

The mediating effect of the innovation ecosystem in the relationship between Corporate Social Responsibility and Innovation Performance of the Testing, Inspection, and Certificate (TIC) enterprises in China

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ABSTRACT

Nowadays, innovation is the first driving force leading development in China. while most of TIC enterprise develop in growth stage, innovation and resource acquisition from external and internal ecosystem are very important for TIC industry. Several theory including stakeholder theory, ecosystem theory and resource-based theory were depended on in this study. The investigation was conducted through a sample size survey. The analysis was carried out considering a representative sample up to 97 TIC enterprises of variety industries. The tool of Partial Least Square-Structural Equation Modeling (PLS-SEM) was applied to assess the model and hypothesis test.

The path analysis indicated that CSR have positive relationship with TIC Innovation performance. Additionally, it also found that the findings innovation ecosystem had a partial mediating effect on the relationship between CSR and innovation performance. The study quite consolidates the ideology that TIC should build good relationship among stakeholders form ecosystem' perspectives. The implication indicate that TIC enterprise should make good use of all kinds of resource in ecosystem with interaction with all kinds of stakeholders. In addition, we have also discussed the limitations and future research perspective

1. Introduction

Innovation is the first driving force to promote development. China regards innovation drive as an important strategy for economic transformation and development and building a modern powerful country. According to the report of global innovation index 2019 (WIPO, 2019), China has become one of the 15 most innovative economies in the world. In recent years, the annual composite growth of Chines Testing, Inspection and Certificate (TIC) industry is 10%-15%, which is about 1.5-2 times of GDP growth in China. TIC industry, also called the third-party testing industry, which is a third party outside the interests of sale and implement activity in accordance with relevant laws, standards or contracts. The third-party testing industry includes three categories: testing, inspection and certification. TIC is abbreviation of Testing, Inspection and Certificate.

Based on the statistical report of national inspection and testing service industry in 2020 (SAMR, 2021), there are 48,919 inspection and testing institutions in China, an increase of 11.16% compared with the previous year. The annual operating income reached 358.592 billion yuan, along with an increase of 11.19% over 2019. In 2020, the annual revenue of private inspection and testing institutions was 139 billion yuan, with increase of 18.44% over 2019 that higher than the stated TIC enterprises. But unfortunately, in comparison of the revenue of 456 foreign TIC enterprises which account for the 30%, greatly exceed the amount of local TIC enterprises. In terms of the number of patents, the national inspection and testing institutions have 86,944 valid patents, with an average of 1.78 per institution, and their innovation ability is weak (SAMR, 2021).

To comply with the customer requirement and standard, it is the essence for the TIC industry. However, with the increasingly fierce competition in the TIC industry and the continuous emergence of quality and safety accidents, such

as

inaccurate test data and even false testing, cause a crisis of trust in TIC enterprises to society. In the absence of public trust, the survival and maintenance of test enterprises has become quietly difficult, let alone innovation and development. Therefore, the local TIC enterprises have to confront the rough situation that how to win the public trust and become more competitive in the market, especially compete with foreign TIC entity. As TIC industry is a very fragmented industry, TIC enterprises will gradually also adopt alliance, merger and reorganization and other means to achieve the effect of abnormal convergence of resources and expansion of capital integration under the government support so as to enhance their advantages in market competition.

In order to survive and develop, enterprises must seek new breakthroughs, establish purposeful relations with other stakeholder groups in the system, and achieve win-win results on the basis of resource sharing and complementary advantages (Li et al., 2014). The innovation ecosystem emphasizes the trinity of "open", "cooperation" and "innovation". It is a spiral evolution process, which can form an effective coupling between information and technology among economic entities and finally realize collaborative innovation among enterprises (Ceccagnoli, Forman, Liang, 2014; Corsaro, Cantu & Tunisini, 2012).

Thus, this study aimed to study the influence of the CSR on innovation of the TIC enterprise from the ecosystem perspective. In the current era of rapidly changing and highly competitive big data, TIC enterprise innovation is always considered as risky, uncertain and challenging activity. How to make TIC enterprises break through the inherent and closed innovation system, seek cooperation with stakeholders, integrate innovation resources and improve their innovation performance is the core problem that TIC enterprises need to solve urgently. Corporate social responsibility represents the needs of all stakeholders related to the enterprise. From this perspective, corporate social responsibility obviously becomes a new breakthrough in TIC enterprise innovation. Taking active social responsibility can stimulate enterprises to carry out a series of innovation activities to meet these needs, thus promote the innovation of the enterprise. This study aimed to observe the profile of TIC industry and impact mechanism of social responsibility of TIC enterprises on their innovation performance from the perspective of innovation ecosystem. Namely, we also illuminated the implication to practice, theory, and future research.

2. Theoretical Background

2.1. Relationship between corporate social responsibility and innovation performance

Based on the theory stakeholder theory (Freeman, 1984), research and development within TIC enterprises cannot meet the needs of innovation activities. The innovation activities of enterprises are gradually transformed from traditional manufacturers to manufacturing enterprises, scientific research institutes, suppliers, vendors, governmental administrator and other stakeholders (Grindley & Teece, 1997). Resources are essential factors for enterprises to maintain competitive advantage (Collins, 1994). He, Chakrabarty & Eden (2016) indicated that heterogeneous resources obtained from stakeholders are also important to the improvement of innovation performance. The premise of establishing good cooperation with stakeholders is to obtain the trust of stakeholders and fully meet the requirements of stakeholders. CSR represents the needs of all stakeholders related to the enterprise (Kang, 2019). Therefore, it is responsible for the stakeholders to meet the needs of stakeholders, and the stakeholders participate in the reorganization and utilization of internal and external resources of the enterprise and achieve win-win results on the basis of resource sharing and complementary advantages, so as to effectively improve innovation performance (Kang, 2020).

