Research on the Relationship Between Intangible Resources and Innovation Performance of Manufacturing Listed Companies in the Process of Internationalization

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Abstract

Against the backdrop of economic globalization and innovation-driven development strategies, this paper examines the relationship between three intangible resources, human resources, technological resources, and relational resources, and corporate innovation performance among China's listed manufacturing firms, as well as the moderating effect of internationalization on these relationships. Findings indicate that technological and relational resources positively influence corporate innovation performance, while internationalization exerts a positive moderating effect on these relationships. However, no significant impact was found between human resources and innovation performance, nor did internationalization moderate this relationship. These findings suggest that enterprises should prioritize technological and relational resources as critical strategic assets for development, while enhancing innovation performance requires integrating internal and external resources through holistic planning rather than relying solely on intangible resources and internationalization.

1. Introduction

In the context of economic globalization, an increasing number of Chinese manufacturing companies are deeply integrating into global industrial chains. From 2014 to 2018, manufacturing value-added grew steadily, with the sector continuing to play a vital supporting role in China's economic growth. The China Manufacturing High-Quality Development Report (2019) indicates accelerated progress in China's advanced manufacturing development. Represented by Gree, a group of national benchmark enterprises including Zhenhua Heavy Industries, Sinochem Group,

and CRRC Group have long become pioneers in China's high-quality manufacturing development through technological innovation and brand building.

Currently, many late-entrant enterprises in China remain at a long-term disadvantage in core technologies, with key technologies consistently controlled by foreign capital. Zhou and Li (2022) argue that under continuous innovation-driven pressure, late-entrants must proactively seek out available knowledge to achieve high-quality innovation. For enterprises, acquiring valuable scarce resources is crucial. Barney, Ketchen, and Wright (2020) contend that intangible resources are more important for achieving sustainable competitive advantage. The key to achieving innovative development for Chinese manufacturing companies lies in human capital and substantial R&D investment. Additionally, many companies face internationalization processes, with the Chinese government supporting and encouraging enterprises to engage in international operations. Hall and Oriani (2006) found that internationalization enables firms to acquire diverse knowledge and resources, thereby enhancing innovation performance. Despite rapid growth, China's manufacturing sector still lags behind developed economies in technological capabilities. Consequently, Chinese enterprises should actively seek and leverage additional resources and internationalization skills to accelerate innovation.

2. Literature Review

2.1 Intangible Assets

In the internet era, enterprises face transformation, and the primary drivers of business development are gradually shifting from tangible material resources to intangible resources. While classical theories such as Wernerfelt's (1984) resource-based view provide foundational understanding, recent research has expanded our comprehension of intangible resources in the context of digital transformation and global competition. Contemporary studies have refined the classification frameworks, emphasizing the dynamic nature of intangible resources in modern business environments (Rodrigues et al., 2021). The selection of human resources, technological resources, and relational resources as our focus is theoretically grounded in their distinct yet complementary roles in innovation processes. Human resources provide the cognitive capabilities and learning capacity essential for innovation, technological resources constitute the core knowledge base for product and process innovation, while relational resources facilitate access to external knowledge and market opportunities. This tripartite framework aligns with recent conceptualizations of intangible resources as interconnected systems rather than isolated assets.

Classifications of intangible resources vary. Dumay and Garanina (2021) categorize intangible resources by scope into internal and external resources, specifically including capability resources, inter-firm relationship resources, technological resources, cultural resources, institutional resources, information resources, and others. Guthrie, Ricceri, and Dumay (2022) classify them from management and asset operation perspectives, defining broad intangible resources as: goodwill, marketing relationship networks, information technology systems, organizational culture, strategic planning and policies, and human resources. Andriessen (2004) contends that the role of intangible resources has been amplified by evolving international environments. To enhance innovation performance, companies must fully leverage diverse intangible resources to sustain unique competitive advantages. While classifications vary, this paper focuses on three key categories:

human resources, technological resources, and relational resources.

