try to exploit recombinations of knowledge and technologies (Z. J. Acs & Sanders, 2012), which may impede the commercialisation process (Pathak et al., 2016). Too strict IPP not only curbs the commercialisation of knowledge creators but also squeezes potential imitators and competitors out of the market. Knowledge creators are more sensitive and preventive to possible knowledge flow and tend to apply for patents even without commercialisation plan (Halilem et al., 2017). Implementing a rigorous IPP makes it difficult for an organisation or individual to have full ownership of intellectual property rights (IPR) in a particular technology area, that is anticommons tragedy "in which people underuse scarce resources because too many owners can block each other" (Heller & Eisenberg, 1998, p. 698). This increases the cost of commercialisation of knowledge-owners, as more expenses are required to acquire complementary knowledge and absorptive capacity that provides more possibilities for potential entrepreneurs or imitators to understand new knowledge (Qian & Acs, 2013). Otherwise, the alternative is to obtain it illegally at greater risk. Kiebzak et al. (2016) find that the relationship between patent litigation and VC investment is an inverted U shape, which is consistent with our assumption about the relationship between IPP and regional entrepreneurship. IPP is positive for the development of entrepreneurial activities due to its protection of entrepreneurs' IPR. However, excessive IPP may lead to oligopolists/monopolists monopolising IPR, thereby inhibiting new entrepreneurial activities.[1] Thus, we propose,

H1: IPP and regional entrepreneurship present an inverted U-shaped relationship, which means that IPP promotes regional entrepreneurship, but hinders regional entrepreneurship after a certain level in transition economies like China.

2.3. The moderation role of IPP

Some scholars have paid attention to the moderating role of IPP in the relationship between entrepreneurship and its determinants. For example, Autio and Acs (2010) reveal that IPP negatively moderates the relationship between education and entrepreneurial growth aspirations but presents a positive moderation in the relationship between household income and entrepreneurial growth aspirations. In China, regulatory institution including government support and government transparency actively moderates the relationship between knowledge filter in incumbents and their employee venturing behaviours (Shu et al., 2020). For economies in transition, imitative innovation or incremental innovation dominates, and they are more sensitive to IPP improvement than developed economies dominated by radical innovation. In the case of patents, for example, despite China's huge number of patent applications, the majority of domestic patents granted by the State Intellectual Property Office are "petty" patents for "middling" technologies, and dependence on foreign technology is as high as 50% in many areas (Cao, 2014). The incentive effect of IPP on radical innovation that relies on specialised knowledge base is greater than that on incremental innovation (Autio & Acs, 2010), and stricter IPP may make it difficult for the diversified knowledge base needed for incremental innovation to spill over in a transition country dominated by "middling" technologies, where there are various informal and institutional barriers such as local protectionism (Wang, 2004). Strict IPP in transition economies may be a kind of knowledge filter that "is a consequence of the basic conditions inherent in new knowledge" (Audretsch & Keilbach, 2007, p. 1247).

Firstly, rigorous IPP may reduce the degree of uncertainty of new knowledge. IPP encourages radical innovation, and creates more uncertainty for innovators pursuing technologies, products, and services that are new-to-the-market and country. However, for general innovation, or incremental innovation, stricter IPP reduces the enthusiasm of innovators for knowledge reorganising, developing, and applying. Strengthened IPP weakens the scale of knowledge recombination and integration, along with the gradual reduction of uncertainty. Incremental innovation activities in transition economies like China account for the majority of innovation activities, and the incentive effect of strengthening IPP on radical innovation will be outweighed by the IPP's reverse effect on incremental innovation. Therefore, stricter IPP in transition economies may slow down the scale and rate of knowledge spillover through reducing the uncertainty of knowledge, so as to reduce the availability of entrepreneurial opportunities.

Secondly, stricter IPP improves the degree of appropriability of knowledge. Exclusive innovation can be a sufficient incentive for knowledge creators to engage in innovative activities that require the sharing of many other proprietary outcomes to be translated into economic value. Stricter IPP improves the

appropriability and potential returns of new knowledge, suppressing knowledge spillover (Akiyama & Furukawa, 2009). Potential entrepreneurs can easily obtain the knowledge needed for commercialisation, and the market access threshold is relatively low under the weak IPP situation. As the IPP being strengthened, the rights of knowledge creators are better protected, and the cost of potential entrepreneurs to obtain such exclusive knowledge increase, which inhibits their motivation to transform entrepreneurial ideas into practice.

Thirdly, strengthening IPP may intensify market competition, which reduces the motivation of potential entrepreneurial firms to commercialise new knowledge. Stringent IPP makes the competitive advantage of firms with new-to-the-market knowledge more prominent, which impels other incumbents and potential entrepreneurs to pay more efforts and costs in innovative activities to achieve competitive success, increasing the market competition. Under the framework of KSTE, Plummer and Acs (2014) empirically verify that localised competition negatively moderates the positive relationship between new knowledge and entrepreneurship. Therefore, we expect IPP to weaken the positive relationship between new knowledge and entrepreneurship. Accordingly, we propose that,

H2: IPP negatively moderates the positive relationship between new knowledge and entrepreneurship in transition economies like China.