TIC enterprise undertakes the social responsibilities of products and services, shareholders and creditors, employment and workers' rights and interests, TIC service supply chain, environmental protection, charity and public welfare (Kang, 2020). It has mainly built a mutually beneficial innovation ecosystem with scientific research institutes, demanders, upstream and downstream enterprises and the government. After enterprises have more external resources, they need to establish internal resource reorganization and create new resources. Internal integration and creation can help enterprises update their innovative ideas and understanding (He et al, 2016) also make the best strategic choice (Danneels, 2008), and enhance resource flexibility and coordination flexibility (Wen & Zhou, 2014), which are conducive to promoting enterprise innovation, the synergy and symbiosis between TIC enterprises and other subjects of innovation ecosystem, so as to enable enterprises to have higher innovation performance.

To fulfill the social responsibility of TIC enterprises to shareholders and creditors is to ensure the interests of shareholders and creditors. Firstly, the essence of an enterprise is the aggregation of contracts, and value creation is the goal of the survival and development of the enterprise. Secondly, the continuous cooperation relationship between TIC enterprises and shareholders and creditors should be fulfilled at the same time, which will be beneficial to enterprise financing. Among the similar enterprises with good corporate social responsibility activities, institutional investors pay more attention to those enterprises with strong sense of social responsibility and tend to invest (Lei & Wang, 2012), because the more active such enterprises undertake social responsibility, the more they can attract more institutions to invest in them, and the higher the holding of shares by institutions. At the same time, it is also likely to attract the attention of overseas investment institutions with strong strength (Duan & Li, 2014). In short, loose financing conditions are very beneficial to promote the capital turnover of enterprises, especially in innovation. The entry of investment

institutions can also better strengthen the supervision of relevant testing laboratory quality management and improve their management level and innovation level. TIC enterprises should actively fulfill their social responsibilities for employment and workers' rights and interests. On the basis of the above discussion, we developed our hypothesis as follows.

H2: Corporate Social Responsibility of shareholders and creditors of TIC enterprises has positive relationship with innovation performance.

TIC enterprises should actively fulfill the social responsibility of employment and workers' rights. Firstly, the social responsibility of TIC enterprises to employees is positively correlated with the overall satisfaction of employees to the enterprise and the return of employees to work. The higher the level of social responsibility of employees, the easier it is for enterprises to attract high-level talents and store human capital for enterprise innovation (Turban & Greeting, 1997). TIC enterprises are knowledge intensive enterprises. In the era of knowledge economy, talents are one of the most important resources of TIC enterprises. Secondly, TIC enterprises that actively fulfill their social responsibilities and have a high level of social responsibility have excellent corporate culture such as honest operation, positive progress and strong sense of responsibility, which will affect employees' outlook on life and values and have a positive impact on the construction of social spiritual civilization. When choosing a career, excellent talents will choose a career that can make them devote themselves to and realize value (Kim, Brodhag and Mebratu., 2014). A respected enterprise with a sense of social responsibility is certainly easier to recruit and retain excellent talents and will save management costs and training costs for the enterprise. Finally, TIC enterprises can effectively maintain social stability by absorbing labor employment, which not only promotes the harmonious progress of society, but also contributes to the construction of a good macro environment for enterprise innovation and development, so as to promote the innovation and development of enterprises and improve the innovation performance of enterprises. Link and Naveh (2006) also indicate that ISO14001 benefit firms to increase the positive effect of their business activities on the environment as well as improving their business performance. therefore, the following hypothesis of employment and workers' rights on innovation performance was proposed.

H3: Corporate Social Responsibility of employment and workers' rights of TIC enterprises has positive relationship with innovation performance.

To fulfill the social responsibility of the supply chain, like instrument and spare consumer suppliers who influence the quality and efficiency of testing of TIC enterprise. TIC enterprises should be based on long-term cooperation and strive to build a strategic partnership of mutual trust, mutual benefit and win-win with upstream and downstream partners. By fulfilling the social responsibility of the supply chain, enterprises gain mutual trust and interdependence between the two sides, and the degree of information and technology sharing between them is very high, so as to give full play to their respective advantages and specialties, carry out cooperative innovation, obtain new technical knowledge, optimize development and production processes, and save product development time and cost, reduce the risk and cost of technical standard development and improve innovation performance(Chen & Zhang,2016).

The social responsibility of TIC enterprises and the development of enterprises themselves are unified and mutually promoted. Corporate social responsibility is a win-win strategy, and an important way for TIC enterprises to create competitive advantage in the future and improve innovation performance. Only when the social responsibility is integrated into the innovation and development process of the enterprise, the innovation and development of the enterprise is beneficial to the public, the environment and the whole society, and will be respected and supported by the society (Khanna & Brouhle, 2009).Based on the above discussion, the following hypothesis is put forward in this paper. H4: Corporate Social Responsibility of the supply chain of TIC enterprises has positive relationship with innovation performance.

2.2 Mediating effect of innovation ecosystem on the relationship between social responsibility of TIC and innovation performance

Based on the innovation ecosystem (Adner, 2006) and resource-based theory (Wernerfet,1984), the support of innovation ecosystem plays an important role in the process of innovation, while the performance of corporate social responsibility plays a significant role in promoting the support of innovation ecosystem (Yang, 2014). Heterogeneous resources are the key to the growth of enterprises, and these heterogeneous resources are mainly external resources identified, obtained and integrated through the innovation ecosystem (Xu, Shi & Wu, 2011). It has increasingly become an important way for TIC enterprises to obtain resources with competitive advantages and improve their own innovation performance through external innovation ecosystem. On performing their social responsibilities, TIC enterprises can maintain real-time information communication with external systems, break through the original dominant logical constraints, and it is easier to form flexible resource requirements and more conducive to the formation of flexible organizational structure (Kang, 2019). These impacts will help enterprises strengthen the network strength with the external ecosystem, help to obtain the required flexible resources for enterprise innovation activities, promote

enterprises to identify innovation opportunities contained in the external system, and promote the collaborative cooperation, symbiosis and upgrading among enterprises, enterprises and other entities in the innovation ecosystem (Huggins, 2012). In other words, corporate social responsibility is conducive to enterprises' easier access to the support of innovation ecosystem.