2.2 Internationalization

With the advancement of economic globalization, Chinese enterprises are seeking advanced technological resources, capabilities, and knowledge in global markets. Recent research in emerging economies has demonstrated that internationalization serves as a critical mechanism for enhancing firms' absorptive capacity and knowledge base. Building on classical internationalization theory, contemporary studies have revealed how firms from developing economies leverage international operations to overcome resource constraints and accelerate innovation (Kumar et al., 2020; Bahl et al., 2021). The knowledge-based view suggests that internationalization enables firms to identify, acquire, and exploit valuable knowledge resources across borders, thereby enhancing their innovative capabilities. This perspective is particularly relevant for Chinese manufacturing firms seeking to transition from imitative to innovative strategies through global learning and technology acquisition.

3. Research Design

3.1 Research Hypothesis
The advancement of corporate development and profit enhancement through innovation relies on the support of intangible resources. This paper focuses on examining human capital, technological resources, and relational resources, measured respectively by the educational attainment of executives, R&D investment, and government subsidies. The theoretical framework integrates the knowledge-based view and absorptive capacity theory to explain the micro-mechanisms through which these resources affect innovation performance. Specifically, human resources contribute to innovation through enhanced cognitive capabilities and learning processes; technological resources provide the foundational knowledge base for innovation activities; while relational resources facilitate access to external knowledge and complementary assets. Internationalization strengthens these relationships by expanding firms' knowledge search boundaries and enhancing their ability to recognize, assimilate, and apply external knowledge. This integrated theoretical perspective provides a more comprehensive understanding of how intangible resources and internationalization interact to drive innovation performance in the context of emerging economies.

3.1.1 Executive Educational Attainment and Innovation Performance
Human resources, as a vital component of intangible assets, have long been a focus of scholars and experts. The executive team serves as a key indicator of an organization's human resource capabilities. Educational attainment is intrinsically linked to an individual's ability to gather information and make decisions. Employees with higher education levels demonstrate superior learning and adaptability, exhibit heightened sensitivity to market trends, and leverage their strengths to manage unexpected situations, thereby reducing error rates. Hambrick (1996) posits that the strategic decision-making efficiency of senior management teams correlates with their average educational attainment. Teams with higher educational levels demonstrate stronger decision-making capabilities, enabling them to swiftly discern market conditions and corporate resources to make precise judgments. Flood (1997) further observes that senior management teams with strong elitist tendencies also exhibit higher educational attainment and a greater propensity

toward standardized, procedural decision-making. Concurrently, highly educated teams demonstrate greater caution in decision-making when confronting moral hazards to safeguard their reputation. Therefore, the following hypothesis is proposed:

H1: The educational attainment of senior executives positively influences the innovation performance of Chinese manufacturing enterprises.

3.1.2 R&D Investment and Innovation Performance

Technological resources are considered one of the critical intangible assets for enterprises to maintain competitive advantage. Although technology is particularly crucial, many companies still imitate existing foreign technologies. Czarnitzki and Hussinger (2021), in examining the long-term and short-term relationship between corporate R&D investment and R&D output among the three major entities of R&D activities, concluded that corporate R&D expenditure contributes most significantly to patent outcomes. Atalay (2013) contends that technological innovation—whether manifested in patent outputs or incremental improvements within production processes—enhances corporate performance. Sustained growth and innovation necessitate increased R&D investment. Therefore, the following hypothesis is proposed:

H2: R&D investment positively correlates with innovation performance in Chinese manufacturing enterprises.

3.1.3 Government Subsidies and Innovation Performance

Relationships constitute a unique component of Chinese culture, with Chinese people viewing them as vital resources for enterprise development. Such relationships enable companies to access effective resources. Government subsidies can provide financial support to enterprises, thereby promoting innovation. Berube (2009) compared innovation performance between subsidized and unsubsidized firms, finding that patent output depends on government subsidies. Fan and Han (2011) argue that government subsidies promote corporate innovation and facilitate commercialization of outcomes. For companies, relational resources—specifically government subsidies derived from relationships—not only provide financial support but also deliver valuable policy-related information. These resources are difficult to imitate or substitute and exert significant influence on enterprises. Therefore, the following hypothesis is proposed:

H3: Government subsidies are positively correlated with innovation performance in Chinese manufacturing enterprises.

