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Promoting Intellectual Property Protection for Green Technology Innovation of Enterprises in Sichuan Province

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Abstract

This study explores the role of intellectual property protection in driving green technology innovation of enterprises in Sichuan Province. Through theoretical analyses and empirical studies, it is found that intellectual property protection can effectively drive enterprises' green technological innovation and achieve this effect by enhancing R&D capabilities. However, the study is limited by the sample size, uncontrolled variables and the complexity of causality. Future research should expand the sample, control more variables, explore causality in depth, and conduct cross-regional comparative studies. This study provides valuable insights into understanding the role of intellectual property protection in promoting green technological innovation.

Keywords: *Intellectual Property Protection, Green Technology Innovation, Enterprise R&D Capability, Sichuan Province, Promotion Role.*

INTRODUCTION

As a key engine to drive the shift of production and lifestyles towards green and low-carbon, green technology innovation can promote green transformation of enterprises and advance green, low-carbon and recycling development by improving resource utilisation efficiency and reducing pollutant emissions. In view of this, the 'Implementation Plan on Further Improving Market-Oriented Green Technology Innovation System (2023-2025)' issued by China's National Development and Reform Commission (NDRC) and the Ministry of Science and Technology (MOST) in December 2022 points out that by 2025, 'a batch of leading green technology enterprises, green and low-carbon science and technology enterprises, and national-level specialised, specialised, and new "small-giant" enterprises in the field of green technological innovation will be cultivated'. small giants' enterprises in the field of green technology innovation'. This implementation programme clearly stresses the importance of enterprises' innovation and points out the future direction of green technology innovation and green low-carbon and recycling development for enterprises. Under the guidance of China's relevant policies and documents, enterprises in the new era will improve their development quality and operational efficiency, and at the same time, take 'harmonious coexistence of man and nature' as the core development concept, drive their own green technological innovation, in order to accelerate the promotion of green, low-carbon and high-quality development. So, how to promote the marginal utility of enterprises on the basis of continuous promotion of green technological innovation? This issue has become an important topic that needs to be resolved in Sichuan Province at this stage.

Currently, some enterprises in Sichuan Province, China, have problems such as lack of awareness of intellectual property protection, weak fight against intellectual property crimes, and insufficient attention to technological achievements (Ren, Du & Zhang, 2023), which is very easy to form 'technological barriers' and market monopoly, which is unfavourable to enterprises' green technological innovation. Intellectual property protection is the key to promote the reform of factor market (Fan & Cai, 2021), which can significantly reduce the degree of mismatch and distortion in the factor market, quickly gather the required factors for innovation activities, optimize the efficiency of factor allocation, and thus promote the development of enterprises' innovation in green technology.

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LITERATURE REVIEW

Under the requirements of the visionary strategic goals of peak carbon and carbon neutrality, the promotion of green economic development has become the main tone of Sichuan Province's current economic development. The green innovation behaviour of enterprises' innovation plays a key role in the green economic transformation of Sichuan Province. Promoting enterprises' innovation can help alleviate environmental problems, such as reducing carbon pollution and energy consumption, which is strategically important for realising the "dual-carbon" goal. However, the low willingness of enterprises' innovation in Sichuan Province has seriously hindered the green transformation process of market players. This paper focuses on the impact of intellectual property rights (IPR) protection on enterprises' green technological innovation and R&D capability as a mediator between IPR protection and enterprises' green technological innovation.

The Impact of Intellectual Property Protection on Enterprises' Green Technology Innovation

The study of Chen (2021) adopts the method of constructing a non-cooperative evolutionary game model, and by simulating the behaviour and decision-making of enterprises under different environmental regulation conditions, the impact mechanism of incentive-type environmental regulation tools on enterprises' green technological innovation is discussed in depth. The results of the study show that incentive-based environmental regulatory tools can effectively stimulate enterprises' enthusiasm for green technology innovation, promote enterprises' investment in green technology innovation, improve innovation efficiency, and thus promote the development of green technology innovation. This finding provides an important reference for managers to make decisions on green technology innovation, and also provides theoretical guidance for enterprises to better cope with the challenges of environmental regulation in practice.

