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INNOVATION AND FIRM PERFORMANCE: THE MODERATING ROLE OF INTELLECTUAL CAPITAL AMONG CHINESE COMPANIES

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ABSTRACT

This study examines the impact of innovation on firm performance and how intellectual capital (IC) moderates the association between innovation and firm performance. We apply an innovation index that measures the frequency of innovative related words, which appear in firm financial reports to proxy for innovation. IC is estimated through the value-added IC (VAIC™) model. This study analyses Chinese firm-year observations of financial profitability (firm value) datasets, which total 19,152 (18,276) over the years from 2007 to 2019. Results indicate that the innovation index is positively related to financial profitability and firm market value. Moreover, the moderating outcomes suggest that IC boosts the positive relationship between innovation index and firm performance. Overall, this study highlights the importance of having innovation and IC together for gaining firm competitive advantages and progressing profitably. That is, firms should be innovative and must manage their IC well.

Keywords: Innovation index, Intellectual capital, Financial profitability, Firm value, Moderating effect

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INTRODUCTION

For the past 20 years, China has been investing further in innovation. According to the gross domestic spending on research and development (R&D) from Organisation for Economic Co-operation and Development, OECD (2021), China's figure increased 12.9 times from USD39,806 million (0.893% of gross domestic product [GDP]) in 2000 to USD514,798 million (2.235% of GDP) in 2019. China's investment in innovative research is second only to that of the U.S. Although compared with many other countries, China has achieved remarkable efficiency in its innovation system, it still lags compared with major developed countries (Zeng, 2017).

Innovation value lies in bringing companies far enough to differentiate themselves from their competitors to create competitive advantages and thus gain market shares (Buccieri et al., 2021; Kaliappen & Hilman, 2014; Semuel et al., 2017). The gradual scarcity of natural resources deprives companies that otherwise can obtain resources at low costs, so they should actively seek alternatives or increase resource utilisation to maintain economic rents. From another point of view, when a competitor has a competitive advantage in a natural resource, the company's innovation driving the increasement of productivity (Li, 2020) can help it offset the competitor's advantage and make a profit.

Firm development cannot be separated from innovation, but some innovation activities do not bring economic returns, and even can only waste company resources. If a company consumes limited resources to achieve differentiation, but the innovation is not deep enough, then its products or services may only achieve an assimilation effect, and such innovation has a difficult time helping enterprises achieve profit growth. At the same time, competitors are constantly updating their products and services. To achieve effective innovation, companies should integrate their resources and focus on intellectual capital (IC), which has a significant impact on innovation (Agostini et al., 2017). For example, human capital (HC) can help companies gain insights into market demands and predict future industry trends, which can help differentiate innovation. Therefore, when enterprises innovate, they should pay attention to the importance of IC on driving innovation results into economic benefits.

In China, the country has become one of the world's largest and fastest-growing economies, with a rapidly expanding technology and innovation sector. With its focus on innovation-driven development and policies such as "Made in China 2025" and "Innovative China", China is positioning itself as a global leader in innovation. However, China still faces challenges in this area, with concerns around intellectual property theft and inadequate legal protection for intellectual property rights. This can discourage companies from investing in innovation, as they may not be able to effectively protect their intellectual property.

Secondly, China's economic growth has been fuelled by the development of its IC, particularly in the form of its large and highly educated workforce. However, there are still challenges in effectively leveraging this IC to drive innovation and economic growth. Therefore, studying the relationship between IC, innovation, and economic growth in China is crucial for understanding the factors that drive China's continued economic development, as well as for identifying strategies for Chinese companies to effectively leverage their IC for innovation and growth in a global context.

This study aims to investigate (i) the association between innovation and firm performance, and (ii) the moderating effect of IC on how innovation can explain firm performance in the context of China. Chinese firms are chosen as samples because firstly, the Chinese government has been encouraging innovation since the 18th National Congress of Chinese Communist Party in 2012, when the Chinese government proposed the innovation-driven strategy that requires firms to gather all resources to boost innovation. Secondly, the Chinese government has launched the Belt-and-Road Initiative with the aims to let Chinese enterprises go abroad through the trade routes of land and sea. This initiative involves significant organisational infrastructure development, which requires significant HC and great improvement in structural capital (SC) to foster institutional environment.