3. Methods

3.1. Sample and data

As an economy in transition, China attaches great importance to entrepreneurial activities which distribute unevenly due to the heterogeneity of regional endowments that affect the formation of new ventures. Therefore, this entrepreneurial inequality provides an interesting background for research on the impact of new knowledge on entrepreneurship. (Figure 1) clearly shows the dispersion of entrepreneurial levels in China's provinces. We use data from 30 provinces or municipalities (Municipalities include Beijing, Shanghai, Tianjin and Chongqing. Tibet, Hong Kong, Macau and Taiwan are excluded due to the unavailability of data) in China from 2000 to 2017 to verify the hypotheses.

3.2. Measures

3.2.1. Dependent variable: entrepreneurship

Global Entrepreneurship Monitor defines entrepreneurship as the process for adults to start, operate and manage a firm, which coincides with those who consider new firm creation to be the appropriate focus of entrepreneurial research. This article agrees that the creation of new firms is a typical manifestation of entrepreneurship. Therefore, the number of newly established firms per 10,000 people is used to

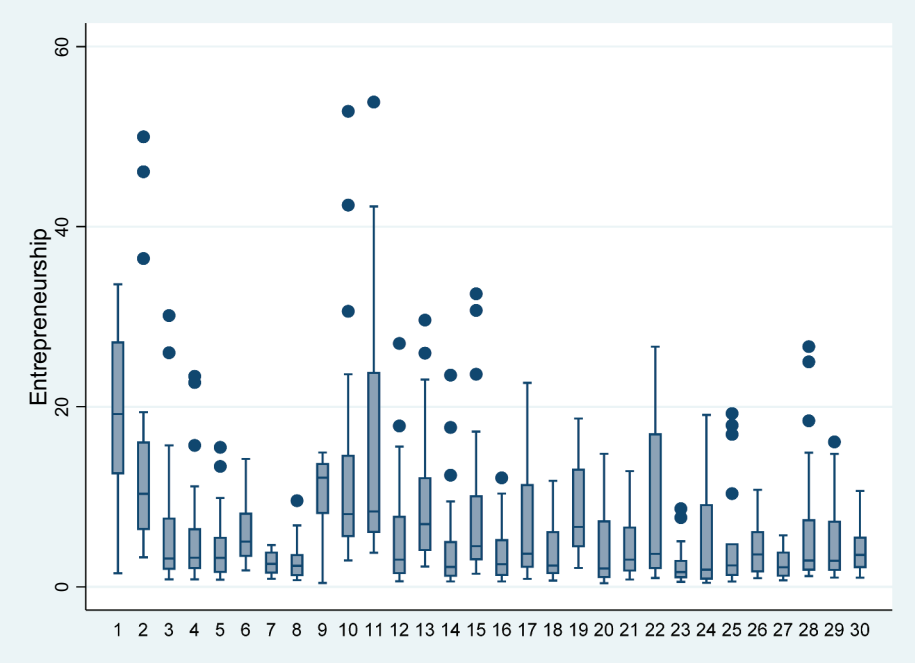

Figure 1. Number of startups per 10,000 people in provinces of China (2000–2017).

characterise entrepreneurship (Hou et al., 2021), which comes from the China Basic Unit Statistical Yearbook and the China Statistical Yearbook (CSY).

3.2.2. Independent variable: new knowledge (NK)

Knowledge input is a prerequisite for knowledge generation, and the exploitation of knowledge is the driving force to increase productivity. Scholars point out that the recombination of existing knowledge stock will produce new knowledge, and the indivisibility and wholeness of knowledge are necessary conditions for carrying out innovative activities (Antonelli et al., 2020). Due to the existence of knowledge externality, the spillover of newly created knowledge provides new opportunities for the market through geographical proximity, technology proximity, cognitive proximity, etc. Therefore, the knowledge stock can well reflect the acquisition of new knowledge. We elaborate a stock measure composed of accumulated annual R&D flows (RDSTOCK) (Acs et al., 2009). The R&D expenditures stock in the base year of 2000 is calculated according to the perpetual inventory method. The rate of depreciation of R&D capital exceeds that of ordinary material capital, so we choose the annual depreciation rate of 15% (Antonelli et al., 2020). The measure of knowledge stock is also corrected for inflation by the consumer price index (CPI) in the base year of 2000 and log-transformed. To test the robustness, this article draws on the measurement method of Antonelli et al. (2020) to measure new knowledge, that is, using the perpetual inventory method to calculate the stock of patent applications (PSTOCK), and the depreciation rate is 15%. The data on R&D investment and patent applications are both from the China Statistical Yearbook on Science and Technology (CSYST).

3.2.3. Moderating variable: IPP

The higher the degree of IPP, the more active the technology market will be since both parties of a technology transaction believe that technology is legally protected. Therefore, the activity of technology transactions is a good indicator of IPP. Specifically, a region with more vigorous IPP enforcement, such as comprehensive laws and regulations, there will be fewer opportunities to use intellectual property illegally, or they will face a greater penalty. Consequently, those who need new knowledge have to purchase and pay for the knowledge owner, and the result is an increase in technology transfer transaction amount. We use the proportion of technology transactions to regional GDP to measure regional IPP (Hou et al., 2021), which is from CSY.

(Figure 2) depicts the changes in entrepreneurship, IPP and new knowledge from 2000 to 2017 in China. Entrepreneurship level grew slowly before 2008 and increased substantially after 2008, which may be due to a series of government policies to encourage entrepreneurship to relieve employment pressure after the financial crisis (Hou et al., 2021). IPP did not change much during the observation period, except for a slight increase in the last few years. Both indicators of new knowledge show a consistent growth trend.

