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Intellectual Property Protection and Corporate Debt Financing Costs: Evidence from Listed Companies in China

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Abstract: ***The cost of capital is one of the key points of financial research. This paper introduces Intellectual Property Protection (hereinafter referred to as IPP) into the study of explaining the cost of capital, and empirically examine the impact of IPP on the cost of debt financing of enterprises invarious regions of China, based on the data of China's Shanghai and Shenzhen A share market. The results indicate that:(1) IPP has a significant negative effect on enterprise debt financing cost;(2) through the grouping test based on the factor intensity of industry, it was found that the negative effect of IPP on debt financing cost in the sample of technology-intensive industries was more significant and negative than that of non-technology-intensive industries;(3) through the grouping test based on the ownership of firms, it was found that the negative effect of IPP on debt financing cost in the sample of non-state-owned enterprises was more significant and negative than that of state-owned enterprises(SOEs). Besides, IPP is not only conducive to the creation of enterprise value directly, but also adds value indirectly by reducing the cost of enterprise debt financing. This paper sheds light on the research into intellectual property system construction by linking law enforcement and enterprises' micro financial behaviors, and it provides empirical evidence for this linkage. At the same time, the effect of industrial heteregeity and ownership also provide some practical implications by (1) tightening supervision over law enforcement, promoting the excise of administrative functions according to law, safeguarding judicial justice and raising the level of law enforcement so that IPP laws and regulations are strictly implemented;(2) speeding up the market-oriented reform of state-owned enterprises and encouraging market competition fairly.***

Keywords: IPP; Debt financing cost; Information asymmetry; Moral hazard.

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1. Introduction

As an important institutional arrangement, intellectual property system defines the rights and obligations in the process of intellectual property creation and its utilization, transfer and disposal in a scientific and reasonable way, which is conducive to reduce transaction costs and risks, encourage R&D investment and innovation. The technology promotion effect of intellectual property protection (IPP) makes it increasingly become the strategic resources of national development and the core element of building national competitiveness. In response, Chinese Government issued a series of policy documents, such as the Outline of National Intellectual Property Strategy (2013), the Outline of the National Strategy on Innovation-driven Development (2016).

In the process of implementing the strategy of strengthening the country with intellectual property rights and building an innovative country, most enterprises, especially the small and medium-sized private enterprise, are faced with financing difficulties, which impedes the R&D innovation of Chinese enterprises. At present, it is mitigated by equity financing and debt financing by Chinese enterprises. Due to the imperfection of capital market and many restrictions on corporate equity financing (IPO) and bond financing, bank loan has been main financing channel in China. Debt financing cost has become an important factor affecting external financing, which has a direct impact on financing decision-making, and then on the R&D investment and technological innovation.

Under the macro background and trend of gradually strengthening IPP and building an innovative country, does IPP, as an institutional supply, has an impact on corporate debt financing cost while stimulating R&D innovation and increasing technology supply? For project screening and risk management, does bank creditor consider the impact of gradually IPP reinforcement on corporate financing, and take different measures accordingly.

For the purpose of solving the above questions, this paper constructed IPP index from two dimensions of administration and jurisdiction activity to measure regional difference of IPP, and employed a sample of listed companies on Shanghai and Shenzhen stock markets to test the impact of IPP on debt financing cost. At the same time, we introduce three contingent factors, industry, ownership and asset size of firms, to examine the different effects across different groups. It is found that (1) IPP has a significant negative effect on enterprise debt financing cost; (2) the negative effect of IPP on debt financing cost in the sample of technology-intensive industries was more significant and negative than that of non-technology-intensive industries; (3) the negative effect of IPP on debt financing cost in the sample of non-state-owned enterprises was more significant and negative than that of state-owned enterprises (SOEs). Besides, IPP is not only conducive to the creation of enterprise value directly, but also adds value indirectly by reducing the cost of enterprise debt financing.

This paper makes the following contributions to the literature:(1) IPP index is reconstructed from two dimensions of administration and jurisdiction to investigate the actual IPP protection in the province where the listed companies are located under the background of national uniform IPP legislation, so as to mirror regional differences of IPP in the context of selective law enforcement. The existing research on IPP is found that IPP index is constructed from two dimension of legislation and law enforcement [1,2], which is contradictory to the unity and universality of intellectual property legislation in China. (2) our research reveals how IPP work on debt financing cost. Few researches have integrated IPP and corporate debt financing cost into the same framework, and the existing research on IPP and debt financing cost has not yet explored the mechanism of IPP on debt financing cost. Our research reveals that IPP stimulates R&D investment by overcoming externality, and restrains opportunity behavior in the course of intellectual property transaction, so as to enhance the social trust and reduce transaction risk; IPP encourage technological information disclosure, reduce information asymmetry, enhance expectation consistency between inside managements and outsider investors, which results in lower risk premium; The fast development of intellectual property finance will increase capital supply and reduce debt financing cost.