This study contributes to literature in three dimensions. Firstly, our study provides a new insight on the moderating role of IC in the association between innovation and firm performance. Prior studies discussed innovation (Gunday et al., 2011; Hizarci-Payne et al., 2021; Lee et al., 2019; Walker et al., 2015) and IC (Hamdan, 2018; Li et al., 2020; Nadeem et al., 2018; Smriti & Das, 2018) on firm performance separately. Secondly, we measure firm performance from two aspects: accounting-based performance (return on assets [ROA]) and market-based performance (Tobin's Q [TBQ]). Lastly, our findings are robust to a range of analytical methods (ordinary least squares [OLS] pooled regression and logistics regression) for consistency purposes.

THEORETICAL DISCUSSION AND HYPOTHESIS DEVELOPMENT

Theoretical Discussion

Schumpeter theory

In the era of knowledge economy, traditional economic approaches cannot meet the needs of guiding socioeconomic development. At present, economic globalisation and intangible assets are of remarkable importance, and Schumpeter theory is considered an in step with the pace of social development (Śledzik, 2013). Economic development is a historical process in which structural changes are driven by innovation (Schumpeter, 1911; 1934). Moreover, innovation is an important source of competitiveness (Porter & Stern, 1999) and economic power (Hanusch & Pyka, 2007). Therefore, innovation helps companies progress and drives economic development.

Schumpeter argues that innovation is different from invention: it should apply to the market, and it is a market behaviour. The market tests innovation and follows the law of input and output. Schumpeter divides innovation into five categories: product innovation, production or sales innovation, market innovation, raw material or semifinished product innovation and industry structure innovation (Schumpeter, 1911; 1934). For the innovation process, Schumpeter gives four types of divisions: invention, innovation, diffusion and imitation (Burton-Jones, 2001). According to Schumpeter, entrepreneurship is once a unique element of production and a rare social input that causes economic history to change. Innovation is the "creative destruction" that drives the economy forward, with an entrepreneur serving as the change creator; the primary role of the entrepreneur is to allocate current resources to "new applications and combinations" (Schumpeter, 1911; 1934). That is, innovation is closely linked to enterprises, entrepreneurs encourage innovation in the hope of bringing great competitive advantages to enterprises, and innovation depends on enterprises to become market value creation activities.

Resource-based theory

The operation of an enterprise requires the use of various resources. A resource is defined as everything that may be considered a firm strength or weakness, including tangible and intangible assets. Wernerfelt (1984) provided examples of attractive resources that help companies gain an edge whilst others fail to catch up in a short period, for example, machine capacity, customer loyalty, production experience and technological lead. Resource-based theory holds that resources with competitive advantages can bring economic rents to firms and help them beat their rivals. Barney (1991) described the characteristics of these competitive resources: valuable, rare, imperfectly imitable and not substitutable.

Resource-based theory is widely applied in different research fields, such as human resource management, economic and finance, entrepreneurship, marketing and international business; the theory is also suggested to link with knowledge, dynamic capability, corporate governance, management buy-out and venture capital financing (Barney et al., 2001). That is, any activities undertaken by an enterprise regarding resource integration rely on resource-based theory. Enterprise innovation activities need additional advantageous resources. Based on the background of the era of knowledge economy, IC, as a critical knowledge resource, can bring sustainable competitive advantages to enterprises (Hussinki et al., 2017; Mubarik et al., 2019) for sustained development (Alvino et al., 2021; Secundo et al., 2020).