3.1.4 The Regulatory Role of Internationalization

As global integration advances, enterprises must integrate into internationalization. An increasing number of companies enhance their international competitiveness by expanding overseas markets. Internationalization enables market expansion, broadens business horizons, absorbs international expertise, improves organizational structures, and drives technological advancement. In human resources, enterprises seek to strengthen the internationalization of their executive teams to boost innovation performance. Harrison (2000) posits that human capital can boost product profitability and innovation. When innovation benefits outweigh costs, firms exhibit heightened willingness to innovate and greater enthusiasm for resource allocation. Through internationalization, firms gain access to more highly educated employees, thereby increasing learning opportunities required for innovation activities. Thus, the following hypothesis is proposed:

H4a: The internationalization of Chinese manufacturing companies positively moderates the relationship between executive educational attainment and innovation performance.

The internationalization of Chinese manufacturing firms strengthens the relationship between R&D investment and innovation performance. From a knowledge-based view perspective, internationalization enables firms to access diverse knowledge pools and technological capabilities across borders, enhancing their absorptive capacity and ability to leverage existing R&D investments more effectively. Meyer and Li (2022) argue that internationalization can mobilize technological resources and enhance the effectiveness of existing resources. Through internationalization, firms rapidly acquire technologies and knowledge from overseas markets that elevate their innovation capabilities, swiftly shaping their competitive advantages. Therefore, the following hypothesis is proposed:

H4b: The internationalization of Chinese manufacturing firms strengthens the relationship between R&D investment and innovation performance.

The internationalization of Chinese manufacturing companies positively moderates the relationship between government subsidies and innovation performance. The absorptive capacity theory suggests that internationalization enhances firms' ability to effectively utilize government subsidies by providing access to complementary knowledge and resources. Zhang and Xiong (2016) found that to strengthen the effectiveness and productivity of government subsidies, enterprises should acquire valuable knowledge and information from overseas markets. This is particularly true for China's high-end manufacturing sector, which increasingly targets developed nations with advanced systems. Through R&D activities in these well-regulated economies, companies learn technology, management practices, and methodologies, thereby ensuring international R&D and innovation. Therefore, we propose the following hypothesis:

H4c: The internationalization of Chinese manufacturing companies positively mediates the relationship between government subsidies and innovation performance.

3.2 Research Methods

3.2.1 Sample Selection and Collection
This paper's sample comprises manufacturing companies listed on the Shanghai and Shenzhen A-share markets in 2024. Data on R&D expenditure, government subsidies, overseas sales revenue, patent applications, and executive educational attainment were collected from the WIND database. After excluding *ST and ST companies and firms with missing information from the initial sample, the final dataset comprises 1,472 companies.

3.2.2 Variable Measurement
1) Dependent variable: Innovation performance (patent). Since corporate innovation output cannot be directly measured, it is typically assessed through patent grants or patent applications. This study employs patent applications as the measurement metric.

2) Explanatory Variables: Intangible Resources. In this paper, intangible resources are categorized into three dimensions: human resources, technological resources, and relational resources. Human resources are measured by the educational attainment (edu) of company executives, assigning values to each executive's education level within each company: secondary vocational school or below = 1, junior college = 2, bachelor's degree = 3, master's degree = 4, doctoral degree = 5, 6 = other; then calculating the average educational attainment of executives in each company. Technical

resources are measured by research and development (R&D) expenditure, expressed as the natural logarithm. Relational resources are measured by government subsidies (gov), expressed as the natural logarithm.

3) Moderating Variable: Internationalization (int). The internationalization level of the sample companies is measured through various indicators, including overseas investment, overseas sales, overseas employees, and the number of overseas subsidiaries. Due to data availability, overseas sales revenue as a percentage of total assets is used as the metric. To account for heteroskedasticity, the natural logarithm is applied.

4) Control variables: Firm size (size), firm age (age). Firm size is represented by the natural logarithm of total assets, while firm age is represented by the natural logarithm of the time elapsed from the firm's establishment to the observation year.