2. Literature Review and Hypotheses

2.1 IPP and Debt Financing Cost

R&D is a tediously long, cumbersome and unpredictable process, which needs not only macro policy support, such as IPP, industrial policy support etc, but also micro financial support. At present, debt financing and equity financing are two major channels for Chinese enterprises to obtain external funds. Due to tax saving effect and leverage effect, debt financing are more popular in China.

It is difficult for innovative enterprises to obtain debt financing support for R&D, even if they have access to credit support, debt financing cost is still higher. The reasons are as follows: First, compared with physical capital investment, higher risk of R&D and innovation activities usually result in banks demanding higher risk premium, the higher risk not only embodies uncertain R&D results, but also embodies higher default risk caused by limited and unstable cash flow within the innovative enterprises [3]. Besides, the personal attribute [4] and limited mortgage value of R&D activity and thereof knowledge assets will increase capital cost in the form of risk premium [5]. Secondly. Considering the exclusivity, innovative enterprises are reluctant to share innovation information with others. This information asymmetry result in a higher lemon premium [2], which may lead to the atrophy or even disappear of R&D financing market in serious cases. Thirdly, the double principal-agent phenomenon in the process of R&D financing will make bank creditors suffer higher moral hazard and supervision cost. for example, innovative enterprise defaults and diverts bank loans for other long-term projects with higher uncertainty, senior management expand on-the-job consumption, all of which will further increase risk premium of corporate debt financing. In a word, the externalities, opportunity behaviors and information asymmetry result in higher debt financing cost, which hinders corporate R&D.

Therefore, when innovative enterprises try to obtain R&D financing support from banks, IPP may have the

following impact on the cost of corporate debt financing.

First of all, IPP can effectively reduce the risk of technology leakage [6], improve the voluntary and initiative of information disclosure of knowledge assets such as R&D expenditure, patent application, reduce information transmission distortion, information asymmetry and adverse selection in the financing process, which results in lowering corporate debt financing cost. In accordance with signaling theory, the management of high-quality companies has the motivation to send signals to outside investors in time. Hall and Lerner (2010) [4] found that as an observable signal, R&D expenditure can effectively mitigate "lemon problem" Czarnitzki et al (2014) [7] found that EU enterprises send signals to outside investors through "patent application" to mitigate information asymmetry in the process of R&D financing. IPP encourages innovative enterprises to publicly disclose R&D investment, patent application and other information, which can distinguish them from non-innovative enterprises, so as to play the role of enterprise screening and signal transmission.

Secondly, IPP can inhibit opportunistic behavior and moral hazard in the process of innovative financing by increasing infringement penalties, lowering the dimension authority cost of oblige, so as to encourage more R&D investment and facilitate knowledge asset transaction. Under the background of insufficient loan guarantee, low efficiency of judicial system and high transaction cost, IPP can effectively inhibit debtors' repudiation in the process of R&D financing [8], improve the value of guarantee collateral and the recovery rate of banks in debt settlement [9], which result in restore and improving social trust, and lowering risk premium caused by moral hazard. To some extent, IPP not only creates a favorable environment for the expansion of bank credit market [10], but also adds the commercial value of collateral [11], and reduces the risk of loan default of innovative enterprises.

Finally, with the deep integration of knowledge asset and financial capital and the continuous innovation of intellectual property finance, IPP will add the exchange value and market price of intangible assets such as knowledge asset [12], broaden financing channels for innovative enterprises, enable them to obtain external funds through patent pledge, asset securitization, trust, insurance and other means [13]. At the same time, it will signal the innovators' technology advantages and industry position to the outsiders, which will lower the financing cost [14].

Accordingly, we propose the following Hypothesis:

H1: IPP will lower corporate debt financing cost by overcoming R&D externality, reducing opportunity behavior in the process of knowledge asset transaction and information asymmetry, promoting the development of intellectual property financing.

2.2 Industry, IPP and Debt Financing Cost

The debt financing for R&D of innovative enterprises may be influenced by industrial nature. Bank creditors may treat technology-intensive industries and non-technology-intensive industries differently when making loan decisions. The variation of input scale and relative price of production factors leads to the difference of industrial R&D intensity and collaterals. High human capital and R&D investment will result in severe information asymmetry and adverse selection due to their inalienability and exclusivity, which increase debt financing cost of innovative enterprises. Wang. W and Jiang. G.F. (2004) [15] found that the extra capital cost caused by information asymmetry is more prominent in technology-intensive industries with strong spillover effect. Similarly, Hall et al. (2016) [14] found that the financing cost of technology-intensive industries is higher than that of non-technology-intensive industries in EU.

Kanwar and Evenson (2008) [16] found that strengthening IPP is a precondition for high-tech enterprises with high intensity of knowledge resources to have access to external financing. There is a strong correlation between debt financing and IPP for high-tech enterprises. According to Evergrande Research Institute, the bank loan funds mainly went to manufacturing, transportation, infrastructure, real estate and other industries, while the emerging industries such as information transmission, computer service and software, which are based on knowledge, received little credit funds in China. The reason behind these phenomena is that the intellectual property intensive industries [17] are abundant with human capital and knowledge asset, less tangible assets available for mortgage, which result in higher financing constraints. Wu. C.P and Tang. D. (2016) [2] found that IPP enhances the supply

of credit funds to these industries with strong external financing constraints, and reduces debt financing risk and premium by restraining product imitation and increasing the expectation of innovation income.