Hypothesis Development

Innovation and firm performance

Innovation means to improve firm profitability and competitiveness. Androsch and Redl (2017) pointed out that a successful innovation begins with ideas, ends with products on the market and delivers business returns to a company. Kemp et al. (2003) concluded that all innovation activities should finally lead to improve firm performance for it to make sense. That is, innovation expects business returns. If innovation is only performed to prove that technology is the best in the industry, then it does not make sense. On the one hand, innovation helps companies increase their resource utilisation and productivity to make profits. For example, product innovation can contribute to labour productivity; thus, companies invest further in innovation and are competitive (Wadho & Chaudhry, 2018). On the other hand, according to Schumpeter (2016), innovation is the reorganisation of production factors to achieve the effect of resource heterogeneity advocated in resource-based theory. That is, innovation helps companies differentiate and become competitive.

Since the 21st century, research on the relationship between innovation and firm performance has become more relevant than before. Rousseau et al. (2016) found that the relationship between innovation and firm performance shows mixed results. Some research shows the negative effect of innovation on firm performance (Thornhill, 2006). However, most publications report a positive relationship between innovation and firm performance (de Zubielqui et al., 2019; Gunday et al., 2011; Lee et al., 2019; Rajapathirana & Hui, 2018; Wadho & Chaudhry, 2018). Many recent studies have broken down innovation activity research into different innovation types, such as organisational innovation

(Camisón & Villar-López, 2014), process innovation (Piening & Salge, 2015) and market innovation (Gupta et al., 2016), to achieve an improved understanding of the relationship between innovation and firm performance.

Gunday et al. (2011) explored the effects of different innovation types on firm performance in 184 manufacturing firms from Turkey and concluded that innovation has a positive influence on firm performance in the manufacturing sector. Walker et al. (2015) supported that management innovation contributes to firm performance by quantitatively integrating the empirical results with 52 independent samples from 44 papers. Lee et al. (2019) emphasised on the synergy impact of innovation, noting that it varies depending on the various combinations of innovation forms and the various types of sectors. Hizarci-Payne et al. (2021) studied the impact of innovation on firm performance from the perspective of environmental innovation. Their meta-analysis argued that the association between eco-innovation and firm performance varies across different proxies of firm performance. It also emphasised that eco-innovation shows a more significant impact on developing countries than on developed countries. The impact of innovation on developing countries is a striking revelation that reminds us that further attention should be paid to innovation in developing countries. Therefore, we propose the following hypothesis:

H1: Innovation has a positive effect on firm performance.

Moderating effect of IC on the relationship between innovation and firm performance

Innovation is like the lifeblood of companies, but many firms are getting less than expected returns on their innovation (Rousseau et al., 2016). Is it likely that the lack of co-driving factors influencing firm performance can result in a situation in which the contributions of innovation activities to firm performance fall short of firm expectations? A rich body of studies have observed that co-driving factors may influence the impact of innovation on firm performance, such as market uncertainty (Chu et al., 2018), supply chain (Lim et al., 2017), entrepreneurial orientation (Ferreira et al., 2020), internal R&D and environmental turbulence (Hung & Chou, 2013), managerial environmental concern (Ar, 2012; Lichtenthaler, 2009), performance measurement (Saunila et al., 2014), firm size (Leal-Rodríguez et al., 2015) and strategic planning (Song et al., 2011).

Innovation and IC are relative complements. Innovation activities require the support of IC, such as HC and capital employed. Ko and Lu (2010) advised that companies should make full use of their human resources developing innovative services to quickly identify potential markets and trends. Gupta et al. (2016)

believed that innovation is the result of competitiveness. IC is recognised as the contributor for the competitive advantages of companies (Ting et al., 2020). That is, IC is closely related to innovative activities. However, current literature has not shielded any light on the moderating effect of IC. This study concentrates on this gap in literature, investigating whether IC enhances or impedes the relationship between innovation and firm performance.

Innovation, IC and firm performance have a complex intertwined association. The boundary between innovation and IC research is blurred. In studies on innovation, some regard IC as a factor influencing innovation, whereas others regard innovation as a prerequisite for affecting IC efficiency (Mention, 2012). Although innovation is like a black box, it can ultimately help IC influence performance, and the links among these three are gradually showing up. McDowell et al. (2018) observed that innovativeness partially mediates the relationship between IC and firm performance. Based on Austrian firms with a 10-year period, Leitner (2017) claimed that IC improves a company's ability to effectively implement innovation and thus improves its performance. Zhang et al. (2018) admired that IC enhances product innovation performance directly in China and India. They also found that the effect of IC on innovation is more significant with Chinese manufacturers than with Indian companies.