A study by Ling and Ji (2023) found that enterprise digitisation has significant potential to enhance the optimisation of resource allocation and the operational capability of a company's assets. Through the application of digital technology, enterprises are able to manage and utilise their resources more efficiently and achieve maximum utilisation and rational allocation of resources. In addition, digitisation also helps to enhance the operational efficiency of company assets, strengthen the synergy and optimisation of internal processes, and improve production efficiency and product quality. Therefore, enterprise digitalisation can not only optimise the allocation of resources and enhance the operational capability of company assets, but also serve as an important means and support for driving green technological innovation. This research result provides important theoretical and practical guidance for enterprises to realise green technological innovation.

As an important measure to safeguard innovation achievements, intellectual property protection can provide necessary judicial protection and policy support for enterprises' innovation achievements (Cui, 2019), and enhance the subjective initiative of enterprises to carry out green technological innovation activities. Firstly, intellectual property protection can give the innovation subject the exclusive right to green technology and help enterprises' innovation in green technology. A sound intellectual property protection system can help improve the relevant judicial procedures, ensure that the innovation subject is free from technological monopoly in a specific period, help enterprises set up exclusive rights to green technology, help relevant enterprises to build green technology advantages (Chen, Sun & Wang, 2023), improve the innovation activity of enterprises, and drive enterprises' innovation in green technology.

Secondly, intellectual property protection measures can combat infringement and safeguard enterprise green technology innovation. With the continuous optimisation of the intellectual property management system, intellectual property protection can crack down on infringement behaviours such as illegal manufacturing of counterfeit patents, effectively reduce opportunistic behaviours such as 'free-riding', greatly safeguard the rights and interests of the main body of innovation, and provide a key safeguard for the continuous promotion of enterprises' innovation in green technology.

Therefore, this study proposes the following hypothesis:

H1: Intellectual property protection can effectively drive enterprise green technology innovation.

R&D Capability as A Mediator Affecting Intellectual Property Protection And Enterprises' Green Technological Innovation

In an environment where intellectual property protection is lacking, the cost of market infringement of enterprises' innovations is lower and enterprises face a greater risk of market infringement. This will increase enterprises' innovation costs and reduce their willingness to innovate in green technologies. And the increase in the level of regional intellectual property protection will form a deterrent effect on the infringement of R&D innovation achievements, increase the cost of intellectual property infringement, and protect the innovation interests of market players (Wu & Tang, 2016). The improvement of the level of intellectual property protection can not only reduce the frequency of infringement, but also enhance the legal punishment for infringers, further reducing the occurrence of infringement. This deterrent effect can motivate enterprises' innovation in green technology more actively, as they can invest their R&D capabilities into innovation activities with more confidence without excessive concern about the risk of IPR infringement.

In addition to this, an increase in the level of regional IPR protection can attract more investors and partners as they have more trust in the technological innovations and the protection of IPRs of enterprises in the region. This will provide enterprises with more financial and resource support, enhance their R&D capability and further promote the development of green technology innovation. Therefore, strengthening the protection of intellectual property rights will not only help to protect the R&D capabilities of enterprises, but also promote the sustainable advancement of green technological innovation.

At this time, with the support of the external intellectual property protection system, the enterprise's green technology innovation cost will be greatly reduced, which will increase the enterprise's green technology innovation willingness and strengthen the guiding role of the green technology innovation strategy, which will prompt the enterprise to increase its R&D investment. The continuous increase of R&D investment will avoid the interruption of green technology innovation activities and improve the efficiency of enterprises' innovation. Secondly, enterprises' innovation in green technology often face higher R&D risks, through R&D cooperation, technology introduction and innovation knowledge sharing can effectively reduce the risk of innovation uncertainty in green technology innovation activities (Ma, Liu & Jiang, 2014). In an environment with a high level of intellectual property protection, the property right attribution of green technology innovation results is clearer, and the economic rights and interests of green technology innovation results can be effectively protected.

Therefore, this study proposes the following hypothesis:

H2: Intellectual property protection improves enterprises' green technology innovation by enhancing their R&D capability.