TIC enterprises fulfill their CSR and enhance their enterprise innovation performance by the opportunity to obtain the support of innovation ecosystem. According to the division of the dimensions of corporate social responsibility variables and the variable composition of innovation ecosystem support, this paper puts forward research hypotheses from the mediating effect of resource acquisition.

TIC enterprises obtain the heterogeneous resources needed for enterprise development by fulfilling their social responsibilities. TIC enterprises highly fulfill the social responsibility of employment, which helps to stimulate the enthusiasm, enthusiasm, creativity and potential of employees, and attract more excellent talents. Human resources are one of the key elements of innovative activities. TIC enterprises fulfill the social responsibility of suppliers. Suppliers will regard enterprises as high-quality customers. Maintaining a good relationship between enterprises and suppliers can increase mutual trust, reduce costs, and even help companies obtain cutting-edge technology at the first time, thus increasing the market social capital of enterprises. To fulfill the social responsibility of environmental protection, tic enterprises strive to respect, care for and protect nature, and make scientific and rational use of natural resources.

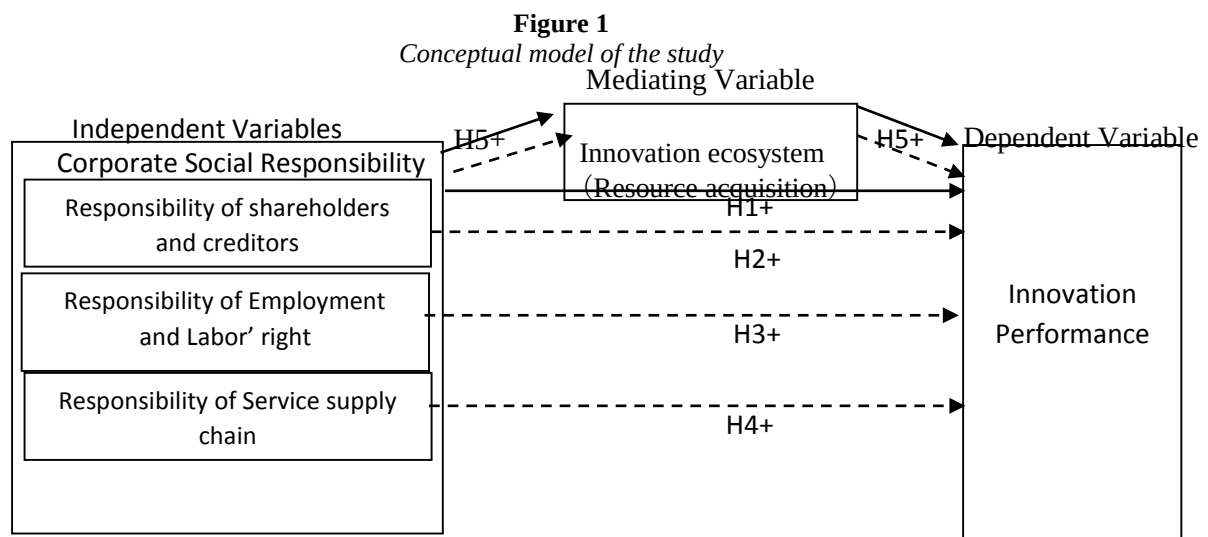
Thus, the innovation resources of TIC enterprises can be obtained from the innovation ecosystem including consumers, supply chains, scientific research institutions, governments, financial institutions and other members. While fulfilling their social responsibilities, TIC enterprises should speed up the construction of mutually beneficial external relationship networks and form a continuous interactive relationship with the subjects in the network, so as to make it easier to obtain innovation resources from these members (Chen & Zhou, 2018). The performance of social responsibility can optimize and expand the stakeholder relationship network of enterprises and build a platform for enterprises to obtain innovative resources. At this time, enterprises can continuously obtain valuable resources from the stakeholder network at a lower cost and enhance their ability to obtain innovative resources (Wang & Peng, 2010). Furthermore, the higher dynamic ability will improve the quantity and quality of enterprises to obtain innovative resources and bring more valuable resources for enterprises. In conclusion, enterprises with social responsibility can build a wide and high-quality external relationship network with members of main sources of innovation resources, and then improve their ability to obtain innovative resources from external networks. Therefore, enterprises can enhance their ability to obtain external innovation resources from innovation ecosystem by taking social responsibility.

Based on the above discussion, this paper puts forward the following hypothesis:

H5: Innovation ecosystem mediates the relationship between TIC corporate social responsibility and innovation performance.

3. Prepare Conceptual Framework

This paper aimed to identify the antecedents that influence innovation performance of the TIC enterprise and examine the theoretical relationship of Shareholders and creditors' responsibility, supply chain responsibility, employment and employee's right and resource acquisition to innovation performance in TIC industry context from the perspective of innovation ecosystem as presented in Figure 1.



4. Methods

Sample and Procedure

This paper used a questionnaire to obtain first-hand data. In this paper, a business survey research procedure was utilized as this approach supports and provides standardized information to define the variables and assess the relationships between variables (Malhotra & Grover, 1998).

The questionnaire design was finished after the consult of some experts and high executive managers in TIC industry, and validity data test with SPSS version 26 and Smart PLS version 4.0.8.3 (www.smartpls.com) tools.

The questionnaire was distributed to one senior manager of TIC enterprises, like the CEO, Director, General Manager, Deputy General Manager, for they better understand the business status, innovation activities, corporate social responsibility and the concept of innovation ecosystem. The whole process of questionnaire survey and recovery in this paper took one and a half months, from August 18, 2022 to September 28, 2022. A total of 140 questionnaires were distributed in this survey, 97 of which were recovered, with a recovery rate of 70%. The amount of 97 questionnaires were valid, with an effective rate of 100%. The demographic attributes of the data are shown in Table 1.