Amin and Aslam (2017) targeted to explore the linkage among IC, innovation and firm performance using value-added IC (VAIC) to measure IC, R&D to measure innovation and several traditional financial measures to present firm performance. The positive effect of IC is found on innovation and firm performance, and innovation significantly influences firm performance. Delgado (2011) suggested the moderating effect of IC and only explained the moderating effect of HC on the relationship between relational capital and radical innovation. Given that the impact of IC on performance presents mix results in literature, IC levels in companies may affect the outputs of innovative business returns. That is, IC may affect the relationship between innovation and performance. Thus, we propose this hypothesis:

H2: Intellectual capital moderates the positive association between innovation and firm performance.

RESEARCH METHODOLOGY AND DATA

Data Collection and Screening

Our sample comprised Chinese firms listed in Shanghai and Shenzhen stock exchanges between 2007 and 2019. We excluded banks and insurance firms due to differences in regulatory requirement that pertain to them. We also deleted firms with serious missing values in their financial reports. In addition, we ensured that the sample firms have required variables of interest. That is, the sample firms must contain nonzero and nonnegative innovation indices. The innovation index presents textual-based data; it measures the frequency of innovative related words that appear in firm financial reports. We collected these textual-related data from the Wingo database (see Appendix 1 for the description of the innovation index provided by the Wingo database). Regarding other data used in this study, financial profitability, firm size, firm age and other firm character variables are available in the firm financial reports collected by the China Stock Market & Accounting Research (CSMAR) database (https://wrds-www.wharton.upenn.edu/documents/1146/GTA-CSMAR-One-Sheet.pdf). The final dataset is 19,152 firm-year observations.

Variable and Measurement

This study uses regression-related variables for variable measurements. For dependent variable (DV), two proxies are used to measure firm performance: (1) ROA is measured as the ratio of profit after taxes to total assets (Anderson et al., 2003), and (2) TBQ is the sum of the market value of the equity and the book value of the debt over the book value of asset (Wernerfelt & Montgomery, 1988).

For independent variable (IV), innovation (INN) is the innovation index, which comprises textual-based innovation-level data calculated according to the frequency of innovative-related words that appear in firm financial reports. This study adapted the R&D disclosure score proposed by Nekhili et al. (2012) and Lakhal and Dedaj (2020) on R&D disclosure index. Building on Cooke's (1992) work, this study utilises content analysis to identify the presence or absence of innovation information in the annual reports. Different from the simple word frequency analysis method, the Wingo descriptive innovation index is constructed using the method of "seed word set + word embedding expansion", and the resulting indicator is more accurate, objective and scientific. Specifically, the construction process of the descriptive innovation index is as follows: firstly, the financial textual research team develops a seed word set about innovation by reading numerous policies and regulations related to innovation information disclosure, research literature and text information disclosed by listed companies. Secondly, the vocabulary expansion of the seed word set is carried out through the Wingo similar word database.[1] This database uses a word-embedding neural network language model, which shows words as multidimensional vectors on the basis of contextual semantic information and obtains similar words by calculating the vector similarity. Lastly, experts from the industry and academia are invited to verify the descriptive innovation index and cross-verify it with the quantitative innovation indicators in current literature. The results show that descriptive innovation indicators have high and significant positive correlations with traditional innovation indicators. Their time trends and industry distributions are also generally consistent. This result further validates the effectiveness of descriptive innovation indicators (Jin et al., 2017).