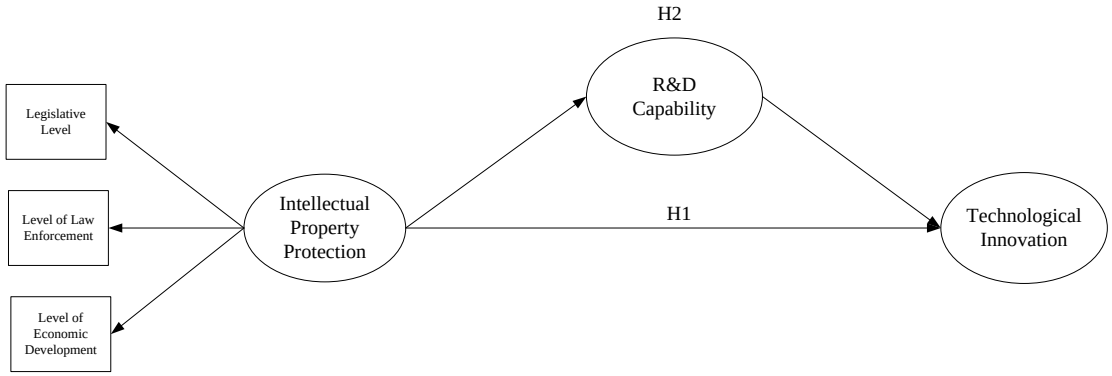

Figure 1 Conceptual framework

MATERIALS AND METHODS

Sample and Procedure

The researcher designed an online survey consisting of five sections, including demographic information, IPP, technological innovation, R&D innovation, and the dependent variable enterprises' innovation output. To address the questionnaire recall issue, the authors hired a professional survey firm to assist in data recall in SOEs and private enterprises in the Sichuan Province region of China. The firm contacted senior managers of SOEs and private enterprises in Sichuan Province, China, and collected data mainly through online questionnaires. Calculations were made to ensure that the number of responses was at least five times the number of individual questions. In total, the study consisted of 28 questions requiring a minimum of 140 responses. A total of 1,559 questionnaires were distributed and 502 were successfully returned, giving a response rate of 32 per cent. This exceeded the minimum requirement and provided a sufficiently reliable sample for the study. Of the 502 questionnaires returned, 397 (79%) were male and 105 (21%) were female. The participants were mainly in middle and senior management positions, totalling 428 (85.20%), while the rest were general managers. SmartPLS version 4 was used for data collection, screening, demographic analysis and descriptive analysis.

Description of the Variables

This study takes enterprises‘ innovation as the explanatory variable and refers to the research method of Liu (2023), which uses the data from the questionnaire to measure the level of enterprises’ innovation in green technology. Through the data collection method of the questionnaire, this study quantifies and assesses the level of green technology innovation of enterprises. The survey questionnaire was designed with a series of questions for enterprises' green technology innovation activities, covering aspects such as technology innovation projects and technology applications. Participating enterprises were asked to conduct a self-assessment of their practices and achievements in the field of green technology innovation to provide an objective data base.

By collecting and analysing the data from the questionnaire, this study was able to gain a comprehensive understanding of the performance of different enterprises in green technological innovation, as well as to compare and assess them. These data not only help the researcher to understand the actual situation of current enterprises in green technology innovation, but also provide an important reference for future decision-making and strategic planning. Therefore, the data collection method of questionnaire has high feasibility and applicability in studying enterprises' innovation.

In this study, intellectual property protection (IPP) is used as an explanatory variable to accurately measure the level of intellectual property protection in the external environment in which the enterprises are located. In order to achieve this goal, this study refers to the research methodology of Zhou (2022) and adopts a survey questionnaire to collect relevant data.

By designing a survey questionnaire that addresses the level of IPR protection, this study covers a number of aspects, such as enterprises‘ knowledge of IPR protection policies, observation of IPR infringement, and enterprises’ evaluation of the effectiveness of IPR protection. Enterprises participating in the survey will be asked to answer the questions in the questionnaire according to their own actual situation in order to provide objective and true data reflecting the level of IPR protection.

By analysing the data from the questionnaire, this study was able to gain a comprehensive understanding of the IPR protection environment in which enterprises are located and assess its impact on their green technological innovation. These data not only help the researcher to gain an in-depth understanding of the current situation and attitudes of enterprises in terms of IPR protection, but also provide an important reference for future decision-making and enterprise strategic planning. Therefore, the use of questionnaires to measure the level of

intellectual property protection has high feasibility and applicability in the study of enterprises' green technological innovation.