Table 1 *Characteristic distribution of sample enterprises*

Respondent's Profile Attributes	Categories	Frequency	%
Gender	male	66	68
	female	31	32
Age	26-30 years old	2	2.1
	31-40 years old	34	35.1
	41-50 years old	53	54.6
	51 years old and above	8	8.2
Education	Doctor	4	4.1
	Master	31	32
	Bachelor	53	54.6
	Junior college	9	9.3
service age	Less than 1 year	1	1
	1-5 years	21	21.6
	6-10 years	30	30.9
	11-15 years	34	35.1
	more than 16 years	11	11.3
Management	senior manager	55	56.7
	middle manager	39	40.2
	manager	3	3.1
Company age	0-4 years	10	10.3
	5-9 years	36	37.1
	10-14 years	24	24.7
	15-20 years	16	16.5
	more than 20 years	11	11.3
Firm Size	Below 50	12	12.4
	51-100	30	30.9
	101-500	36	37.1
	501-1000	8	8.2
	1000 and above	11	11.3
Industry	Inspection and Audit	15	15.5
	Metrology	13	16.5

Respondent's Profile Attributes	Categories	Frequency	%
Revenue	Food testing	30	30.9
	Environmental testing	63	64.9
	Construction testing	14	14.4
	Automobile testing	10	10.3
	Consumer goods testing	16	16.5
	electronic and electrical safety	17	17.5
	Below 500	7	7.2
	500-3000	26	26.8
	3000-10000	29	29.9
	10000-30000	15	15.5
	30000 and above	20	20.6
Technology center level	District level	6	6.2
	Municipal Level	27	27.8
	Provincial Level	49	50.5
	National Level	15	15.5

The questionnaire includes 26 measurement items. For the TIC enterprises are required to register in the local government supervision platform, the address information can be accessible. The measurement items of the scale were set with a few of closed-ended questions, which were measured by Likert's 5-level scale. This paper developed the research instrument using measurement scales identified from previous studies, as presented: 5 = "very agree", 1 = "very disagree" and the degree of agreement gradually weakens from 5 to 1.

This article used a stakeholder-based approach to measure CSR perception suggested by Turker (2009), including 13 items grouped into 3 dimensions: Shareholders and creditors' responsibility (SCR), Employment and labor rights and responsibilities (EL), Service for Supply Chain responsibility (SSC). Innovation ecosystem (ESI) concept was measured by adapting 6 items from Zhou & Wang (2014). A sample item of innovation performance (IP) including 7 items was measured by questions adapted by Yan & Luo (2018).

4.1 Data Analysis and RESULTS

The sample characteristics mainly focus on descriptive statistical analysis of the TIC enterprise age, size, industry distribution and other indicators of the research sample TIC enterprises to describe the composition and distribution of the sample enterprises. The result of the descriptive statistical analysis for the survey, of which can be found as follows.

For management level of respondent, the middle and senior management accounted for 97% of the survey sample, of which 57% were senior managers, indicating that the management positions of the respondents were relatively high, in compliance with the purpose and design requirements of the survey.

For Firm established age, the time of establishment of TIC enterprises is less than 72% of all respondents in 10 years, 16.5% in 10-15 years, and 10.3% in more than 15 years. The development of TIC enterprises in China is not yet mature. Thus, the development of TIC enterprises is still in the growth stage.

In line with the survey on the employee number and scale of TIC enterprises, which is found that the number of enterprises with less than 500 people account for 91.8% and the scale of the enterprises is relatively balanced. The enterprises are concentrated in the scale of 100-300 (31%) and 300-500 (37%) employees. TIC enterprises are still dominated by small-scale enterprises.

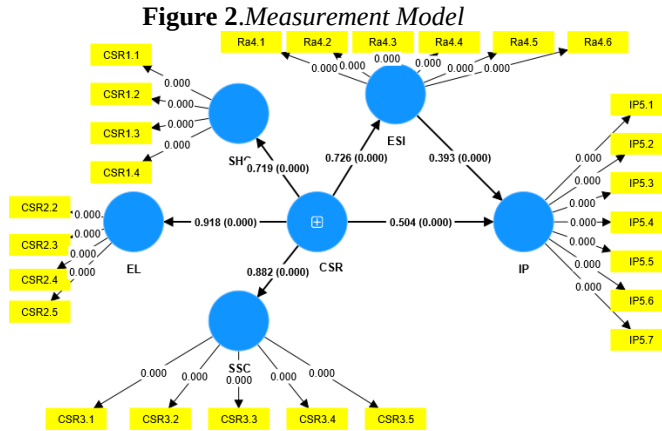
For the TIC industry, it is found that 65% of enterprises involved in Ecological environment testing, 31% in Food testing, 16.5% in Metrology, 15.4% in inspection and audit. Ecological environment testing took top in also report of SARM 2020. Some enterprises are involved in multiple fields at the same time, account for 30% in two fields, mainly focusing on the food and environment industry.

From the sample data, it is found that the revenue of 2021 TIC enterprises as follows: 7% of the enterprises below 5 million yuan, 27% of the enterprises between 5 million yuan and 30 million yuan, 30% to 100 million yuan, 15.5% of the enterprises between 100 million yuan and 300 million yuan, and 20.6% of the enterprises above 300 million yuan. Most of TIC enterprise's annual revenue is less than 100 million yuan.

Combined with the number, age of TIC enterprises, the TIC industry is dominated by small and medium-sized enterprises, while the number of comprehensive, large and powerful enterprises is rather small. The fragmentation characteristics of the TIC industry have not changed.

Measurement model

In this study, the measurement scales of corporate social responsibility, resource acquisition of innovation ecosystem and innovation performance were developed and designed, and then the survey data were collected, sorted out and analyzed. Firstly, we tested the reliability and validity of the research variable scale. Secondly, we combined with the theoretical model of the impact of corporate social responsibility on innovation performance, the statistical analysis was carried out with TIC enterprise survey data. Finally, PLS-SEM was used to verify whether the assumptions are valid and further analysis.



Note: CSR = Corporate social responsibility; SHC= Shareholders and creditors' responsibility; EL = Employment and labor rights and responsibilities; SSC = Service for Supply Chain responsibility; ESI = Innovation ecosystem (Resource acquisition); IP= (Innovation Performance).