There may be a positive correlation between industrial knowledge attribute and its debt financing cost. For the knowledge-based industries, or rather, technology-intensive industries, the spillover effect of R&D is obvious, which calls for much more monopoly gain; the information asymmetry caused by the intangibility and inalienability of knowledge asset raises debt financing cost. In addition, limited mortgage value of knowledge asset, caused by faster technology upgrading and the lack of evaluation method, result in bank's reluctance to lend or demanding higher premium.

Accordingly, we propose the following Hypothesis:

H2: Compared with other industries, the debt financing cost of technology-intensive industries, especially high-tech industries are more significantly affected by IPP.

2.3 Ownership, IPP and Debt Financing Cost

Corporate ownership plays a great influence on bank's loan decision, which results in different debt financing costs for state-owned enterprises (SOE) and non-state-owned enterprises (non-SOE) in China. Existing studies shows that, due to the impact of corporate ownership [18], non-state-owned enterprises are facing more severe financing constraint .while state-owned enterprises having close ties with local government can easily obtain bank loans [19,20]. Compare with non-state-owned listed companies, state-owned listed companies can obtain more long-term bank loans [21]. The debt financing cost of listed companies increased after their privatization. Compared with other listed companies, private listed companies bear higher debt financing costs [22].

What causes this kind of credit discrimination when SOEs and non-SOE are allowed to coexist in China.

The key is that the ownership (controlling state) of SOEs belongs to the state, which makes SOEs have an indivisible internal relationship with government and easily get some privilege from the government, while non-SOEs are private and have no special relationship with government. The political connection of SOEs makes it easy to obtain the protection or favoritism from formal institution [23], and also makes the bank relax their loan inspection and post loan supervision [24]. The close fundamental relationship of SOEs with government may weaken the role of IPP in corporate debt financing while providing invisible guarantee for their loans. When IPP is weak, the government background of SOEs enables them to obtain better legal protection, reduces the possible moral hazard and adverse selection in the process of bank loans. To some extent, political connection is an alternative mechanism of legal protection [25]. Under the influence of industry access and government procurement, SOEs often have some privilege and monopoly power in certain fields [26], which inhibits the innovation incentive of IPP and hinders the healthy development of intellectual property finance.

Compare with SOEs, non-SOEs are inferior in terms of their relationship with the government, which results in their disadvantage of access to crucial resources such as industry access, bank credit, and so on. If they want to survive in the competition with SOEs, they must try their best to form their own comparative advantage, such as technological advantage, flexible operation. Strengthening IPP will overcome R&D externality and encourage more R&D investment of non-SOEs, reduce the uncertainty and cost of knowledge transaction and facilitate intellectual property transaction. Besides, Strengthening IPP is conducive for non-SOEs to make good use of intellectual property (such as patent, copyright) pledge to relieve financial pressure.

The above analysis shows that the ownership has an important impact on IPP and corporate debt financing cost, and there are structural differences in this impact. Therefore, we propose the following Hypothesis:

H3: Compared with SOEs, the debt financing cost of non-SOEs is more significantly affected by IPP.

3. Research Design

3.1 Data Selection

In this paper, we constructed non-equilibrium panel data of Shanghai and Shenzhen A-share listed firms from 2008-2017. The following firms were eliminated from the sample: (1) The financial indicators of financial firms are different from that of other firms, so we eliminated the financial firms to ensure the consistency of the research;(2) The financial indicators of ST firms are usually abnormal and were excluded in our sample;(3) The listed firms with delisting or missing data of key indicators and that were difficult to verify were eliminated, (4) The listed firms that issue B shares or H Shares at the same time were eliminated;(5) We eliminated observations of new IPO firms that have been listed for less than one year. In order to eliminate the influence of outliers, this paper reduced the quartiles of continuous variables below 1% and above 99%, and finally obtained 12580 valid observations.

The macroeconomic data used in this sample were from CEIC database, and corporate financial data and stock data are from CSMAR database.

3.2 Variable Selection

Referring to similar studies [27,28], we constructed the following econometric equation to study the impact of IPP on corporate debt financing cost. In order to avoid endogeneity, we took the approach of one period lag of independent variables and control variables.

$$Debt\_\cos t_{i,t} = \beta_0 + \beta_1 IPP_{i,t-1} + \gamma X_{i,t-1} + \varepsilon_{i.t}$$

For the above formula, i represents i firm, t-1 represents t-1year, X is control variables, $\varepsilon_{i.t}$ is the disturbance term.