4. Empirical Analysis

The paper employs SPSS 17 as the statistical analysis tool. Table 1 presents descriptive statistics. The data reveal that among the 1,472 companies, both the mean and standard deviation of the innovation performance dependent variable are substantial, with a mean of 118.948370 and a standard deviation of 636.5620323. This indicates significant variation in innovation patent applications across companies. The range of internationalization levels is also relatively large, indicating pronounced disparities among enterprises in their internationalization processes.

Table 1 Descriptive Statistics

Variable	N	Minimum	Maximum	Mean	Standard Deviation
Patent	1472	1.0000	18454.0000	118.948370	636.5620323
Size	1472	19.6770	27.3074	22.062267	1.2061092
Age	1472	1.6094	4.1271	2.850842	.3017926
Edu	1472	1.5000	5.0000	3.294358	.4690578
Rd	1472	11.1586	23.1268	18.144020	1.2788654
Gov	1472	9.9035	21.7010	16.440640	1.3652414
Int	1472	-12.8695	.3819	-3.016924	1.9873324
Valid N (listwise)	1472				

Note: The table presents descriptive statistics for 1472 manufacturing listed companies. Patent represents innovation performance, Size represents firm size, Age represents firm age, Edu represents executive education level, Rd represents R&D investment, gov represents government subsidies, and Int represents internationalization level.

Table 2 presents the correlation analysis results. The findings indicate significant correlations between innovation performance and several other variables. The correlation coefficient between company size and R&D expenditure is 0.794, while that with government subsidies is 0.715. This is because, ceteris paribus, larger companies undertake more R&D projects and invest greater amounts in R&D, thereby receiving higher government subsidies. Additionally, we conducted VIF (Variance Inflation Factor) analysis to examine multicollinearity. Results indicate that all VIF

values are below 10, and most correlation coefficients between study variables are less than 0.4, suggesting no multicollinearity issues exist. Preliminary data indicates significant influence relationships between executive education level, R&D investment, government subsidies, and innovation performance. More precise analysis requires further validation.

Table 2 Correlation Analysis

Variable	Patent	Size	Age	Edu	Rd	Gov	Int
Patent	1	.309**	.057*	.139**	.333**	.295**	.056*
Size	.309**	1	.235**	.281**	.794**	.715**	-.029
Age	.057*	.235**	1	.091**	.164**	.152**	.006
Edu	.139**	.281**	.091**	1	.302**	.286**	-.030
Rd	.333**	.794**	.164**	.302**	1	.677**	-.092**
Gov	.295**	.715**	.152**	.286**	.677**	1	.036
Int	.056*	-.029	.006	-.030	.092**	.036	1

Note: Pearson correlation coefficients are reported. ** $p < 0.01$, * $p < 0.05$. Patent represents innovation performance, Size represents firm size, Age represents firm age, Edu represents executive education level, Rd represents R&D investment, Gov represents government subsidies, and Int represents internationalization level.

As shown in Table 3, the analysis of main effects indicates that all VIF values in the model are below 5, indicating no multicollinearity issues. Furthermore, the DW values are close to 2, suggesting no autocorrelation in the model, which is well-specified. The table reveals that, among the control variables, firm size and age have no impact on innovation performance. The P-value for executive education level is greater than 0.05, indicating that executive education does not affect innovation performance. Therefore, hypothesis H_1 is rejected. The P-values for R&D investment and government subsidies are 0 and 0.005 respectively, both less than 0.05. Thus, hypotheses H_2 and H_3 are accepted.

Table 3 Main Effects Analysis

Variable	Unstandardized Coefficients		T	Sig.	VIF
	B	Std. Error			
Constant	-3369.998	299.494	-11.252	0.000	-
Size	37.607	23.473	1.602	0.109	3.303
Age	-21.665	53.171	-0.407	0.684	1.061
Edu	41.678	35.106	1.187	0.235	1.118
Rd	99.569	20.856	4.774	0.000	2.932
Gov	47.269	16.975	2.785	0.005	2.213

Model Summary: $R^2 = 0.122$, Adjusted $R^2 = 0.119$, F = 40.805***

Note: *** $p < 0.001$, ** $p < 0.01$. B represents unstandardized coefficients, Sig. represents significance level, VIF represents variance inflation factor. The model shows that Rd (R&D investment) and Gov (government subsidies) have significant positive effects on innovation performance, while other variables are not statistically significant.