According to the research hypothesis, the mediating variable in this study is R&D enterprise input capacity. This means that the researcher believes that the impact of intellectual property protection on enterprises' innovation in green technology is not direct, but through its impact on R&D enterprises' input capacity. Therefore, the researcher hypothesises that an increase in the level of IPR protection will promote enterprises to increase their investment in R&D, which in turn will increase their R&D enterprise investment capacity. After increasing the R&D investment capacity, enterprises will be more likely to carry out green technological innovation, thus realising the mediating effect of IPR protection on enterprises' green technological innovation.

RESULTS

In this study, a second-order model was developed for measurement model and structural model testing, as shown in Figure 2.

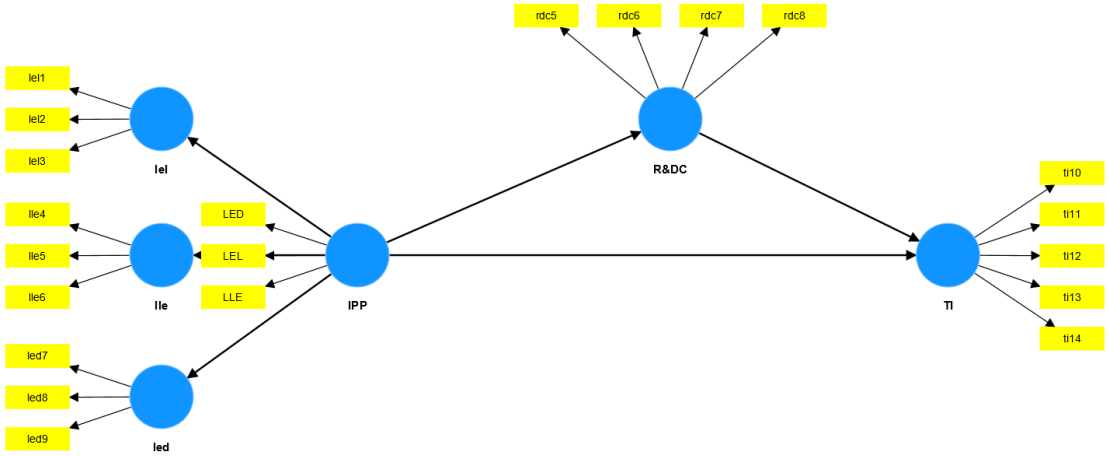

Figure 2: Simplified model

Descriptive Statistics

Descriptive statistics is to analyse various characteristics of a set of data, including the mean, standard deviation, minimum, maximum and median of the whole set of data, which is often used to test the stability of the sample data to facilitate the accuracy of the later study. Therefore, it is very necessary to carry out descriptive statistics on the variables before conducting the following study, and the specific results are shown in Table 1.

Table 1 Results of descriptive statistics of variables

Variable	Min	Max	SD	Mean
Legislative Level（IPP-LEL）	1	5	1.323	3.666
Level of Law Enforcement (IPP-LLE)	1	5	1.304	3.686
Level of Economic Development (IPP-LED)	1	5	1.372	3.588
R&D Capability（R&DC）	1	5	1.307	3.638
Technological Innovation (TI)	1	5	1.310	3.666

Source(s): Own work

Statistical indicators for the four variables, including minimum (Min), maximum (Max), standard deviation (SD) and mean (Mean) are presented in Table 1. These variables represent different aspects of IPP， R&D Capability（R&DC）and Technological Innovation (TI).

For the legislation level (IPP-LEL) variable, the values range from 1 to 5 with a standard deviation (SD) of 1.323 and a mean of 3.666. This suggests that enterprises' perceptions of their knowledge of IP laws vary somewhat in the sample, but are generally at a moderate level.

For the level of law enforcement (IPP-LLE) variable, the values also range from 1 to 5, with a standard deviation of 1.304 and a mean of 3.686. Similar to the level of legislation, there is some variation in the level of enterprises' perceptions of IPR knowledge, but overall it is at a medium level.

For the level of economic development (IPP-LED) variable, the values also range from 1 to 5, with a standard deviation of 1.372 and a mean of 3.588. enterprises' innovation incentive perceptions vary somewhat with respect to the level of economic development of the region in which they are located, but are generally at an intermediate level.