3.2.1 Dependent Variable

The dependent variable in this research is corporate debt financing cost (*Debt-Cost*). Referring to Pittman et al (2004) [29], it is measured by dividing annual interest payment of the firms by the average interest-bearing liabilities in that year. The interest payment comes from "interest expense" under the "financial expense" detailed account; the average interest-bearing liabilities in that year are equal to the mean of short-term loans, long-term loans and long-term loans due within one year at the beginning and end of the period. Based on the practice of Wang Y.T and Jiang F.X (2017)[28],we multiply them by 100 for analysis.

3.2.2 Independent Variable

IPP, the core independent variable in our research, is intellectual property protection index of 32 provinces autonomous regions and municipalities where the listed firms were located in China. Although Intellectual property law promulgated by National People's Congress and national regulations issued by the State Council in China are unified and applied across the country, these regions are heterogeneous in the degree of marketization process, rule of law and public rights awareness, which makes regional governments, within the existing legal framework of intellectual property, have the discretion to decide when ,how and who to enforce the intellectual property law and regulations to obtain the initiative and flexibility of IPP under new circumstances [30]. In this regard, we constructed regional IPP index on the basis of different intellectual property law enforcement in China.

In terms of intellectual property law enforcement, China implemented a "dual track" intellectual property system, which was composed of administrative protection initiated by the State Intellectual Property Office, the Administration for Industry and Commerce and judicial protection passively tried by local courts.

At present, judicial protection was the main way to solve intellectual property disputes in China, which had a significant impact on corporate innovation and value[12,31], and was an important indicator embodying regional IPP difference. We used the winning rate of intellectual property cases to measure the level of IPP judicial protection(IPP_1), that was, the number of successful cases of infringed parties in intellectual property infringement cases in each province divided by the total number of cases that judgments have been rendered in that year.

As a supplement to judicial protection, administrative protection was mainly embodied in the acceptance and joint law enforcement of patent infringement cases by local intellectual property offices. In regard, we used two indicators to measure the level of administrative enforcement of intellectual property laws and regulations: (1)

non-infringement rate of intellectual property cases, which was equal to 1 minus the number of patent infringement cases accepted by local intellectual property office in that year divided by the cumulative number of authorized patents at that year; (2) the frequency of joint law enforcement, which was equal to the number of joint enforcement cases by local intellectual property office and other government departments divided by the number of patent infringement cases in that year. After taking the logarithm of the equal weight summation of the above indictors, we got IPP_2.

Regional IPP index was the mean of IPP_1 and IPP_2 which was expressed as follows:

$$IPP = (IPP_1 + IPP_2) / 2$$

In the above index construction, the judicial protection index came from the analysis and collation of intellectual property infringement cases from "Peking University Magic Weapon-China Judicial Case Base" from 2007-2018. The number of patent infringement cases and the cumulative number of patent authorizations in each province were from annual report of "Patent Satistics" over the years, and the number of joint laws enforcement by intellectual property office and other government departments in each region was from the website of the State Intellectual Property Office.

3.2.3 Control Variables

In order to improve the explanatory power of the model and weaken the influence of omitted variables, referring to Han Q. et al (2017) [27], Wang Y.T.et al (2017) [28], control variables with corporate and regional characteristics that may affect corporate debt financing cost were controlled. In addition, control variables were delayed for one period to reduce the endogeneity.

Control variables with corporate characteristics include (1) the first big proportion of shareholding(top1),and the shares held by persons acting in concert should be calculated together;(2) firm size(Size),which was measured by the natural logarithm of total assets;(3) financial leverage(Lev), which was measured by the interest-bearing liabilities-total assets ratio (4)tangible assets ratio (Tangi),which was measured by the tangible assets-total assets ratio, and tangible assets equal to total assets less intangible assets less goodwill,(5) firm growth(Growth),which was measured as the growth rate of sales revenue,(6)cash flow(CF),which was measured by the net operation cash flow-total assets ratio,(7)firm profitability(Profit),which was measured by the net profit-net assets ratio,(8)listing age(Age),which was measured by the natural logarithm of firm's establishment period plus1.

We also control three variables with regional characteristics: (1) GDP, (2) CPI, (3) urban financial development index (Mktcap), which is measured by the ratio of total market value of all listed companies in the city-local GDP.

Table 1: Variable Definitions

Variable type	symbols	Variable definition	Calculating method
Dependent Variable	Debt_cost	Debt financing cost	100 × interest payment/[(beginning interest-bearing liabilities+ending interest-bearing liabilities)/2]
Independent Variable	IPP	IPP index	As defined above
Control Variables	Top1	The first big proportion of shareholding	if concerted actors exist, the shares should be consolidated
	Size	Firm size	natural logarithm of total assets
	Lev	Financial leverage	total interest-bearing liabilities/total assets
	Tangi	Tangible assets ratio	(total assets-intangible assets-net goodwill)/total assets
	Growth	Firm growth	(ending sales revenue-beginning sales revenue)/beginning sales revenue
	CF	Cash flow from operation activities	net cash flow from operation activities/total assets
	Profit	Firm profitabilty	net profit/net assets
	Age	Firm age	natural logarithm of firm's establishment period plus1.
	GDP	Gross domestic product	urban GDP where listed firms located
	CPI	Consumer price index	urban CPI where listed firms located
	Mktcap	Financial development index	total market value of all listed firms in the city/local GDP

4. Empirical Results

4.1 Descriptive Statistics

Table 2 reports the descriptive statistics. As shown in Table 1,the dependent variable, i.e. the mean of corporate bank financing cost is 1.578,the maximum value reaches 9.967 and the minimum value is only 0,which indicates that corporate financing cost from bank varies greatly. From the perspective of the test variable, i.e. IPP index, the average value of IPP is 0.528, while the highest value is 1.5 and the lowest value is 0, which indicates that there are great differences in corporate financing cost for the firms with different level of intellectual property protection. In terms of other variables, the wide disparity between the maximum and the minimum indicates that there is a large difference between different firms.