As shown in Table 4, the moderation effect analysis indicates that the model passed the F-test, with

VIF values below 5 and DW values around 2, suggesting good model fit. The results analyzed the interaction effect between internationalization and executive education level. The interaction term (P=0.415>0.05) indicates that internationalization did not influence the relationship between executive education level and innovation performance, thus failing to validate hypothesis H4a. The interaction effect between internationalization and R&D investment on innovation performance (B=21.831, p=0.009<0.05) indicates that internationalization positively moderates the relationship between R&D investment and innovation performance in Chinese manufacturing firms. Thus, hypothesis H4b is supported. The interaction effect between internationalization and government subsidies on innovation performance indicates that internationalization moderates the relationship between R&D intensity and innovation performance in Chinese manufacturing enterprises (B=17.356, p=0.025<0.05). Thus, hypothesis H4c is supported.

Table 4 Moderation Effects Analysis

Variable	Unstandardized Coefficients		T	Sig.	VIF
	B	Std. Error			
Constant	-3181.223	297.226	-10.703	0.000	
Size	46.816	23.569	1.986	0.047	3.416
Age	-45.847	52.638	-0.871	0.384	1.067
Edu	43.858	34.767	1.261	0.207	1.124
Rd	87.294	21.086	4.14	0.000	3.074
Gov	43.756	16.807	2.603	0.009	2.226
Int	18.585	8.019	2.318	0.021	1.074
Eduxint	15.11	18.539	0.815	0.415	1.124
Rdxint	21.831	8.367	2.609	0.009	1.894
Govxint	17.356	7.746	2.24	0.025	1.823

Model Summary: R^2= 0.147, Adjusted R^2= 0.141, F = 27.897***

Note: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$. B represents unstandardized coefficients, Sig. represents significance level, VIF represents variance inflation factor. The interaction term Rdxint (R&D investment × internationalization) shows a significant positive moderating effect (B = 21.831, $p < 0.01$), and Govxint (government subsidies × internationalization) also shows a significant positive moderating effect (B = 17.356, $p < 0.05$). However, Eduxint (executive education × internationalization) is not significant (p = 0.415).

5. Conclusion and Inspiration

5.1 Conclusion and Discussion

Regression analysis of 1,472 Chinese manufacturing companies revealed that R&D investment and government subsidies positively correlate with corporate innovation performance. Furthermore, internationalization exerts a positive moderating effect on the relationship between R&D investment, government subsidies, and innovation performance. Technological resources and relational resources exert a positive influence on innovation performance. Internationalization exhibits a positive relationship with innovation performance, strengthening the positive link between technological and relational resources and innovation performance in Chinese manufacturing firms. These findings suggest that while internationalization itself enhances

innovation performance, firms possessing and leveraging valuable intangible resources can achieve even greater innovation performance gains. There is no significant correlation between executive educational attainment and corporate innovation performance, and this remains unchanged even when moderated by internationalization. Although this conclusion contradicts previous research findings, Wang F. and Wang Y. (2019) discovered that higher employee educational attainment correlates with greater corporate innovation efficiency. This suggests that the average educational level of corporate executives is not sufficiently high to exert a substantial impact on innovation performance. As China's population of highly educated individuals continues to grow and executive educational attainment gradually increases, corporate innovation performance will consequently evolve. The findings offer insights for manufacturing enterprises. From a resource-based perspective, this study underscores the competitive advantage of intangible resources. By acquiring valuable technological and relational resources through diverse channels and leveraging them effectively, enterprises can enhance innovation performance and ultimately boost economic efficiency.

5.2 Limitations and Future Research Direction

Firstly, the measurement of human, technological, and relational resources currently relies solely on executive education levels, R&D investment, and government subsidies. Future research should adopt multi-indicator approaches to enhance reliability. Secondly, the sample data is limited to 1,472 A-share listed companies in 2024. Expanding the scope to include multiple industries and extended time periods will help overcome sample limitations. Thirdly, reputation resources represent another vital intangible asset. Due to challenges in data collection and measurement, this aspect was not explored in this paper. Future research could build upon this foundation.

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