We control the following variables that could provide alternative explanations for regional entrepreneurship.

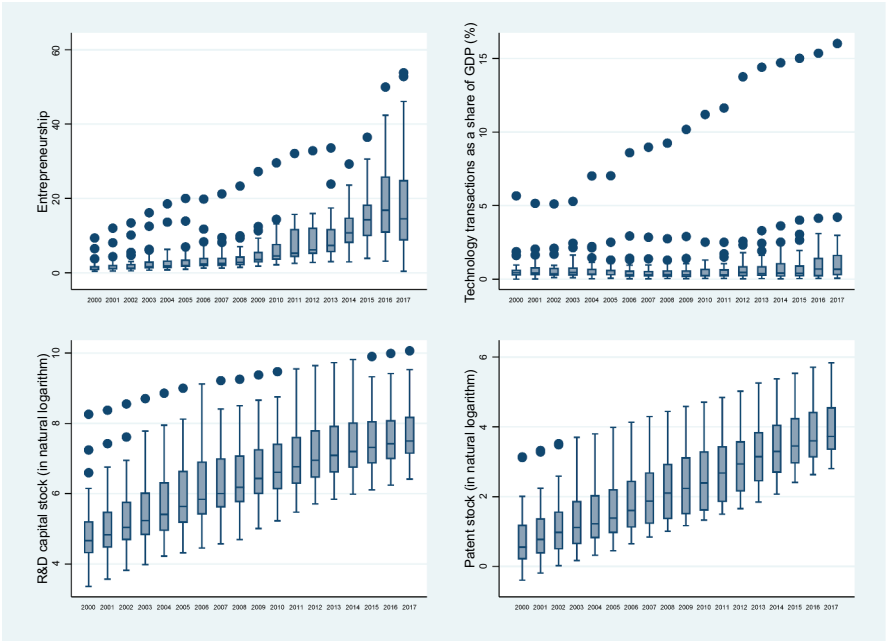

Figure 2. Box plot of main variables.

(1) Regional GDP per capita (PGDP). Higher GDP per capita means a good macroeconomic environment that can provide more market opportunities and attract more talents for potential entrepreneurs (Autio & Acs, 2010). We employ GDP per capita (from CSY) as a proxy variable for regional economic development, and the measure is corrected for inflation by the consumer price index in the base year of 2000 and log-transformed.
(2) Urbanisation level (URB). The agglomeration caused by urbanisation has a positive effect on new firm formation. The reason is that the agglomeration effect can promote knowledge spillover, the sharing of entrepreneurial information and the mutual learning of business models. We elaborate a variable to capture the share of the population living in urban areas which is derived from CSY.
(3) Strength of higher education (HES). The greater the number of HES in a region, the greater the number of university spin-offs, i.e., the easier it is to stimulate entrepreneurship by creating new knowledge and providing human capital that can identify, absorb, and apply new knowledge (Fini et al., 2020). The number of HES derived from CSYST is adopted to measure the strength of higher education in a province (log-transformed).
(4) Human capital (HC). Human capital can not only increase productivity, but also enhance the capacity of innovation and entrepreneurship. Regional human capital helps potential entrepreneurs to identify, acquire, absorb, transform, and apply tangible and intangible knowledge. We use the proportion of the employed population with a college degree or above as a proxy for regional human capital, and it comes from the China Labour Statistical Yearbook.
(5) Regional unemployment rate (UNE). The ability of individuals to identify and take advantage of opportunities is derived from previous work experience, which is a necessary condition for entrepreneurship. Unemployment means a lack of knowledge and work experience (Nikiforou et al., 2019), so we expect unemployment to be detrimental to entrepreneurship. And the data source is CSY.
(6) Regional FDI per capita (FDI). Per capita FDI reflects the degree of openness and investment environment of a region but also means a more competitive environment, which may crowd out domestic entrepreneurship (Pathak et al., 2016). CSY is also its data source.

Table 1. The descriptive statistics of variables.

Variable	Period	Obs	Mean	Std. Dev.	Min	Max
ENT	2000–2017	540	7.209	8.185	0.417	53.827
RDSTOCK	2000–2017	540	6.447	1.345	3.360	10.064
PSTOCK	2000–2017	540	2.405	1.394	−0.392	5.836
IPP	2000–2017	540	0.941	1.988	0	16.016
PGDP	2000–2017	540	9.833	0.747	7.887	11.450
URB	2000–2017	540	49.630	15.283	18.414	89.600
HES	2000–2017	540	4.065	0.693	1.609	5.875
HC	2001–2017	510	12.313	8.809	1.960	55.870
UNE	2000–2017	540	3.558	0.711	0.800	6.500
FDI	2000–2017	540	722.616	939.940	6.014	6125.021
PTI	2000–2017	540	42.343	8.329	28.303	80.560

(7) The proportion of tertiary industry in GDP (PTI). The tertiary industry accommodates the main employment population and may have a significant effect on entrepreneurship (Dobón & Soriano, 2008). Therefore, it is necessary to control the proportion of the tertiary industry in GDP, and we obtain it from CSY. (Table 1) lists the basic descriptive statistics of variables, and Appendix Table A1 provides the correlation matrix.