The measurement model is widely used in deciding the relationship between the three dimensions CSR and their indicator of the research in Figure 2 Measurement Model.

The reliability and internal consistency of model is evaluated by CR, Cronbach's alpha and AVE. Model specified in this study has three constructs with reflective measurement models. The relationship between their latents and manifest variables need to be estimated. The outer loadings of all items used in this study are accepted. Table 2 reveals that the composite reliability (CR) value is 0.923 for CSR, 0.944 for Innovation ecosystem, 0.935 for Innovation Performance. This finding demonstrates that all variables have a satisfactory (above 0.70, Bagozzi and Yi (1988)) level of internal consistency reliability. Meanwhile, all of the average variance extracted value are above 0.5 proposed by Bagozzi and Yi (1988), the measures used in this study have a high level of convergent validity.

Table2 Measurement models

Construct	Item	Loading	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
CSR			0.918	0.923	0.930	0.509
SHC			0.917	0.923	0.941	0.801
	CSR1.1	0.886				
	CSR1.2	0.905				
	CSR1.3	0.866				
	CSR1.4	0.921				
EL			0.839	0.844	0.892	0.674
	CSR2.2	0.822				
	CSR2.3	0.829				
	CSR2.4	0.788				

	CSR2.5	0.845				
SSC			0.891	0.897	0.920	0.699
	CSR3.1	0.830				
	CSR3.2	0.744				
	CSR3.3	0.839				
	CSR3.4	0.940				
	CSR3.5	0.917				
ESI			0.944	0.946	0.955	0.781
	Ra4.1	0.864				
	Ra4.2	0.8766				
	Ra4.3	0.886				
	Ra4.4	0.901				
	Ra4.5	0.886				
	Ra4.6	0.891				
IP			0.935	0.939	0.948	0.723
	IP5.1	0.831				
	IP5.2	0.787				
	IP5.3	0.907				
	IP5.4	0.863				
	IP5.5	0.880				
	IP5.6	0.890				
	IP5.7	0.784				

Source: Own survey results

Discriminant validity is general measured with Cross-loading, or Fornell and Larcker criteria or HTMT criteria. As calculated via the SmartPLS4.0 software for questionnaire data, the results of Cross-loading (Table 3), Heterotrait-Monotrait (Table 4), Fornell & Larcker criteria and (Table 5) are follows.

For Cross loading (Table 3), the minimum value is 0.744 and the maximum value is 0.921, both of which can well reflect the implicit variables.

For the result listed in table 4, the values all are less than the threshold value (0.90), which is the HTMT criterion for discriminant validity recommended by Henseler et al. (2015). Thus, Table 4 indicates accordance with criteria of HTMT.

In addition, for the result of table 5, the square root of the AVE of each construct is more than its correlation with other constructs, discriminant validity is established accordingly, based on the Fornell and Larcker criteria suggested by Hair et al. (2017).

Table 3 *Evaluation of Structural models by Cross loading*

Item	EL	SHC	SSC	ESI	IP
CSR1.1	0.395	0.886	0.316	0.494	0.476
CSR1.2	0.515	0.905	0.400	0.569	0.591
CSR1.3	0.423	0.866	0.248	0.455	0.441
CSR1.4	0.538	0.921	0.355	0.496	0.475
CSR2.2	0.822	0.717	0.637	0.650	0.721
CSR2.3	0.829	0.320	0.671	0.451	0.532

CSR2.4	0.788	0.337	0.582	0.571	0.515
CSR2.5	0.845	0.303	0.674	0.548	0.609
CSR3.1	0.548	0.218	0.830	0.441	0.560
CSR3.2	0.534	0.363	0.744	0.448	0.493
CSR3.3	0.741	0.366	0.839	0.443	0.596
CSR3.4	0.681	0.297	0.840	0.573	0.592
CSR3.5	0.732	0.308	0.917	0.568	0.653
Ra4.1	0.626	0.499	0.569	0.864	0.662
Ra4.2	0.593	0.559	0.526	0.876	0.666
Ra4.3	0.546	0.525	0.521	0.886	0.636
Ra4.4	0.679	0.579	0.580	0.901	0.740
Ra4.5	0.552	0.402	0.431	0.886	0.627
Ra4.6	0.594	0.412	0.506	0.891	0.680
IP5.1	0.596	0.412	0.625	0.593	0.831
IP5.2	0.612	0.403	0.558	0.690	0.787
IP5.3	0.635	0.514	0.645	0.636	0.907
IP5.4	0.645	0.461	0.564	0.658	0.863
IP5.5	0.701	0.591	0.621	0.716	0.880
IP5.6	0.590	0.449	0.589	0.686	0.890
IP5.7	0.560	0.470	0.529	0.513	0.784

Source: Own survey results

Table 4: Evaluation of Structural models by HTMT Criterion

	EL	ESI	IP	SHC	SSC
EL	--				
ESI	0.756	--			
IP	0.815	0.802	--		
SHC	0.577	0.601	0.596	--	
SSC	0.896	0.643	0.760	0.407	--

Source: Own survey results

Table 5: Evaluation of Structural models by Fornell–Larcker Criteria

	EL	ESI	IP	SHC	SSC
EL	0.821				
ESI	0.680	0.884			
IP	0.732	0.759	0.850		
SHC	0.527	0.565	0.557	0.895	
SSC	0.781	0.594	0.696	0.373	0.836

Source: Own survey results

Structural model

Through the reliability and validity test of the above scale construction, it showed that the test of the measurement model meets the requirements. The evaluation of measurement model was followed by evaluation of the structural model, with the tool of smart PLS. Both of the coefficient of determination R^2 and Effect size F^2 were used to evaluate and determine the structural model. As the result of R^2 show in table 6, according to the acceptable criteria on the values of R^2 Chin (1998b) and Sarstedt et al. (2017), the results of 0.512 and 0.689 for ESI and IP individually is considered the fulfillment of the structural model. The result in table 6 of the effect size F^2 for ESI and IP, which

show the effect size of ESI and IP. The value of F^2 for ESI and IP as 0.245 and 0.393, depicting the medium size and large effect size respectively according to Cohen (1998).