Table 2: Descriptive statistics

.	Samples	Mean	Standard Error	Min	Max
Debtcost	12580	1.578	33.727	0	9.967
IPP	12580	0.528	0.148	0	1.5
Age	12580	0.605	0.249	0	1.079
Cf	12580	0.034	0.071	-0.174	0.211
Top1	12580	30.653	19.018	0	75.51
Growth	12580	0.272	1.247	-.911	2.134
Profit	12580	0.067	0.132	-0.268	8.279
Size	12580	9.395	0.395	8.189	12.191
Lev	12580	0.131	0.119	0	0.751
Tangi	12580	0.908	0.104	0.125	1
CPI	12580	102.259	1.168	97.03	108.2
GDP	12580	985.122	811.159	14.234	3063.299
Mktcap	12580	0.981	1.41	0.002	7.714
TobinQ	12580	2.771	2.124	0.076	30.241

4.2 Regression

4.2.1 Base Regression: The Whole Sample

Table 3 reports the regression result of the total sample. In the benchmark regression, control variables representing the characteristics of lists firms and regions were sequentially added, and the coefficients of IPP were all significantly negative at the level of 1%. Put it another way, the impact of IPP on corporate debt financing cost of listed firms was significantly negative, which was in accordance with hypothesis 1.The higher the level of IPP was, the lower the corporate debt financing cost was.

In term of other control variables, the coefficient of firm age (Age) was significantly positive at the level of 1%, which indicated that the shorter listed firms were incorporated, the lower the bank loan cost was. The possible reason behind it was that the shorter the firm was incorporate, the smaller the assets depreciated physically and technologically, the higher the realizable value was, and the smaller the credit risk that bank took, so the lower the debt financing cost was. The coefficient of The first big proportion of shareholding (Top1) was significantly negative at the level of 1%, which indicated that the higher the shareholding ratio of the first largest shareholder, the more likely to inhibit “double agency problem” of the large shareholder encroaching on the interest of small and medium shareholders and reduce corporate debt financing cost caused by agency cost. The coefficient of corporate growth (Growth) was significantly negative, which indicated that the faster the listed firm growed, the better the development, the more credit support they can get from banks at a lower cost. The coefficient of firm profitability (Profit) was significantly negative. Higher profitability meant thicker risk buffer and lower risk of corporate debt default, thus reducing debt financing premium. The coefficient of firm size (Size) was significantly positive, which was inconsistent with our expectation. The possible reason was that in the rapidly changing are, the larger the corporate scale, the less flexibility and advantages of “small boat, good turn”, which resulted in higher risk premium in bank lending. The coefficient of corporate leverage (Lev) is significantly negative, which indicated that the higher the asset-liability ratio was, the lower the debt financing cost was; The coefficient of tangible asset ratio (Tangi) was significantly positive, which indicated that the higher the proportion of tangible assets was, the higher the debt financing cost was, which was inconsistent with our expectation. The possible explanation was that, compared with intangible asset that were difficult to imitate, quantify and control, high proportion of tangible assets meant that the corporate technical threshold may be low, there were many uncertainties in its competitiveness and long-term development, so banks would ask for higher risk premium when they decided to lend.

The coefficients of regional GDP and CPI were significantly negative, which indicated that the higher the regional economy developed, the higher CPI, the lower the debt financing cost of listed firms. The coefficient of financial

development (Mktcap) was significantly positive, which suggested high substitution between equity financing and debt financing.

Table 3: The impact of IPP on corporate debt financing cost

Varibles		Debt_cost	
IPP	-0.202***	-0.234***	-0.228***
	(0.3768)	(0.3741)	(0.3744)
Age		0.446***	0.435***
		(0.496)	(0.513)
Cf		0.230	0.200
		(0.174)	(0.176)
Top1		-0.123**	-0.121**
		(0.580)	(0.580)
Growth		-0.142***	-0.136***
		(0.320)	(0.320)
Profit		-1.116***	-1.116***
		(0.183)	(0.183)
Size		0.750***	0.746***
		(0.330)	(0.332)
Lev		-1.341***	-1.362***
		(0.974)	(0.988)
Tangi		0.537***	0.583***
		(0.113)	(0.115)
CPI			-0.0180*
			(0.999)
GDP			-4.46e-05**
			(1.83e-05)
Mktcap			0.214**
			(0.107)
Constant	0.519***	-6.942***	-5.080***
	(0.420)	(0.319)	(1.079)
Obs	12,580	12,580	12,580
R-squared	0.51	0.75	0.76