4. Empirical results

4.1. Hypothesis test

In (Table 2), the independent variable of Models 1 and 3 is the stock of R&D capital. New knowledge shows a significant positive effect on entrepreneurship, which is consistent with previous findings (i.e., Z. J. Acs & Sanders, 2012), indicating that not only in developed economies, but also the fact that new knowledge promotes entrepreneurship holds true in transition economies. In M1, among the control variables, only urbanisation has a significant positive effect because urbanisation brings more opportunities to the market.

To further understand the match between IPP and local economy, industry, innovation, etc., the square term of IPP is constructed (decentred before construction) in M2. The results suggest an inverted U-shaped relationship between the IPP and entrepreneurship, in which IPP is initially directed to motivate entrepreneurship but hinders entrepreneurship when it crosses a certain point. In a transition economy like China, the positive role of IPP in entrepreneurship has not been significant due to imperfect IPP system and relatively low awareness of IPP. However, IPP for economies that tend to be incremental or imitative innovation inhibits knowledge spillovers because they have a relatively weak knowledge base and have adapted to low-cost or even cost-free access to new knowledge. Once the IPP is strengthened, the cost of knowledge acquisition, recombination and creation is bound to increase, which in turn will significantly inhibit the knowledge reorganisation, diversification and

Table 2. The regression results of full sample.

	M1	M2	M3	M4	M5	M6
		RDSTOCK			PSTOCK	
NK	7.972**	8.517**	6.942*	3.907***	3.632***	3.254**
	(3.385)	(3.605)	(3.672)	(1.152)	(1.223)	(1.250)
IPP		2.231	1.660		0.297	0.746
		(1.565)	(1.488)		(1.673)	(1.734)
IPP^2		−0.201**			−0.137	
		(0.084)			(0.097)	
IPP*NK			−0.788**			−0.762*
			(0.383)			(0.440)
PGDP	5.132	2.911	4.019	6.072	5.059	4.662
	(4.049)	(3.711)	(3.608)	(4.028)	3.614	(3.348)
URB	0.068*	0.025	0.046	0.073	0.024	0.033
	(0.040)	(0.036)	(0.034)	(0.046)	(0.035)	(0.031)
HES	−0.104	1.220	0.807	0.984	1.179	1.246
	(1.639)	(1.319)	(1.342)	(1.484)	(1.282)	(1.333)
HC	0.373	0.570	0.634	0.285	0.624	0.686*
	(0.263)	(0.407)	(0.413)	(0.256)	(0.406)	(0.402)
UNE	−0.340	−0.016	−0.171	−0.320	−0.106	−0.154
	(0.953)	(0.851)	(0.829)	(0.98810)	(0.873)	(0.849)
FDI	−0.0025	−0.002	−0.0017	−0.003	−0.002	−0.001
	(0.002)	(0.001)	(0.0014)	(0.002)	(0.165)	(0.001)
PTI	0.174	0.122	0.151	0.223	0.165	0.161
	(0.179)	(0.136)	(0.156)	(0.192)	(0.149)	(0.140)
Constant	−94.458**	−82.361*	−83.752*	−71.605*	−62.010	−58.695*
	(44.385)	(43.035)	(42.441)	(39.704)	(37.211)	(34.564)
Year Dummy	YES	YES	YES	YES	YES	YES
FE OR RE	FE	FE	FE	FE	FE	FE
Hausman	41.03	50.93	41.63	22.38	34.57	30.95
Prob>chi2	0	0	0	0.008	0	0.001
R-sq	0.63	0.661	0.648	0.623	0.655	0.657
Obs	510	510	510	510	510	510

Robust standard errors in parentheses; *p < 0.1, **p < 0.05, ***p < 0.01; NK: New knowledge.

spillover, reduce opportunities for new knowledge to create new markets, and thus reduce entrepreneurial opportunities.

Different from our research findings, Pathak et al. (2016) find that in 20 emerging economies including China, IPP has a negative effect on technological entrepreneurship, although it is not significant, and the increase in the scale of informal economy strengthens the adverse impact of IPP on technological entrepreneurship. IPP is not necessarily the stronger the better, as Z. J. Acs and Sanders (2012) point out "there may be an offsetting effect of strengthening patent protection on the rate of innovation and growth, when invention and innovation draw on the same scarce resources". (p. 812). When new knowledge must be commercialised outside existing firms, barriers to knowledge spillover may inhibit entrepreneurial motivation. And the risk of prosecution for patent infringement and failure in court may outweigh the initial benefits of legally protecting monopoly profits, especially when inventors successfully licence many patent applications that are not intended to be commercialised.

In M3, IPP and its interaction with independent variable are added, and the negative effect of interaction between IPP and new knowledge is significant, suggesting that IPP negatively moderates the positive impact of new knowledge on entrepreneurship and supports our Hypothesis 2. This result echoes Autio and Acs (2010) finding that IPP has a negative moderation effect in the relationship between an individual's education and entrepreneurial growth aspirations in that higher education level implies stronger knowledge creation ability. IPP increases the cost and difficulty of knowledge acquisition, making the marginal cost of potential entrepreneurs higher than the marginal benefits, thus inhibiting the potential entrepreneur's tendency to commercialise new knowledge.