For moderating variable, we adopt the Pulic (2000) model. Following Ting and Lean (2009), Ståhle et al. (2011), Kweh et al. (2013), Iazzolino and Laise (2013) and Hsieh et al. (2020), VAIC™ is value-added IC, which is made up of human capital efficiency (*HCE*), structural capital efficiency (*SCE*) and capital employed efficiency (*CEE*).[2] The equation is presented as follows:

$$VAIC = HCE + SCE + CEE$$

The algebraic forms of components of IC and overall VAIC™ are expressed in the following manner. Value added (*VA*) is calculated by subtracting operating expenses, except personal costs, including *HC*. Thus, *VA* is computed using the following expression:

$$VA = I + DP + T + D + R,$$

where *I* is the interest expense, *DP* is the depreciation expense, *T* denotes corporate tax, *D* refers to the dividend, and *R* is the retained profit during the year. *HCE* is the predominate component of the formula of VAIC™. It is computed as the ratio of *VA* divided by *HC*. This measure shows how much value is being added by an organisation employee. The computation is shown below:

$$HCE = VA/HC,$$

where *HCE* = human capital efficiency, *VA* = value added, which is the difference between firm gross income and operating expense, except incurred-on employees. That is, we obtain total revenues minus total expenses but not employee costs, consistent with Zhang et al. (2021) who examined IC in the Chinese context; *HC* refers to worker renumeration.

SCE is the second intangible component of VAIC™. It is obtained by dividing *SC* from *VA*. This computation shows how much value is contributed through structural resources. Note that an inverse relationship exists between *HC* and *SC*. The total value contributed from *HC* is inversely proportion to the value contributed from *SC* (Pulic, 2000). The calculation for *SCE* is shown as follows:

$$SCE = SC / \mathrm{VA} ,$$

where *SCE* = structural capital efficiency, *VA* = value added, which is the difference between firm gross income and firm operating expense, except employee expense, *SC* = structural capital calculated by taking the difference between *VA* and *HC*.

CEE is computed by dividing *VA* from capital employed. This ratio shows the portion of value addition from physical and financial firm assets. The computation of *CEE* is presented as follows:

$$CEE = VA/CE ,$$

where *CEE* = capital employed efficiency, *VA* = value added, which is the difference of revenue and operating expense, except employee expense, *CE* = capital employed refers to book value of firm resource.

As for control variables, we include firm size (*FSIZE*), age (*FAGE*), leverage (*FLEV*), board size (*BSIZE*) and board independence (*BIND*) as control variables. In order to enhance the accuracy of the model and minimise noise in the measurement of *INN* and IC's effect on firm efficiency, this study only uses firm-specific characteristics as control variables, which are selected based on similar business behaviour and risk. Moreover, macroeconomic variables are excluded from the analysis to maintain the focus only on Chinese listed firms. The chosen control variables consist of internal explanatory factors that have the most significant impact on business performance, efficiency, and sustainability (Imhanzenobe, 2020). *FSIZE* is measured as the natural logarithm of total assets (Lu et al., 2014). *FAGE* is the natural logarithm of days of establishment (Ferreira et al., 2020). *FLEV* is the ratio of total liabilities to total assets (Nourani et al., 2019). *BSIZE* is the natural logarithm of the total number of directors at the board level (Hsieh et al., 2020). *BIND* is the ratio of independent directors to total directors at the board level (Kweh et al., 2021).

Regression Model

Multivariate analyses are conducted on the following regression models to achieve our research objectives. Regression models, Equtions. (1.1), (1.2) and (1.3) are designed to assess the association between innovation and firm performance, IC and firm performance, and innovation and IC on firm performance, respectively.

$$FProf_{it} = \beta_0 + \beta_1 INN_{it} + \beta_2 FSIZE_{it} + \beta_3 FAGE_{it} + \beta_4 FLEV_{it} + \beta_5 BSIZE_{it} + \beta_6 BIND_{it} + \sum_S \gamma_S Year_{S,it} + \sum_u \lambda_u Industry_{u,it} + \varepsilon_{it} \quad (1.1)$$

$$FProf_{it} = \beta_0 + \beta_1 VAIC_{it} + \beta_2 FSIZE_{it} + \beta_3 FAGE_{it} + \beta_4 FLEV_{it} + \beta_5 BSIZE_{it} + \beta_6 BIND_{it} + \sum_S \gamma_S Year_{S,it} + \sum_u \lambda_u Industry_{u,it} + \varepsilon_{it} \quad (1.2)$$