For the enterprises' research and development capability (R&DC) variable, the values again range from 1 to 5, with a standard deviation of 1.307, showing the degree of variation in the R&DC ratings of the enterprises in the sample. As the standard deviation is close to 1.3, this suggests that the R&D capability ratings of most enterprises are relatively clustered around the mean, but there is still a degree of dispersion. The mean value of R&D capability is 3.638, which is slightly above the median value, indicating that the enterprises in the sample as a whole are more active in terms of R&D capability. This implies that the majority of enterprises are likely to have a high level of performance in terms of R&D investment, R&D staffing, or R&D results. However, further analyses are still needed to determine the specific level of R&D capability and its impact on enterprises' innovation in green.

Finally, the enterprises' technological innovation (TI) variable, which again has a range of values from 1 to 5 and a standard deviation of 1.310, suggests that the enterprises in the sample have a certain amount of variability in their technological innovation scores, but most data points are relatively concentrated around the mean. The mean value for technological innovation is 3.666, which is slightly above the median value, indicating that the enterprises in the sample as a whole are positive in terms of technological innovation. This implies that most enterprises are likely to have a high level of performance in terms of technology development, product improvement or market application. However, further analyses are still needed to determine the specific level of technological innovation and its impact on firm performance and competitiveness.

These statistical indicators in Table 1 provide basic information about the variables in the study sample and provide an important reference for subsequent data analysis and research.

Measurement Model Evaluation

Indicator Loads and Internal Consistency Reliability

In this study, PLS-SEM was used to analyse the metrics. Table 2 shows the details of the loadings. According to Hair et al. (2011), it is desirable for the loadings of the indicators to be greater than .7. The factor loadings in this study ranged from .810 to .919, which were all greater than .7. Internal consistency reliabilities should be represented by Cronbach's alpha (α) and composite reliabilities (CR). According to Hair Jr et al. (2010) Hair Jr et al. (2010), the Cronbach's alpha coefficient must be greater than .7 for a variable to have good reliability. The Cronbach's alpha values in this study ranged between .774 and .859 and the CR values ranged between .775 and .861, both of which were greater than .7. This is shown in Table 2.

Table 2 Validity and reliability of the measurement model

	Item	Loadings	VIF	Cronbach's Alpha	CR	AVE
IPP	LEL	.919	2.948	.785	.785	.699
	LLE	.909	2.760	.774	.775	.689
	LED	.887	2.295	.834	.835	.751
R&DC	R&DC	.839	1.986	.859	.860	.703
TI	TI	.810	1.863	.859	.861	.639

Source(s): Own work

Convergent Validity

The average variance extraction rate (AVE) reflects the extent to which the latent variables explain the variance of the observed variables and is an important measure of convergent validity. The average variance extraction rate should be greater than .5 (Hair, 2012; Hulland, 1999). According to the results of PLS, the AVE values in this study ranged from .639 to .751, which are all greater than .5 (Table 2).

Distinguishing Validity

In this study, the Fornell-Larcker criterion, factor loading values, and heterogeneous-monomorphic correlation ratios (HTMT) were used for the test of differential validity.The Fornell-Larcker criterion states that the square root of the average validity value of each construct should be greater than its correlation with the other constructs (Hair et al. (Hair, 2012; Vinzi, 2010). The results of the study showed that the AVE values of each construct were lower than their squared differences (Table 3).

Table 3 Fornell-Larcker Standard

	IPP	R&DC	TI
IPP	.905		
R&DC	.266	.838	
TI	.321	.582	.800

Source(s): Own work

The cross-loading method means that the factor loading of an indicator on the construct to which it belongs should be greater than the loading between that indicator and the other constructs in the model. (Chin, 1998) The values of the externally loaded indicators for each construct (shown in bold) were significantly higher than their cross-loadings on the other constructs, which demonstrates the validity of discriminant validity (Table 4).

Table 4 Cross-loading analysis

	IPP	R&DC	TI
LED	.887	.227	.273
LEL	.919	.242	.305
LLE	.909	.253	.292
rdc5	.213	.838	.492
rdc6	.189	.841	.483
rdc7	.229	.835	.474
rdc8	.257	.840	.501
ti10	.250	.491	.800
ti11	.274	.436	.799
ti12	.214	.438	.781
ti13	.287	.485	.819
ti14	.253	.471	.799

Source(s): Own work

Henseler et al. (2015) proposed HTMT to assess discriminant validity, where the HTMT value must be less than .90 to have discriminant validity. As can be seen in Table 5, the HTMT values for this study ranged between .303 and .676, which is less than .90, indicating good discriminant validity between the variables used for the measurement.The range of HTMT values meets the requirements for discriminant validity, indicating that the measurement tool used was able to accurately differentiate between the different concepts or constructs, and thus effectively assessed the relationship between the potential variables involved in the study.