We re-execute the above regressions using the alternative indicator of new knowledge (per capita patent application stock), and the results are basically consistent, as shown in M4 and M5. In M6, the square term of IPP is negative but not significant. Knowledge transformation takes time, so it is not enough to do simultaneous regression, but also need to consider the lag of new knowledge. Therefore, we perform regression using new knowledge, IPP, and interactive items that lag by one phase, and the results are shown in Appendix Table A2. When the stock of R&D capital is used to proxy new knowledge, its positive effect on entrepreneurship as well as the negative moderating role IPP are consistent with those in (Table 2). When the explanatory variable is the stock of patent applications, the incentive effect of new knowledge on entrepreneurship is verified again. However, the negative moderating effect of the IPP is not significant, which may be due to the failure to achieve the desired effect of patent protection.

4.2. Heterogeneity analysis

To reveal the heterogeneity between industries in the above relationship, the situation of four industries is considered (as shown in Appendix Table A3). In the manufacturing industry, IPP shows a significant negative impact, while a non-linear impact is not significant, and it does not show a significant moderating effect of IPP in the relationship between new knowledge and entrepreneurship. In the PSE industry, the inverted U-shaped relationship between IPP and regional entrepreneurship is confirmed, and the negative moderating role of IPP is supported. In the SRTS industry, the relationship between IPP and regional entrepreneurship is U-shaped, and IPP actively moderates the relationship between new knowledge and entrepreneurship. However, in the ICT industry, the impact of IPP on entrepreneurship is not significant, and insignificant moderating effect of IPP indicates that China's IPP implementation effect has not yet reached the expectation. These results indicate that the IPP framework needs to be contingently designed according to the characteristics of local sub-industry.

The level of entrepreneurship varies widely from province to province in China, as shown in (Figure 1). To compare the heterogeneity, we divide the whole sample into two clusters according to whether it is higher than the median of the newly established firms per 10,000 people. Nine provinces or municipalities above the mid-value are classified as the high-entrepreneurship cluster, while the other cluster includes 21 provinces or municipalities below the mid-value. In the high-entrepreneurship cluster, although the new knowledge, IPP and their interaction term have the same direction of action as Table 2, they are not significant (as presented in Table 3). Highly entrepreneurial regions are relatively developed regions in China, with a good knowledge base, infrastructure, and entrepreneurial opportunities. There may be a crowded effect caused by fierce competition, so that they are not sensitive to new opportunities brought by new knowledge. Both radical innovation and incremental innovation activities in these regions are active, and the adverse effect of IPP on incremental innovation may be neutralised by IPP's benefits in stimulating radical innovation so that IPP does not significantly promote entrepreneurial opportunities in these regions. In low entrepreneurial cluster, the incentive effect of new knowledge and the moderating role of IPP is not significant. The above heterogeneous results indicate that most regions of China are still in the stage of knowledge accumulation, and it is necessary to strengthen investment in innovation resources to create more new knowledge and entrepreneurial opportunities.

4.3. Necessity-driven VS opportunity-driven entrepreneurship

Entrepreneurship can be divided into necessity-driven and opportunity-driven entrepreneurship, and this paper will compare the heterogeneity of new knowledge and IPP's role in these two kinds of

Table 3. The results of high/low-entrepreneurship cluster.

	High-entrepreneurship cluster		Low-entrepreneurship cluster	
	RDSTOCK	PSTOCK	RDSTOCK	PSTOCK
NK_{t-1}	4.213	6.666	0.936	1.947
	(6.299)	(4.784)	(1.155)	(1.281)
IPP_{t-1}	20.645***	13.967***	−0.586	−0.967
	(4.034)	(2.617)	(1.005)	(1.031)
IPP_{t-1}* NK_{t-1}	−5.755***	−4.093***	0.023	−0.125
	(1.153)	(0.570)	(0.537)	(0.479)
PGDP	17.445**	7.843	1.692	1.027
	(6.845)	(8.099)	(2.885)	(2.420)
URB	−0.034	−0.017	0.071	0.065
	(0.072)	(0.048)	(0.063)	(0.054)
HES	−2.928	−2.346	−0.199	−0.320
	(3.389)	(3.285)	(0.679)	(0.490)
HC	0.903	0.613	0.088	0.114
	(0.523)	(0.480)	(0.201)	(0.198)
UNE	−2.177	−1.630	−0.483	−0.610
	(1.388)	(1.263)	(1.023)	(1.058)
FDI	0.0002	0.0004	−0.0003	−0.0009
	(0.001)	(0.0009)	(0.002)	(0.002)
PTI	0.146	−0.278	−0.083	−0.075
	(0.398)	(0.434)	(0.122)	(0.116)
Constant	−204.329***	−77.956	−14.857	−4.591
	(54.590)	(82.537)	(28.147)	(21.023)
Year Dummy	YES	YES	YES	YES
FE OR RE	FE	FE	RE	RE
Hausman	49.34	32.67	10.04	8.04
Prob>chi2	0	0	0.526	0.710
R-sq	0.724	0.746	0.672	0.677
Obs	153	153	357	357

Robust standard errors in parentheses; *p < 0.1, **p < 0.05, ***p < 0.01; NK: New knowledge.