Standard error in parentheses; * p<0.10, ** P<0.05, *** p<0.001

4.2.2 Grouping Regression

In order to test hypothesis 2, this paper referred to the classification of Wu Lihua & Yan Yan (2011) [32], Deng Qing & Wang Yuyan (2014) [32], petroleum processing and coking, nuclear fuel industry, chemical industry, non-metallic mineral products industry, metal smelting and rolling processing industry, general equipment manufacturing industry, specialized equipment manufacturing industry, transportation equipment manufacturing industry, electrical machinery and equipment manufacturing industry, computer industry and other electronic equipment manufacturing industry, communication equipment, metal products industry, etc were classified as technology-intensive industries and the other were classified as non-technology intensive industries.

For the purpose of testing Hypothesis 3, this paper defined the listed state-owned firms as the firms whose actual controller were “state-owned enterprises”, “administrative units and institutions”, “central institutions” and “local institutions”, and the other firms as non listed state-owned enterprises. Grouping regression was carried out, and the regression results were shown in Table 4.

Table 4: Grouping Regression

	(1)	(2)	(3)	(4)
Variables	Non-technology intensive	Technology-intensive	SOE	Non-SOE
IPP	-0.0511	-0.348***	-0.0806	-0.223***
	(0.102)	(0.320)	(0.254)	(0.780)
Corporate control variable	control	control	control	control
Regional control variable	control	control	control	control
Constant	-2.674**	-6.621***	-5.697	-4.842***
	(1.121)	(1.778)	(3.661)	(1.137)
Obs	5,206	7,374	924	11,656
R-squared	0.58	0.89	0.75	0.77

Standard error in parentheses; * p<0.10, ** P<0.05, *** p<0.001

Table 4 reports the regression results of each sub-sample divided by the grouping variables. In terms of industrial heterogeneity, the table shows that the coefficient of IPP of technology-intensive listed firms (-0.348) is significantly negative at the level of 1%, while the coefficient of IPP of non-technology-intensive listed firms is

negative, but not significant. Compared with non-technology-intensive industries, the impact of IPP on corporate debt financing cost of technology-intensive listed firms is more obvious, which is consistent with hypothesis 2. As for ownership, compared with state-owned listed firms, IPP has a greater and more significant impact on corporate debt financing cost of on-state-owned listed firms (0.223>0.0806), which is consistent with Hypothesis 3.

5. Discussion and Implication

5.1 Impact of IPP on Debt Financing Cost

The regression results in Table 3 shows that the coefficient of IPP is -0.288 and significant at the level of 1%, suggesting that strengthening IPP can effectively reduce the debt financing cost of listed firms, which verifies Hypothesis 1. It is known that information asymmetry widely exists between external investors and financing firms. With increasing information asymmetry, potential investors in information disadvantage will demand higher premium on investment. Lesmond, O'Connor and Senbet (2004) [33] found that the rising information asymmetry will increase the public worries and doubts when buying stocks, which will result in the decease of stock liquidity and further increasing the equity capital cost. Similarly, Gatchev et al (2009) [34] empirically tested the impact of information cost on corporate financing, and confirmed that when information asymmetry increases, corporate debt financing cost increases.

Existing research shows that IPP has an important impact on firms by helping them overcoming externalities [35] and information asymmetry [36]. Externality refers to the fact that it is difficult for innovative enterprises to prevent other enterprises from using their own intellectual property, which results in the lack of innovation motivation and the reduction of innovation investment. Strengthening IPP can restrain and reduce the infringement and duplication of products, increase corporate innovation income and encourage more enterprises to invest in R&D. In addition, Strengthening IPP can also improve social trust of the public, so that innovative enterprises will be more inclined to apply for the recognition of intellectual property rights, disclose information about technology to relevant government departments, and reduce the asymmetry of public information about technology. The recognition of intellectual property rights obtained by innovative enterprises from relevant government departments will improve the trust of external investors, such as banks, in enterprises, reduce the differences with senior managers on technology innovation and profit prediction, increase the attraction of innovative enterprises to external investors, especially strategic investors, and improve the capital structure of innovative enterprises. And then increase the scale of bank creditors' lending, reduce the debt financing cost of innovative enterprises [37]. Finally with more and more enterprises adopting the new model of intellectual property financing, strengthening IPP will reduce information asymmetry, at the same time, it will also inhibit the infringement risk, make innovative enterprises reduce the dependence on internal financing, and obtain more credit financing channels, so as to reduce the cost of credit financing [38].