$$FProf_{it} = \beta_0 + \beta_1 INN_{it} + \beta_2 VAIC_{it} + \beta_3 FSIZE_{it} + \beta_4 FAGE_{it} + \beta_5 FLEV_{it} + \beta_6 BSIZE_{it} + \beta_7 BIND_{it} + \sum_S \gamma_S Year_{S,it} + \sum_u \lambda_u Industry_{u,it} + \varepsilon_{it} \quad (1.3)$$

where β_0 is a constant term, β_m, m = 1–7, denotes coefficients of explanatory variables, i = firm, t = year, *FProf* is the firm performance as proxied by (i) *ROA* and (ii) *TBQ*, and ε_{it} is an error term.

This study also investigates how innovation influences firm performance and the moderating effect of IC on the association between innovation and firm performance. The estimating regression model Equation 1.4 is as follows:

$$FProf_{it} = \beta_0 + \beta_1 INN_{it} + \beta_2 VAIC_{it} + \beta_3 INN_{it} \times VAIC_{it} + \beta_4 FSIZE_{it} + \beta_5 FAGE_{it} + \beta_6 FLEV_{it} + \beta_7 BSIZE_{it} + \beta_8 BIND_{it} + \sum_S \gamma_S Year_{S,it} + \sum_u \lambda_u Industry_{u,it} + \varepsilon_{it} \quad (1.4)$$

where β_0 is a constant term, β_m, m = 1–7, denotes coefficients of explanatory variables, i = firm, t = year, $\gamma_S Year$ is the year fixed effect, $\lambda_u Industry$ is the industry fixed effect, and ε_{it} is an error term.

Research Framework

This study employs a research framework, which is developed on the basis of Schumpeter theory and resource-based theory to examine the relationship between innovation and firm performance and their advance relationship with the presence of IC. Figure 1 illustrates the research framework.

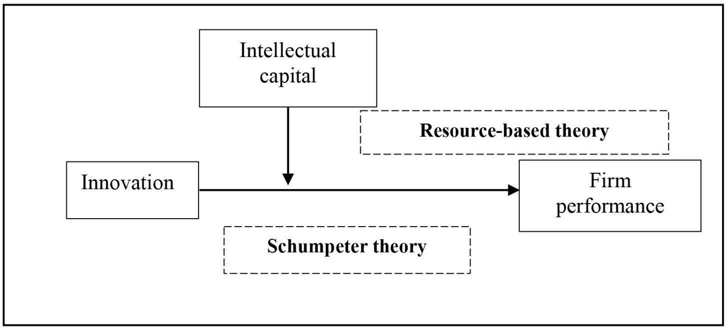

Figure 1: Research framework

EMPIRICAL RESULTS

Preliminary Analysis

Table 1 summarises the descriptive statistics and means of differences of all variables. The univariate result shows that the mean values of *ROA* and *TBQ* are 0.035 and 3.2693, respectively. Thus, the sample companies generate 3.5% profit from the total assets and total market value of the equity. Moreover, the book value of the debt to the book value of asset is 326.93%. On average, the *INN* of publicly listed Chinese companies is 1.7536. The mean of *VAIC* is 6.8884, indicating that VAIC comprising HC, SC and financial capital is 6.8884 averagely. The former, which is a word-embedding neural network language model, suggests that the sample firms disclose their work on innovation, whereas the latter implies that the sample companies generate about RMB6.8884 billion of IC.

The descriptive statistics reveal that the total assets of sample companies' sizes (*FSIZE*) reach RMB4.014 billion on average. The average age (*FAGE*) of sample companies is approximately 5,763 days (about 16 years on average). The mean value of 0.8135 for *FLEV* documents that publicly listed Chinese companies mostly have high leverage with liabilities counting 81.35% of total assets. Eight board of directors exist, and the ratio of independent directors to total directors is 0.3744 in the sample companies on average.