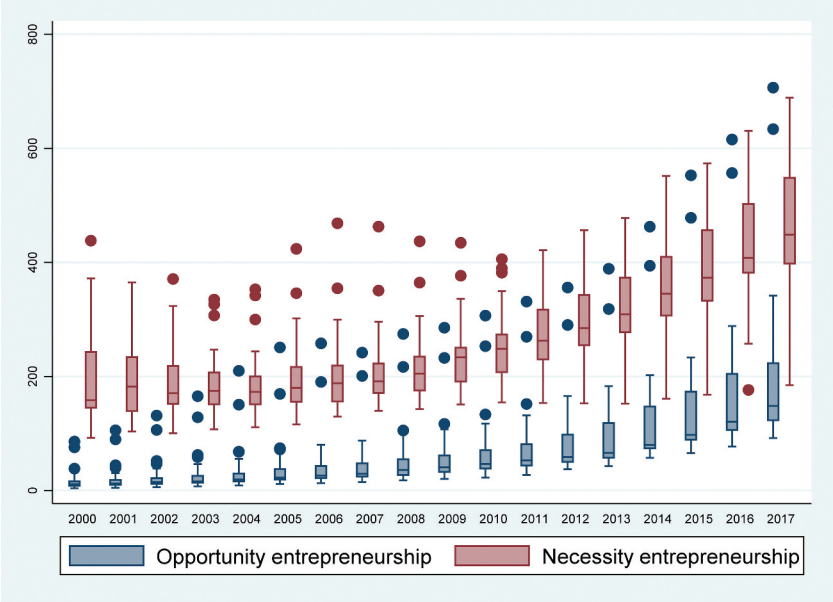

Figure 3. The box diagram of necessity-driven and opportunity-driven entrepreneurship.

Table 4. The regression results of different types of entrepreneurship.

	Necessity-driven entrepreneurship		Opportunity-driven entrepreneurship	
	RDSTOCK	PSTOCK	RDSTOCK	PSTOCK
NK_{t-1}	26.020	−9.963	9.724	10.457
	(35.489)	(21.036)	(19.851)	(8.981)
IPP_{t-1}	3.057	5.922	−17.029*	−21.548***
	(11.061)	(13.363)	(9.192)	(6.879)
IPP_{t-1}* NK_{t-1}	−5.007*	−6.924*	8.247***	9.437***
	(2.665)	3.721	(1.641)	(1.469)
PGDP	140.657**	159.218***	−46.128	−45.342
	(60.235)	(57.148)	(34.424)	(34.388)
URB	0.763*	0.865**	0.582**	0.559**
	(0.376)	(0.357)	(0.247)	(0.234)
HES	29.596	37.973*	−8.935	−11.786
	(18.865)	(19.307)	(11.725)	(12.258)
HC	0.397	0.791	4.856**	4.889**
	(2.445)	(2.482)	(2.226)	(2.126)
UNE	−5.085	−5.514	−5.936	−5.904
	(11.881)	(12.914)	(6.103)	(5.914)
FDI	−0.028***	−0.024***	0.004	0.0009
	(0.005)	(0.007)	(0.010)	(0.009)
PTI	2.94	3.335	−0.135	−0.038
	(2.321)	(2.321)	(1.075)	(0.914)
Constant	−1421.449**	−1505.651**	391.139	434.797
	(592.254)	(622.945)	(395.240)	(343.685)
Year Dummy	YES	YES	YES	YES
FE OR RE	FE	FE	FE	FE
Hausman	29.93	29.91	37.87	32.88
Prob>chi2	0.0016	0.002	0.0001	0
R-sq	0.849	0.851	0.864	0.871
Obs	510	510	510	510

Robust standard errors in parentheses; *p < 0.1, **p < 0.05, ***p < 0.01; NK: New knowledge.

entrepreneurship. Regarding Yu (2020), we use the self-employment of China's provincial private enterprises as the proxy for entrepreneurship. Necessity-driven entrepreneurship is measured by the number of self-employed households (*getihu*) per 10,000 people, while opportunity-driven entrepreneurship is evaluated by the number of private enterprises (*siying qiye*) per 10,000 people, and the data comes from China's National Bureau of Statistics. (Figure 3) depicts the trends in these two types of entrepreneurship from 2000 to 2017, and the necessity-driven entrepreneurship is always higher than its opportunity-driven counterpart, with a consistent growth path.

The negative moderating effect of IPP is significant in the relationship between new knowledge and necessity-driven entrepreneurship regardless of whether the new knowledge is proxied by the stock of R&D capital

or the stock of patent applications (as shown in Table 4). The GDP per capital and urbanisation significantly promote the necessity-driven entrepreneurship, which confirms the critical role of agglomeration effect on necessity-driven entrepreneurship (Yu, 2020). FDI increases market competition and demonstrates the crowding-out effect on necessity-driven entrepreneurship. IPP positively moderates the relationship between new knowledge and opportunity-driven entrepreneurship, suggesting that IPP stimulates entrepreneurial motivation of entrepreneurs' searching market opportunities. Opportunity-driven entrepreneurship needs to be premised on the emergence of market opportunities that are provided by new knowledge, which can only be legally protected to stimulate knowledge creators and other innovators to market opportunities. Intellectual property needs to be regulated in an orderly manner to reduce disorderly competition and thus provide opportunity-driven entrepreneurs with more generous benefits than marginal costs (Plummer & Acs, 2014).

5. Discussion and conclusion

While previous research has focused on the role of knowledge creation and government policy in entrepreneurial success, we argue that regional IPP enforcement may interfere with the process of translating new knowledge into entrepreneurial activities. We find that new knowledge significantly facilitates entrepreneurship, while IPP negatively moderates the above relationship. The role of IPP in entrepreneurship is not linear but inverted U-shaped. Different industries and regional clusters of different levels of entrepreneurship show heterogeneity in the above relationships. The heterogeneous effects of new knowledge and IPP on necessity-driven entrepreneurship and opportunity-driven entrepreneurship are also explored.