Table 5 Heteroskedasticity-Univariate Variance Ratio (HTMT)

	IPP	R&DC	TI
IPP			

R&DC	.303	
TI	.366	.676

Source(s): Own work

Structural Model Assessment

The Problem of Covariance

In the model validation process, covariance must first be eliminated. Multicollinearity is usually tested by the variance inflation factor VIF. A variance value greater than or equal to .2 and a VIF value less than or equal to 5 implies that there is no covariance problem between the indicators (Hair et al., 2011). Table 2 shows that the VIF values in this study ranged from 1.863 to 2.948, all of which were greater than .2 and less than 5. Therefore, the covariance problem did not negatively affect the path coefficients of the structural model in this study.

Structural Modelling Relationships

In this study, the bootstrap algorithm in PLS was used to calculate the path coefficient (β) and t-statistic to test the correlation between the independent and dependent variables. Here 5000 bootstrap samples were used to determine the significance of path coefficients. From the results in Table 6, there is a direct positive correlation of IPP on TI (t=3.282,β= .179, p< .001), IPP on R&DC (t=4.961, β= .266, p< 0.001) and R&DC on (t=3.282, β= .534, p< .001). Therefore, H1 and H2 are supported, i.e., higher IPP and R&DC have a significant effect on TI.

Table 6 Bootstrapping results and effect sizes for structural model assessment (f2)

Hypothesis	Relationship	β	t-value	p-value	f2	Decision
H1	IPP→ TI	.179	3.282	.001	.047	Supported
H2	IPP→R&DC	.266	4.961	.000	.076	Supported
	R&DC→TI	.534	9.267	.000	.420	

Source(s): Own work

To measure successful mediation effects, the following steps must be determined: first, the direct effect without mediation is significant; second, the indirect effect of mediation is significant if the previous conditions are met (Hair et al., 2012). As shown in Table 6, the results indicate that there is a significant effect of R&DC on TI through the mediating effect of R&DC (t=9.267, β= .534, p<0.001). This result supports H2. In addition, the researcher estimated the variance accounted for (V.A.F.) to determine the magnitude of the mediating effect, where VAF > .8 indicates full mediation, .2 ≤ VAF ≥ .8 indicates partial mediation, and VAF < .2 indicates no mediation. Thus, the results indicate that R&D (VAF= .597< .8) partially mediates the relationship between IPP and TI (Table 7).

Table 7 Mediation effects test

Hypothesis	Independent variable	Mediating variable	Dependent variable	Direct effect	Indirect effect	Total effect	VAF	Decision
H2	IPP	R&DC	TI	.266	.142	.321	.597	Partial

Source(s): Own work

Notes: bootstrapping (n = 5000).

Coefficient of Determination (R2)

Researchers Hair Jr et al. (2010) et al. showed that R2 has three critical values of .25, .5, and .75, which reflect the strength of the explanation, representing weak, moderate, and strong, respectively.R&DC (R2 = .071) and TI (R2 = .369) both represent weak (Table 8).

Table 8 Coefficient certainty (R2) and predictive relevance (Q2)

	R-square	R-square adjusted	Q2
R&DC	.071	.069	.048
TI	.369	.366	.230

Source(s): Own work

Effect Size (f2)

Effect size (f^2) is a statistical measure of the extent to which the path effect explains the variance of the dependent variable in a structural equation model, providing a relative measure of the explanatory strength of the model. According to the principle of f2 value assessment (Chin, 1988) when $.02 < f2 \leq .15$, it is a small effect; when $.15 < f2 \leq .35$, it is a medium effect; and when $f2 > .35$, it is a large effect. the effect of IPP on TI (f2 = .047) was moderate. In addition, R&DC (f2 = .420) had a large effect on TI (Table 6).

Predictive Relevance (Q2)

The Stone-Geisser test (Q2) is a test that measures the extent to which the model and its parameters affect the observations. The step of generating Q2 values is performed in PLS-SEM through a blind procedure. As a relative measure of predictive relevance, Q2 values of .02, .15, and .35 indicate that the exogenous constructs have small, moderate, or large predictive relevance (Chin, 1988). The results showed that R&DC (Q2 = .048) had small explanatory power and TI (Q2 = .230) had medium explanatory power (Table 8).