Table 1 also presents the mean difference tests for the variables, companies with *INN* are greater than those with a median innovation index (*INN_Dum* = 1) and lower than or equal to those with the median innovation index (*INN_Dum* = 0). Companies with high *INN* are more profitable, have higher market values and have more independent directors but have lower IC levels, smaller board sizes and are younger than those with low *INN*.

Table 1
Descriptive statistics

	Summary statistics		Test of differences in means			
Variable	Mean	S.D	*INN_Dum* = 1	*INN_Dum* = 0	Mean difference	*t*-statistic
ROA	0.0350	0.1008	0.0377	0.0323	0.0054***	3.7086
TBQ	3.2693	4.1404	3.4212	3.1190	0.3022***	4.9366
INN	1.7536	1.1187				
VAIC	6.8884	35.6883	6.3347	7.4419	−1.1072**	−2.1470
FSIZE	21.7485	20.2284	21.6220	21.8749	−0.2529***	−14.3414
FAGE	8.5714	0.3985	8.5315	8.6113	−0.0798***	−12.2343
FLEV	0.4144	27.3651	0.3780	0.4508	−0.0728***	−23.1646
BSIZE	2.1224	1.2270	2.1095	2.1353	−0.0258***	−8.9748
BIND	0.3744	0.4529	0.3758	0.3729	0.0030***	3.6955

Notes: ROA means return on assets, which is measured as the ratio of profit after taxes to total assets. *TBQ* is Tobin's Q, which is the sum of the market value of the equity and the book value of the debt over the book value of asset. *INN* refers to innovation index, which comprises textual-based innovation-level data. *VAIC* is value-added IC based on Pulic (2000), which is made up of HC, SC and financial capital. *FSIZE* is firm size, which is measured as the natural logarithm of total assets. *FAGE* is the natural logarithm of days of establishment. *FLEV* is the ratio of total liabilities to total assets. *BSIZE* is the natural logarithm of the total number of directors at the board level. *BIND* is the ratio of independent directors to total directors at the board level. *INN_Dum* is a dummy variable with a value of one if an innovation index is greater than the median innovation index, and zero otherwise. The number of firm-year observations (n) for all variables is 19,153 in the full sample, with the exception of that of *TBQ*, which is 18,276. The n for *INN_Dum* = 1 is 9,574 and that of *INN_Dum* = 0 is 9,579 for all variables, with the exception of that of *TBQ* (*INN_Dum* = 1, n = 9,089; *INN_Dum* = 0, n = 9,187). ** and *** denote the significance levels at the 5% and 1% levels, respectively.

Table 2 shows the Pearson correlation analysis. All variables have low correlation coefficients (below than 60%), suggesting that the variables are unaffected by multicollinearity. In the untabulated results of the variance inflation factor (VIF) analysis to test for multicollinearity, we notice that the VIF values are below five, indicating the absence of multicollinearity (O'brien, 2007).

Table 2
Correlation analysis

Variable	ROA	TBQ	INN	VAIC	FSIZE	FAGE	FLEV	BSIZE
TBQ	0.0361***							
INN	0.0370***	0.0397***						
VAIC	0.0664***	0.0155**	−0.0143**					
FSIZE	−0.0075	−0.3189***	−0.1270***	−0.0873***				
FAGE	−0.1159***	−0.0151**	−0.0986***	0.0039	0.2482***			
FLEV	−0.2698***	−0.1822***	−0.1925***	−0.0006	0.4677***	0.2110***		
BSIZE	0.0498***	−0.0993***	−0.0769***	−0.0051	0.2176***	0.0056	0.1438***	
BIND	−0.0417***	0.0448***	0.0333***	−0.0272	−0.0097***	0.0339***	−0.0334***	−0.5462***

Notes: *ROA* means return on assets, which is measured as the ratio of profit after taxes to total assets. *TBQ* is Tobin's Q, which is the sum of the market value of the equity and the book value of the debt over the book value of asset. *INN* is the innovation index, which presents textual-based innovation-level data. *VAIC* is value-added IC based on Pulic (2000), which is made up of HC, SC and financial capital. *FSIZE* is firm size, which is measured as the natural logarithm of total assets. *FAGE* is the natural logarithm of days of establishment. *FLEV* is the ratio of total liabilities to total assets. *BSIZE* is the natural logarithm of the total number of directors at the board level. *BIND* is the ratio of independent directors to total directors at the board level. *** and ** denote the 1% and 5% significance levels, respectively.