Transition economies like China have a paradox when implementing IPP, that is, too strict IPP may inhibit innovation and entrepreneurship, while too loose IPP is not conducive to protecting the motivation of innovators and potential entrepreneurs. Most of the economies in transition have a weaker innovation level than their developed counterparts, and they mainly carry out incremental rather than radical innovation. The strengthening of IPP will hinder imitative innovation but promote radical innovation. Incremental or imitative innovation can also provide entrepreneurial opportunities and economic benefits, although weaker than those of radical innovation. However, the high investment and high uncertainty of radical innovation are circumvented by many economic participants in transition economies who are more inclined to maintain the status quo or conduct incremental innovation, forming path dependence. Therefore, to maintain stable economic development, economies in transition generally will not adopt strict IPP within a short period of time but slowly strengthen IPP. Our empirical results prove the above-mentioned conjecture that the relationship between IPP and entrepreneurship is inverted U-shaped, first promoting positively and then inhibiting entrepreneurship. Therefore, it is necessary to implement an appropriate level of IPP to promote entrepreneurship instead of implementing a strict IPP across the board.

Some main contributions are provided. Firstly, we propose that IPP that is too tight or too loose in transition economies is not good to spur entrepreneurial activities, but to design a degree of IPP that is contingent to local endowments so as not to crowd out potential entrepreneurs with less new knowledge. Existing research on the impact of IPP on entrepreneurship mainly examines the monotonic relationship, but the role of IPP in the formation of entrepreneurial opportunities is not simply linear due to the tension between radical and incremental knowledge creation. We extend the literature on KSTE by revealing how high or modest levels of IPP differ in influencing knowledge reengineering and spillover and the derivation of entrepreneurial opportunities in transition countries dominated by incremental innovation. This partially explains the phenomenon that examinations of the impact of IPP on entrepreneurship without discriminating between dominant innovation activities tend to draw inconsistent conclusions based on economies with different institutional backgrounds.

Secondly, this paper contributes to the literature on institution and entrepreneurship by investigating the moderating effect of formal institution and statistically corroborating the argument that the positive effect of new knowledge on regional entrepreneurship will be suppressed as IPP increases in transition countries like China with relatively weak institutional environments. What is more, we do not treat China as a single homogeneous entity, because there exist significant differences in the enforcement of IPP across provinces. Since China's reform and opening up, the decentralisation and marketisation have continued, and local governments have greater autonomy in economic policy formulation, IPP enforcement, and entrepreneurial incentive policy formulation, etc. (He et al., 2019). China's economic development, innovation and entrepreneurship distribution is unevenly distributed across provinces, which leads to fierce regional emulation. Therefore, China's transition environment with institutional voids has provided us with a good sample of research, especially how different provinces can develop IPP implementation degrees to encourage the commercialisation of new knowledge.

Several implications are provided for decision makers. First, investing more in new knowledge to motivate entrepreneurship enlightens local government to improve new knowledge generation. For instance, the government adopts monetary subsidies to encourage universities to produce more commercially technologies and knowledge, and to build an effective communication platform for the application and promotion of new knowledge. Second, although the laws on IPP are consistent across the country, the enforcement of IPP should be determined by local innovation strength and entrepreneurship level, rather than adopting the one-size-fits-all measure. In areas where innovation and entrepreneurial activities are less active, the knowledge commercialisation requires more buffer time. Third, policymakers need to implement classified management and appropriate IPP enforcement based on the type of entrepreneurship. Specifically, maintaining a relatively loose degree of IPP is necessary for necessity-driven entrepreneurship, while strengthening IPP is beneficial to opportunity-driven entrepreneurship during the transformation period in China.

Inevitably, there are some limitations to this article. First, since we use aggregated data at the regional level from corporate data, it is challenging to examine inter-firm and inter-industry heterogeneities, such as firm size, firm financial performance, etc. Second, new knowledge is radical or incremental, and we cannot distinguish between the impact of radical and incremental innovation on entrepreneurship due to data unavailability, which could be further explored in future studies. Third, how different ownership types of start-ups perform in the process of knowledge spillover has not been examined, which can be investigated by questionnaire methods in future examinations. Last but not the least, the movement of entrepreneurs between regions due to different IPP frameworks should exist, which is an interesting topic. However, the data on entrepreneurs' cross-regional movement is unavailable, which limits further exploration in this article.

Note

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Appendix

Table A1. The correlations of variables.

	1	2	3	4	5	6	7	8	9
1.RDSTOCK	1								
2.IPP	0.51***	1							
3.PGDP	0.92***	0.38***	1						
4.URB	0.83***	0.52***	0.83***	1					
5.HES	0.57***	0.12***	0.47***	0.29***	1				
6.HC	0.78***	0.75***	0.75***	0.78***	0.16***	1			
7.UNE	−0.31***	−0.48***	−0.28***	−0.27***	−0.09**	−0.46***	1		
8.FDI	0.67***	0.44***	0.66***	0.74***	0.23***	0.64***	−0.17***	1	
9.PTI	0.57***	0.76***	0.46***	0.64***	0.03	0.79***	−0.45***	0.51***	1

*p < 0.1, **p < 0.05, ***p < 0.01.

Table A2. The results of the causality test.