DISCUSSION AND IMPLICATIONS

Discussion

In this study, we delve into the impact of intellectual property protection on the green technology innovation of enterprises in Sichuan Province and conduct an empirical analysis based on two core hypotheses. First, we hypothesise that IPR protection can effectively drive enterprises' green technological innovation; second, IPR protection improves enterprises' green technological innovation by enhancing their R&D capabilities. Next, we will discuss these two hypotheses in detail.

Firstly, regarding the hypothesis that intellectual property protection can effectively drive enterprises' green technology innovation, our research results show that strong intellectual property protection can indeed promote the enthusiasm of enterprises' green technology innovation in Sichuan Province. This is because the protection of intellectual property rights not only provides enterprises' innovation with legal protection and reduces the risk of infringement of their innovations, but also enhances their confidence in innovation. This is consistent with Cui (2019) and Chen, Sun & Wang (2023), among others. Under such an environment, enterprises are more willing to invest resources into the research and development of green technologies in order to pursue higher market competitiveness and environmental benefits.

Second, the hypothesis that intellectual property protection improves enterprises' green technology innovation by enhancing their R&D capabilities is supported by our study. We find that the strengthening of intellectual property protection makes enterprises pay more attention to the construction of R&D capabilities, and continuously improve their R&D level by introducing and cultivating talents and increasing R&D investment. The enhancement of these capabilities not only directly promotes the quantity and quality of enterprises' green technology innovations, but also makes enterprises maintain a leading position in the field of green technology. The research views of Wu & Tang (2016) and Ma, Liu & Jiang, (2014) are consistent with this paper.

In summary, intellectual property protection plays an important role in promoting green technological innovation of enterprises in Sichuan Province, and improves green technological innovation of enterprises by enhancing their R&D capabilities.

Theoretical Implications

Deepening the Understanding of the Relationship between Intellectual Property Protection and Innovation

The theoretical discussion in this paper helps to deepen the understanding of the relationship between intellectual property protection and innovation. By specifically analysing the impact of intellectual property protection on the R&D capability of enterprises, as well as the relationship between the R&D capability of enterprises and green technological innovation, this paper reveals the important role of intellectual property protection in promoting green technological innovation. This not only enriches the theoretical connotation of the relationship between intellectual property and innovation, but also provides new perspectives and ideas for subsequent research.

Providing theoretical support for green technological innovation in Sichuan Province

As an important economic province in western China, Sichuan Province is facing the double challenges of transformation and upgrading, and green development. The theoretical discussion in this paper provides theoretical support for green technological innovation in Sichuan Province. By revealing the important role of intellectual property protection in promoting green technological innovation, this paper provides theoretical basis and decision-making reference for the formulation of relevant policies in Sichuan Province. At the same time, the research results of this paper are also applicable to the practice of green technological innovation in other regions, which has certain universality and promotion value.

Promote the Development of Green Technology Innovation Theory

Green technology innovation is one of the important directions of science and technology development in today's world. The theoretical discussion in this paper helps to promote the development of green technology innovation theory. Through in-depth analysis of the role of intellectual property protection in green technological innovation, this paper reveals the intrinsic connection and interactive relationship between intellectual property protection and green technological innovation. This not only enriches the content system of green technology innovation theory, but also provides a new research direction and ideas for subsequent research.

Management Implications

Creation of an Innovative Atmosphere

Intellectual property protection helps to create a cultural atmosphere of respecting innovation and encouraging innovation within the enterprises' innovation. When employees realise that their innovations will be fully protected and reasonably rewarded, they are more willing to share their creativity and ideas, thus promoting the enterprises' innovation ability as a whole.

Transformation And Application Of Innovation Achievements

Intellectual property protection not only protects innovation achievements, but also provides legal support for the transformation and application of the achievements. This helps enterprises to better transform their R&D results into actual products or services, thus enhancing their market competitiveness.

Formulation And Implementation Of Innovation Strategies

Under the background of intellectual property protection, enterprises' innovation strategies can be more clearly planned. Through in-depth analysis of market demand, combined with their own technological advantages, enterprises' innovation plans can be formulated in a more targeted and forward-looking manner, so as to take

the lead in future market competition.