Table 6: Evaluation of Structural models by Coefficient R^2 , and F^2

Variables	Coefficient R^2	Adjusted R^2	F^2 (Effect Size)
ESI	0.512	0.507	0.245
IP	0.689	0.683	0.393

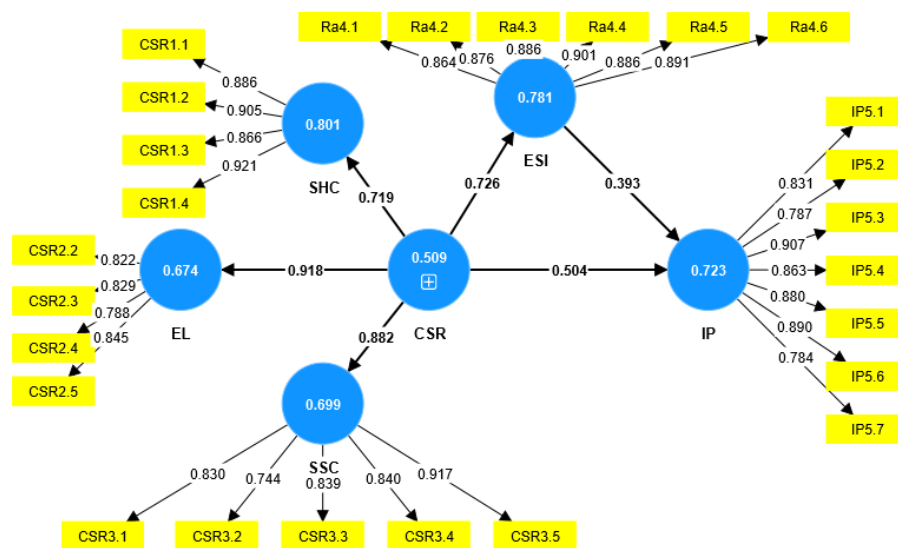
Source: Own survey results

Path Analysis

In general, the path coefficient is only meaningful when it is more than 0.1 can be accepted. From the path coefficient graph above, it can be seen that all implicit variables are positively correlated and the correlation coefficient results are ideal (Figure 3).

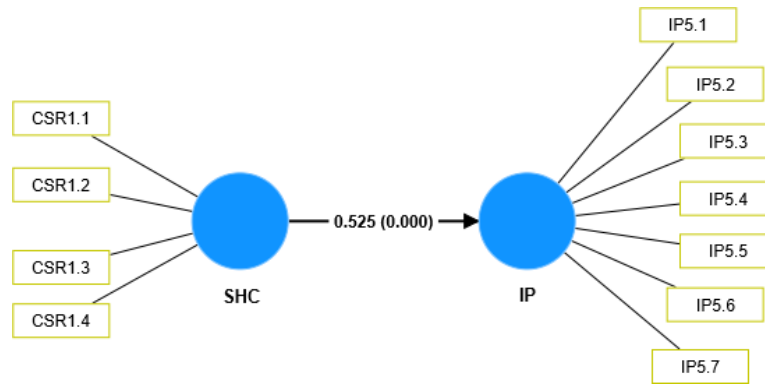
The previous article assumes that corporate social responsibility and innovation performance in the TIC industry have a positive effect. As far as the path coefficient is concerned, CSR has a strong positive effect on innovation performance. The path coefficient is 0.580, $T=5.375$, $P=0.000$, which supports the hypothesis H1 that TIC implementation CSR has a significantly positive impact on enterprise innovation performance.

Figure 3 Structural model



Test the hypothesis H2: Corporate Social Responsibility of shareholders and creditors of TIC enterprises has positive relationship with innovation performance.

Figure 4 SEM for Corporate Social Responsibility of shareholders and creditors and Innovation Performance

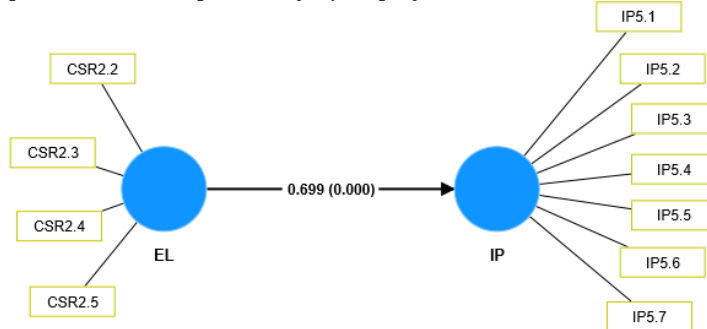


With SEM of structural equation model, inputted relevant data into SmartPLS 4.0 for calculation, and the final software calculation result is: the path coefficient of shareholders and creditors' responsibility on innovation performance is 0.525, $T=5.630$ and $P=0.000$. The output results show that Shareholders and creditors' responsibility has a strong positive impact on enterprise innovation performance. Therefore, it can be considered that the test results strongly support the research hypothesis H2.

Test the hypothesis H3: Corporate Social Responsibility of employment and workers' rights of TIC enterprises has positive relationship with innovation performance.

Using structural equation model SEM, input relevant data into the structural equation model analysis software SmartPLS 4.0 for calculation, and the final software output calculation result is: the path coefficient of employment and labor rights on innovation performance in corporate social responsibility is 0.699, $T=10.785$ and $P=0.000$ (see figure 5). The output results show that Employment and labor rights have a strong positive impact on enterprise innovation performance. Therefore, it can be considered that the test results strongly support the research hypothesis H3.