5.2 Effect of Industrial Heterogeneity on IPP and Debt Financing Cost

Compared with non-technology-intensive industries, the externalities, information asymmetry and agency problems of technology-intensive industries are more obvious. Huge R&D investment, high risk of being imitated and low use cost often lead to insufficient innovation of technology-intensive industries, which is not conducive to social overall technological progress. Technology-intensive industries have higher and newer technologies, trade secrets and patents. These unique technologies and knowledge are important resources and strategic assets that constitute the core competitiveness of these industries. In order to ensure the security of these strategic assets, technology-intensive industries are often reluctant to disclose the information, which result in high information asymmetry. High information asymmetry often leads to bank creditor's reluctance to lend or higher risk premium. In addition, information asymmetry also aggravates the agency cost between external creditor and inside shareholders, shareholders and executives.

Strengthening IPP has cracked down on piracy and infringement, increased the monopoly income of technology-intensive industries, effectively compensated for their early R&D investment and encouraged their further innovation. In addition, strengthening IPP can reduce the risk and cost of the "knowledge (product)" transaction process of technology-intensive industries, increase their income, improve solvency and reduce the risk of credit default; on the other hand, it can help to "screen" the enterprises with high technology intensity, encourage them

to transmit the information of comparative advantage of "knowledge" to the outside, and reduce the adverse selection and risk premium caused by information asymmetry in the process of credit financing, which result in lower corporate debt financing cost as a whole.

5.3 Effect of Ownership on IPP and Debt Financing Cost

Due to the nature of intellectual property rights, IPP has different effect on corporate debt financing cost, which is consistent with China's special national conditions at this stage. The multi-objective, social responsibility of SOEs and their nature political connection with the government make it easy to obtain special care and invisible guarantee from the government in credit financing, and to obtain bank loans at a lower cost, which result in the limited role of IPP in corporate financing. In this sense, the political connection of SOEs has become an alternative of IPP in corporate credit financing. In other words, IPP plays a relatively small role in reducing the credit cost of SOEs.

Compared with SOEs, non-SOEs are often at a disadvantage in the process of bank loans and get a higher risk premium. It is of great significance to strengthen IPP for non-SOEs. First of all, strengthening IPP can not only increase the innovation income of these firms and reduce the risk of loan default, but also stimulate their R&D innovation, so that these firms can maintain the necessary technological advantages and form a certain core competitiveness. Secondly, while promoting R&D investment, IPP encourages non-SOEs to signal "R&D expenditure" and patent granted to the outside to reduce the risk premium caused by information asymmetry in the process of bank loans.

5.4 Implication

The findings of this paper may have some implications for policy makers: (1) In addition to traditional perspective of technological progress, we should also pay attention to the positive role of IPP as a system design in reducing corporate debt financing cost. Therefore, the government should strengthen the enforcement of intellectual property rights, promote the administration according the law, maintain judicial justice, improve the level of law enforcement and ensure the strict implementation of relevant laws and regulations. At the same time, we should avoid or reduce the expected disturbance caused by discretionary law enforcement activities and enhance people's awareness of upholding law. (2) Improve information disclosure system. Timely, comprehensive and accurate information disclosure can help reduce the information asymmetry between the firms and the public (including external investors), and reduce corporate debt cost. In this regard, it is necessary to expand the scope and detail of information disclosure in the process of patent application, including R&D expenditure, authorized patents and other mandatory information disclosure and encourage more voluntary information disclosure. (3) Pay attention to policy coordination and coherence. In addition to the impact of monetary policy on corporate financing cost, this paper finds that increasing the enforcement of intellectual property law can also reduce corporate financing cost in the long run. Therefore, the government should pay attention to the coordination between policies in the counter-cyclical macroeconomic regulation.

6. Robustness Tests

6.1 Endogeneity Problems

In order to solve the possible endogenous problem between IPP and corporate debt financing cost, this paper refers to Luo Yu et al (2016) [10], choosing the legal education experience of the Secretary of the provincial Politics and Law Committee (SPLC) as the tool variable of IPP in the location of each listed company for empirical analysis, and the regression results are shown in Table 5. The empirical result shows that the estimated coefficient of the legal education experience of the Secretary is significantly negative at the level of 10%.and the regression coefficient of other variables has not changed significantly, which is basically consistent with the benchmark regression results (Table 3).

6.2 The Non-linearity of IPP

Considering the nonlinearity of IPP [39, 40] and threshold [41] between IPP and technological progress in China,

this paper adds IPP^2 to conduct empirical analysis again, and the regression results are shown in Table 6. It shows that the estimated coefficient of IPP is significantly positive, and the square item (IPP^2) is significantly negative, indicating that there is an inverted U-shaped relationship between IPP and corporate debt financing cost of listed firms, with a turning point value of 0.4025 (less than the mean and median of IPP). 83.76% of the sample points are located on the right side of the inflection point, which shows that the effect of IPP on corporate debt financing cost is generally in the range of decreasing with the improvement of IPP. Strengthening IPP will reduce corporate debt financing cost. The regression coefficients of other variables did not change significantly and the regression results were stable.