	RDSTOCK		PSTOCK	
NK_{t-1}	8.477**	6.805*	4.431***	3.731***
	(3.576)	(3.881)	(1.196)	(1.278)
IPP_{t-1}		1.242		0.333
		(1.384)		(1.688)
IPP_{t-1}* NK_{t-1}		−0.748**		−0.729
		(0.363)		(0.455)
PGDP	4.905	4.296	5.482	4.189
	(3.757)	(3.416)	(3.847)	(3.200)
URB	0.065	0.043	0.067	0.029
	(0.041)	(0.033)	(0.044)	(0.030)
HES	−0.141	0.883	0.880	1.061
	(1.626)	(1.360)	(1.496)	(1.325)
HC	0.379	0.653	0.262	0.667*
	(0.260)	(0.398)	(0.248)	(0.387)
UNE	−0.308	−0.058	−0.252	−0.037
	(0.906)	(0.795)	(0.970)	(0.817)
FDI	−0.003	−0.002	−0.003	−0.002
	(0.002)	(0.001)	(0.002)	(0.001)
PTI	0.136	0.123	0.196	0.137
	(0.176)	(0.159)	(0.189)	(0.142)
Constant	−91.633**	−83.232*	−64.303*	−52.188
	(42.489)	(41.114)	(37.716)	(33.492)
Year Dummy	YES	YES	YES	YES
FE OR RE	FE	FE	FE	FE
Hausman	44.81	42.44	22.33	30.55
Prob>chi2	0	0	0.008	0.001
R-sq	0.635	0.654	0.629	0.666
Obs	510	510	510	510

Robust standard errors in parentheses; *p < 0.1, **p < 0.05, ***p < 0.01; NK: New knowledge.

Table A3. Regression results of different industries.

	Manufacturing		PSE		SRTS		ICT	
NK_{t-1}	0.664**	0.602**	−0.006	−0.010	0.046	0.410	−0.041	−0.063
	(0.269)	(0.264)	(0.015)	(0.015)	(0.383)	(0.433)	(0.118)	(0.133)
IPP_{t-1}	−0.253*	−0.055	0.017**	0.023***	−0.509	−1.094*	−0.023	−0.002
	(0.138)	(0.130)	(0.008)	(0.008)	(0.456)	(0.623)	(0.215)	(0.201)
IPP^2_{t-1}	0.016		−0.0011**		0.075***		−0.009	
	(0.012)		(0.0004)		(0.025)		(0.010)	
NK_{t-1}* IPP_{t-1}		0.006		−0.007***		0.543***		−0.047
		(0.027)		(0.002)		(0.153)		(0.046)
PGDP	1.270	1.218	−0.009	−0.012	−2.381**	−2.138	−0.108	−0.121
	(1.164)	(1.161)	(0.032)	(0.030)	(1.160)	(1.261)	(0.379)	(0.399)
URB	−0.006	−0.008	−0.00004	0.00003	−0.009	−0.013*	−0.003	−0.002
	(0.010)	(0.012)	(0.0003)	(0.0003)	(0.009)	(0.007)	(0.006)	(0.006)
HES	0.391	0.548	−0.023	−0.020	−0.755*	−1.084*	0.110	0.115
	(0.327)	(0.357)	(0.024)	(0.026)	(0.443)	(0.600)	(0.121)	(0.118)
HC	−0.108**	−0.103**	−0.001	−0.0006	0.227**	0.166*	0.054**	0.058***
	(0.051)	(0.050)	(0.002)	(0.002)	(0.092)	(0.090)	(0.021)	(0.021)
UNE	0.311	0.338	0.012	0.013	0.296	0.261	−0.0008	−0.002
	(0.193)	(0.202)	(0.012)	(0.012)	(0.176)	(0.158)	(0.105)	(0.103)
FDI	−0.0004	−0.0004***	5.48E-06	9.46E-06	0.0007	0.0004	−0.00002	2.88E-06
	(0.0001)	(0.0001)	(6.04E-06)	(5.38E-06)	(0.0005)	(0.0004)	(0.00008)	(0.00008)
PTI	−0.024	−0.026	−0.0003	−0.0002	−0.040	−0.041	−0.007	−0.006
	(0.025)	(0.025)	(0.001)	(0.001)	(0.045)	(0.044)	(0.016)	(0.016)
Constant	−10.294	−10.494	0.183	0.192	23.978*	23.468*	1.004	1.076
	(10.824)	(11.059)	(0.305)	(0.286)	(11.919)	(12.254)	(3.820)	(3.895)
Year Dummy	YES	YES	YES	YES	YES	YES	YES	YES
FE OR RE	FE	FE	FE	FE	FE	FE	FE	FE
R-sq	0.429	0.421	0.594	0.6	0.673	0.717	0.695	0.696
Obs	510	510	510	510	510	510	510	510

Robust standard errors in parentheses; *p < 0.1, **p < 0.05, ***p < 0.01; NK: New knowledge, proxied by the stock of patent applications; PSE: Production and supply of electric power and heat power; SRTS: Scientific research and technical service; ICT: Information and communication technology.

Consistent with the aforementioned measurement method for entrepreneurship, which is proxied by the number of newly established enterprises per 10,000 people.

Entrepreneurship data source: Zhang, Xiaobo. (2018). "Chinese Enterprise Innovation and Entrepreneurship Survey", https://doi.org/10.18170/DVN/DLBWAK, Open Research Data Platform of Peking University, V8, UNF:6:4Nx6NG9Fi5gumrIt3PAmnw = = [fileUNF].