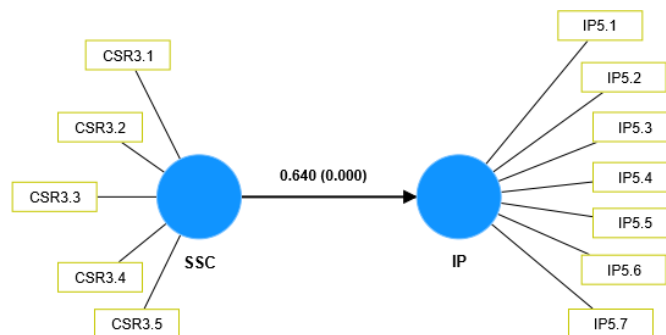
Figure 5: SEM for Corporate Social Responsibility of Employment and Labor and Innovation Performance



Test the hypothesis H4: Corporate Social Responsibility of the supply chain of TIC enterprises has positive relationship with innovation performance.

Service for Supply Chain responsibility on innovation performance in corporate social responsibility is 0.640, $T=10.342$ and $P=0.000$ which show that Service for Supply Chain responsibility has a strong positive impact on enterprise innovation performance (see figure 6). Therefore, it can be considered that the test results strongly support research hypothesis H4.

Figure 6: SEM for Corporate Social Responsibility of the supply chain and Innovation Performance



Mediation Analysis

The result of path analysis is provided in Table 7, after the direct effect of CSR on Innovation performance and indirect effect of ESI on the relationship between CSR and Innovation performance were determinate. Whereas the study also utilized the other mediating test method proposed by Hair et al. (2014), the variance accounted for (VAF) was also calculated and evaluated indirect effect. Based on the result in table 7, the path coefficient of indirect effect of ESI is resulted in 0.328 and direct effect of CSR to IP is resulted in 0.580, thus the total effect is 0.908. therefore, the VAF can be calculated as $0.328/0.908=0.361$. For the result of 0.361 lie in range between 0.20 and 0.80, partial mediation of ESI on the CSR and IP is determined, as suggested by Hair et al. (2017). H5 hypothesis is also supported obviously.

Table 7: Path analysis and hypothesis test

Structural Path	Direct/ Indirect effect	T statistics	P values	Conclusion
CSR -> ESI	0.946	8.781	0.000	
ESI -> IP	0.347	4.369	0.000	
CSR -> IP	0.580	5.375	0.000	H1 supported
CSR -> IP	0.909	11.664	0.000	
CSR -> ESI -> IP	0.328	4.161	0.000	H5 supported
SHC -> IP	0.525	5.630	0.000	H2 supported
EL-> IP	0.699	10.785	0.000	H3 supported
SSC-> IP	0.640	10.342	0.000	H4 supported

Source: Own survey results

4.2 Discussion

The current research examined the relationship between CSR and innovation performance in TIC industry. Five hypothetical relationships were proposed in this study, including H1, H2, H3, and H4 proposed TIC CSR have positive impact on the innovation performance variables, and H5 proposed the mediating role of resource acquisition of the enterprise innovation ecosystem in the impact of CSR on innovation performance. Empirical results indicate CSR and three dimensions of TIC CSR, like shareholders' and creditors' responsibilities, employment and labor' rights responsibilities, supply chain responsibilities, have the directly positive relationship with innovation performance, as suggested by other studies (Garcias, 2019; Luo and Du,2015; Kang,2019). Results shed light on that as the organization fulfill the social responsibility activity, TIC employees try to feedback the innovation performance by cooperation with coworker and stakeholders, therefore, supporting the stakeholder theory. Compared with Employment and labor rights responsibility and supply chain responsibility, shareholders' and creditors' responsibilities played less significantly positive effect on innovation performance, which is different from the findings in pharmaceutical industry (Kang 2020). Performing social responsibility for them can ensure that the enterprise has high-quality innovative talents and can also promote the supply chain to maintain a good long-term cooperative relationship with TIC enterprises, which will have an important impact on improving enterprise innovation performance (Dyer J H, Singh H., 1998). For different TIC industry, the empirical results indicate that CSR can indeed increase performance inconsistently, which is different from the previous study (Lin, Chang & Dang, 2015) showed that the direct effect of CSR on performance varies within different industry types.

In addition, in the mediating impact played by resource acquisition, the empirical test drew the following conclusions: resource acquisition in innovation ecosystem plays a partial mediator role in the relationship between CSR and enterprise innovation performance. Same result was found in other industries. Furtherly, the findings supported the hypothesis that innovation ecosystem (resource acquisition) mediate the relationship between CSR and Innovation performance. TIC enterprise is apt to be recognized and increase more resource which induce increase of innovation performance as they enhance more invests in CSR activities. This signified that the TIC enterprise attracted and utilized all kinds of resources from ecosystem which formed by employees, investors, suppliers, institute of government and academic research, then further leads to Innovation performance. the results are almost same as some other latent research papers on different industry (Adner et al.,2010; Boh, W. F., Huang, C.J., and Wu, A. 2020; Bagherzadeh et al., 2020). Above findings support the theory of resource-based theory, which seem that the resources included in ecosystem can be acquired by TIC as they perform the CSR activity and incentives with stimulation of asset and knowledge sharing and so on. Thus, promote innovation performance of TIC enterprises. TIC enterprises belong to knowledge, technology and information intensive enterprises. TIC enterprises in the innovation ecosystem

can find and obtain more innovative knowledge, information and funds from outside through multiple channels. With the cooperation of innovation entities, the circulation speed and utilization rate of resources in the system have been greatly improved, as well as the success rate of innovation. Namely, it was confirmed that the reasonable construction and effective use of the innovation ecosystem of TIC enterprises will benefit the improvement of innovation performance.

4. Conclusion

Corporate social responsibility has a positive impact on TIC innovation performance. TIC enterprises undertake social responsibility to promote innovation to meet the needs of stakeholders. The research results of this paper showed that the fulfillment of social responsibility by TIC enterprises promotes the innovation performance of enterprises. Due to the particularity of TIC industry, TIC corporate social responsibility was divided into three dimensions: shareholders and creditors, employment and workers' rights and interests, and service supply chain. The empirical results show that the three dimensions of corporate social responsibility have a positive impact on TIC improvement of enterprise innovation performance. Among them, the impact of shareholders and creditors on social responsibility is relatively small, and the impact of employment and labors' rights responsibility and TIC service supply chain responsibility is similar.