Table 5: The impact of legal education experience on corporate debt cost

Variables	Debtcost
Edu-law	-0.471*
	(0.303)
corporate control variable	control
regional control variable	control
Constant	-5.164***
	(1.079)
Obs	12,580
R-squared	0.75

Standard error in parentheses; * p<0.10, ** P<0.05, *** p<0.001

Table 6: IPP and corporate debt financing cost after adding IPP^2

Variables	Debtcost
IPP	0.867*
	(0.491)
IPP^2	-1.077**
	(0.477)
Corporate control variable	control
Regional control variable	control
Constant	-5.371***
	(1.086)
Obs	12,580
R-squared	0.76

Standard error in parentheses; * p<0.10, ** P<0.05, *** p<0.001

6.3 Further Discussion

This paper studies the impact of IPP on corporate debt financing cost and analyzes the differences between different industries and ownships. In order to further investigate the interaction between IPP and corporate debt financing cost in corporate value creation, this paper refers to Zhong Teng and Wang Changyun (2017) [42] to build the following model. The explanatory variable is Tobin Q in the next year, the next three years and next five years. At the same time, other possible influencing factors are controlled, including establishment time, asset scale, financial leverage, cash flow ratio, tangible asset ratio, etc. The regression results are shown in Table 7. Empirical results show that IPP not only directly promotes corporate value creation, but also increases corporate value by reducing corporate debt financing cost.

$$TobinQ_{i,t+1} = \beta_0 + \beta_1 IPP_{i,t} + \beta_{i,t} Debt\cos t_{i,t} + \beta_3 IPP_{i,t} * Debt\cos t_{i,t} + \beta_4 X_{i,t} + \varepsilon_{i,t}$$
$$TobinQ_{i,t+3} = \beta_0 + \beta_1 IPP_{i,t} + \beta_{i,t} Debt\cos t_{i,t} + \beta_3 IPP_{i,t} * Debt\cos t_{i,t} + \beta_4 X_{i,t} + \varepsilon_{i,t}$$
$$TobinQ_{i,t+5} = \beta_0 + \beta_1 IPP_{i,t} + \beta_{i,t} Debt\cos t_{i,t} + \beta_3 IPP_{i,t} * Debt\cos t_{i,t} + \beta_4 X_{i,t} + \varepsilon_{i,t}$$

Table 7: The impact of IPP and corporate debt financing cost on corporate value

Variables	$TobinQ_{i,t+1}$	$TobinQ_{i,t+3}$	$TobinQ_{i,t+5}$
IPP	0.574***	0.410***	-0.159
	(0.118)	(0.145)	(0.158)
Debtcost	0.375	-0.611*	-0.188
	(0.337)	(0.355)	(0.132)
IPP*Debtcost	-0.482	0.942*	0.312
	(0.0515)	(0.558)	(0.231)
Control variables	control	control	control
Obs	11,148	8,662	6,657
R-squared	0.214	0.197	0.185

Standard error in parentheses; * p<0.10, ** P<0.05, *** p<0.001

7. Conclusions

The role of technology promotion of IPP has been widely discussed, and our government has also clearly proposed

the task of strengthening IPP to build an innovative country. However, the institutional nature of IPP has not attracted widespread attention, especially the impact of IPP on corporate debt financing. In this paper, the listed firms other than financial firms in Shanghai and Shenzhen stock markets in 2008-2017 were taken as research objects, and the relationship between IPP and corporate debt financing cost was empirically investigated and then examined from industrial and ownership heterogeneity.

It is found that there was a significant negative correlation between IPP and debt financing cost of listed firms. The reason behind this lay in that strengthening IPP would crack down on piracy, overcome the externalities in the process of innovation and R&D; constantly improving IPP would help to reduce the opportunistic behavior in the process of intellectual property transaction, enhance social trust among the public, and encourage innovative enterprises to apply for patents and other intellectual property rights. The information disclosure in accordance with the law to obtain IPP reduced the information asymmetry between innovative enterprises and bank creditors. The fast development of intellectual property finance increased fund supply for innovative enterprises, thus reducing the corporate debt financing cost.

There were obvious structural differences in the negative relationship between IPP and corporate debt financing cost: compared with non-technology-intensive industries IPP had a greater and more significant impact on corporate debt financing cost of technology-intensive industries; compared with state-owned listed firms, the negative relationship between IPP and debt financing cost of non-state-owned listed firms was more significant. In addition, IPP was not only directly conducive to corporate value creation, but also indirectly added corporate value by reducing corporate debt financing.

Our research also has its limitations, which are as follows. First, on the basis of national conditions, IPP index constructed from the perspectives of administration and judicature fails to cover other aspects of China's IPP, such as intellectual property legislation, people's awareness of safeguarding rights, etc; the attribute of China's national conditions of IPP index limits its expansion use of the research conclusions to other countries. The sample used in this research was only complied of China's listed firms from 2008-2017, which means that our conclusions might not be generalized to other countries due to differences in national cultures and institutional arrangement. Second, the quantitative research method was limited in the interpretation of our conclusions. Therefore, future research could expand this study by using non-listed companies to enhance the generalizability of conclusions and adopting qualitative research methods to provide in-depth and richness evidence, which could be helpful in explaining why and how to strengthen intellectual property protection.

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