In summary, intellectual property protection has a profound impact on the management of green technology innovation of Sichuan enterprises. It not only optimises enterprises‘ R&D investment decisions, motivates and stabilises R&D teams, but also creates a positive innovation atmosphere, promotes the transformation and application of innovation results, and helps enterprises' innovation strategies to be formulated and implemented more effectively. Therefore, strengthening intellectual property protection is an indispensable and important part of promoting green technological innovation among enterprises in Sichuan Province.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Firstly, intellectual property protection plays a crucial role in promoting green technological innovation of enterprises in Sichuan Province. Effective intellectual property protection can not only provide legal protection for enterprises' innovations to ensure that they are not illegally copied or abused, but also punish infringement through legal means and maintain fair competition in the market. This protection mechanism significantly reduces the risks faced by enterprises' innovation in green technology, thus incentivising enterprises to invest more actively in R&D resources to promote the innovation and development of green technology.

Secondly, intellectual property protection improves the level of green technological innovation by enhancing the R&D capability of enterprises. With the support of the intellectual property protection system, enterprises can focus more on R&D activities and continuously improve their R&D capability through technology accumulation and innovation practice. The enhancement of this R&D capability not only helps enterprises develop more efficient and environmentally friendly green technologies, but also enables enterprises to maintain a leading position in market competition and achieve sustainable development.

In summary, intellectual property protection is an important driving force to promote green technological innovation of enterprises in Sichuan Province. By strengthening the construction of intellectual property protection system and improving the R&D capability of enterprises, it can effectively promote the development of green technological innovation of enterprises and make positive contributions to the sustainable development of Sichuan Province and even the whole country.

LIMITATIONS AND FURTHER RESEARCH

Limitations

Sample Limitation: this paper may be limited by the number and representativeness of samples when analysing the relationship between green technology innovation and intellectual property protection of enterprises in Sichuan Province. Due to the difficulty of data acquisition and the limitation of sample selection, it may not be able to fully reflect the actual situation of all enterprises in Sichuan Province.

Variable Control: when exploring the impact of intellectual property protection on green technological innovation, it may be affected by other uncontrolled variables. For example, the financial situation of enterprises, market environment, policy environment and other factors may have an impact on green technology innovation, and this paper may not be able to fully control these variables in the study.

Causality Explanation: although this paper assumes that intellectual property protection can effectively drive enterprises' green technological innovation, there may be complexity of causality in the actual analysis. For example, enterprises may strengthen intellectual property protection because of the need to improve the level of green technological innovation, rather than intellectual property protection directly leading to green technological innovation.

Further Research

Expanding The Sample Scope: In order to have a more comprehensive understanding of the impact of IPR protection on the green technological innovation of enterprises in Sichuan Province, future research can

expand the sample scope to include more enterprises and industries, so as to improve the representativeness and universality of the study.

Controlling More Variables: in the follow-up study, other variables that may have an impact on green technology innovation should be more carefully considered and controlled to improve the accuracy and reliability of the study. For example, the relationship between the financial status of enterprises, the market environment, the policy environment and other factors and intellectual property protection and green technological innovation can be further studied.

In-Depth Research On Causality: In order to more accurately understand the causality between intellectual property protection and green technological innovation, future research can adopt more rigorous causality inference methods, such as causality inference models, time series analysis, etc., in order to reveal the real relationship between the two.

Cross-Regional Comparative Research: Considering that there may be differences in the level of economic development, industrial structure, policy environment and other factors in different regions, future research can carry out cross-regional comparative research to explore the differences and commonalities between different regions in terms of intellectual property protection and green technological innovation, so as to provide scientific basis for the formulation of more effective policies.

In-Depth Analysis of The Internal Mechanism of Intellectual Property Protection: future research can further analyse the internal mechanism of intellectual property protection, such as the patent examination system, infringement compensation mechanism, etc., in order to reveal how these mechanisms affect the R&D motivation and innovation ability of enterprises, and then put forward targeted optimisation proposals.

In conclusion, although this paper has achieved some results in the process of exploring the role of intellectual property protection in promoting green technological innovation of enterprises in Sichuan Province, there are still some limitations. Future research should further overcome these limitations and deepen the understanding of the relationship between intellectual property protection and green technological innovation, so as to provide strong support for the promotion of green technological innovation and sustainable development in Sichuan Province and the whole country.

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