The innovation ecosystem resources acquisition have partial mediating role between CSR and Innovation performance. Ozcan and Eisenhardt (2009) believed that when enterprises cannot obtain valuable resources, strategic alliance can provide participants with the path to acquire valuable resources and create synergy effect to deal with uncertainty and risk. Cai and Hu (2006) also pointed out that the core resources sharing among participants can be realized through strategic alliance, and the competitive advantage can be obtained quickly by sharing core resources. Resource acquisition is the key aspect of innovation ecosystem's support for TIC enterprises' innovation, which refers to TIC enterprises' carrying out various innovation behaviors and obtaining the basic resources that are symbiotic with other innovation entities and innovation ecosystems.

This study on the relationship between CSR and Innovation Performance also have bring out theoretical contributions. Firstly, TIC enterprise innovation ecosystem based on talents, funds and information, with core TIC enterprises, supplier enterprises, seller enterprises, and associated enterprises that are supportive, complementary and competitive with core enterprises as the core, supported by universities, research institutions, governments, demanders, and intermediaries, can achieve efficient integration of heterogeneous innovation resources, and improve the innovation ability and level of TIC enterprises. For TIC enterprises that regard innovation as the lifeline, studying the influencing factors and mechanisms of innovation performance based on innovation ecosystem will theoretically help deepen the theory of innovation ecosystem (Moore,1993) and effectively connect with the theory of enterprise innovation. Secondly, this paper took stakeholder theory as the starting point, and constructed the path of corporate social responsibility - innovation ecosystem - innovation performance, which enriches the research content of enterprise innovation performance and provides a new perspective for subsequent research. At the same time, based on the resource perspective, it verified the intermediary role of resource acquisition in the relationship between corporate social responsibility and innovation performance, and expands the application scope of enterprise resource-based theory. Finally, this paper defines and divides the dimensions of corporate social responsibility for TIC enterprises.

Implications

This research exerted to explore the linkage of the CSR and innovation performance in TIC industry from ecosystem perspective, which was seldom related study on this filed. The business survey was used to gather the data from different industry of TIC enterprises in China, Through the quantitative test of TIC enterprise sample statistics, effective and valuable research results were obtained. The structural equation model examined the hypothesis and effect of their factor well.

The TIC industry has been developing in China for a short time, which is an emerging service industry. TIC industry is also a derivative of the rapid development of China's economy. It plays an important role in ensuring product quality, promoting fair trade and eliminating international fair trade. However, compared with other research, there is less recent research on the TIC industry. This paper studied the relationship between corporate social responsibility and innovation performance in the TIC industry from the perspective of innovation ecosystem perspective.

Regarding this study's implications for theory study, this research was carried out as per resource-based theory, ecosystem theory etc., in order to explore the influencing factors of TIC enterprise innovation performance and deeply analyze the relationship between them. Based on the resource theory, efforts invested in CSR activities can increase the resource acquisition, including capital, which consequently induces positives effects on performance (Lin, Tan & Zhao, 2015). The empirical results of this study on corporate social responsibility and corporate innovation

performance support the resource-based theory. It seems that the resource of capital and knowledge in innovation ecosystem are really consistent with the resource-based theory, which show that TIC enterprises need to integrate all the resource to enhance their performance (Bird et al., 2007). Only the party who have the ability to obtain resources can better survive Warren (2004), therefore, for enterprises, especially new enterprises, it is necessary to correctly handle the complex relationships with customers, suppliers, competitors, government agencies, financial institutions, industry associations, various intermediary service institutions such as accounting firms, law firms, and relatives, friends and acquaintances (Gibb, 1997) based on the stakeholder theory. Enterprises usually have limited initial resources at the initial development stage and need to rely mainly on external resources to meet their resource needs. However, some TIC enterprises make it more difficult for them to obtain external resources. This paper shed light on that innovation ecosystem has become the main way for TIC enterprises to obtain external resources at low cost, which plays a key role in the successful creation and growth of enterprises. Secondly, the paper deeply studied the mechanism of innovation ecosystem on enterprise innovation performance and its' impact mechanism and specifically measure the supporting role of innovation ecosystem in TIC enterprise innovation. This research also has relevant implications for practice seeking to improve their firm's innovation performance. Firstly, create a high-quality innovation ecosystem. In the innovation ecosystem, TIC enterprises should not only improve their innovation ability through internal innovation, but also form an ecosystem with upstream and downstream enterprises to cushion the impact of the external environment, so as to achieve the innovative development of enterprises. Therefore, TIC enterprises should speed up the construction of the innovation ecosystem and make full use of the resources of all parties in the system to promote the development of enterprises. Secondly, fulfill corporate social responsibility. The results show that TIC corporate social responsibility has a direct positive impact on corporate innovation performance through the support of innovation ecosystem. This shows that the fulfillment of social responsibility by TIC enterprises is an important source for enterprises to obtain favorable resources. Enterprises should establish a complete responsibility system, improve their internal awareness of social responsibility, and enhance their sustainable development capabilities. Finally, focus on improving resource acquisition ability.

Limitations and prospects

There are still some limitations in this study, which need to be improved in future research.

Firstly, based on the characteristics of TIC enterprises, combined with the existing research results, the measurement indicators of the main variables are selected. However, the TIC industry involves a wide range of fields, and there may be differences between fields. Whether the research value of this paper is applicable to a specific field needs further research, and later we can try to focus on a specific field.

Secondly, based on the integration of ecology and ecosystem theory, stakeholder theory and resource-based theory, this paper discussed the deep meaning of corporate social responsibility from the perspective of innovation ecosystem and divides the dimensions of TIC corporate social responsibility. In the future, research will integrate more disciplines and theoretical perspectives to understand the connotation of corporate social responsibility. Finally, this paper mainly discusses the mediating role of resource acquisition of innovation ecosystem, and whether there are other intermediary influencing factors, which is also worthy of further study in the future. In addition, due to the author's time and energy, this paper only reveals the path of corporate social responsibility to influence innovation performance through resource acquisition of innovation ecosystem.

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