Multivariate Analysis

OLS regression is performed to examine the association among innovation, IC and firm performance. Table 3 shows the results. Firstly, the impacts of innovation and firm performance are examined. The coefficient of *Adj.* R^2 is 0.1301, indicating that *INN* explains 13.01% of the *ROA* variance and the model is significant at the 1% significance level. The empirical evidence of Equation 1.1 depicts a significantly positive relationship between *INN* and *ROA*. That is, the higher the firm innovation level, the higher the firm performance. This result is consistent with those of Gunday et al. (2011), Walker et al. (2015), Lee et al. (2019) and Hizarci-Payne et al. (2021) who also confirmed that firm innovation brings a positive impact to firms.

Secondly, the association between IC and firm performance is identified. The findings in Eq. (1.2) show that *VAIC* positively influences *ROA*. The coefficient of *Adj.* R^2 is 0.1359, suggesting that *VAIC* explains 13.59% of the *ROA* variance. This finding is in accordance with those of Maji and Goswami (2016) and Nadeem et al. (2018) who found that IC efficiency is positively and significantly related to financial performance. That is, the profit level is high when the firm is having high IC investment. The similar results are found in Equation 1.3 when innovation and IC are simultaneously included. The results remain the same when *INN* and *VAIC* are tested together on their impacts on firm performance. *INN* with its coefficient of 0.00118 ($p < 0.05$) implies that firms with high innovation are likely to have high profit. Consistently, *VAIC* with its coefficient of 0.0002 ($p < 0.01$) indicates that the increase of firm IC is conducive to improving performance.

Lastly, the moderating effect of IC on the association between innovation and firm performance is examined. The result of Equation 1.4 with the coefficient on *INN* × *VAIC* is significantly positive (coefficient: 0.0136, $p < 0.01$). It implies that a significant moderating effect of IC exists in the link between innovation and firm performance. Therefore, IC positively moderates the relationship between innovation and firm performance. Moreover, it is important to note that the unique effect of innovation on firm performance remains positive and slightly stronger than the one without the interaction term (–0.0053 + 0.0136 = 0.0083).

Table 3

Regression analysis (DV = ROA, n = 19,523)

Variable	Equation 1.1		Equation 1.2		Equation 1.3		Equation 1.4	
	Coefficient	*t*-statistic	Coefficient	*t*-statistic	Coefficient	*t*-statistic	Coefficient	*t*-statistic
Constant	−0.3098**	−2.86	−0.3103**	−2.95	−0.3238**	−3.05	−0.3158**	−2.98
INN	0.0017**	2.33			0.0018**	2.48	−0.0053***	−5.09
VAIC			0.0002***	7.15	0.0002***	7.14	0.0002***	10.01
INN×VAIC							0.0136***	15.17
FSIZE	0.0176***	4.37	0.0181***	4.65	0.0183***	4.69	0.0169***	4.42
FAGE	−0.0008	−0.18	−0.0020	−0.48	−0.0013	−0.31	0.0005	0.13
FLEV	−0.1671***	−6.40	−0.1695***	−6.56	−0.1686***	−6.52	−0.1662***	−6.51
BSIZE	0.0088*	1.94	0.0092*	1.99	0.0091*	1.98	0.0117**	2.49
BIND	−0.0451*	−2.02	−0.0405*	−1.83	−0.0409*	−1.86	−0.0310	−1.50
Year effect	Yes		Yes		Yes		Yes	
Industry effect	Yes		Yes		Yes		Yes	
Adj. R^2	0.1301		0.1359		0.1362		0.1554	
F-statistic	160.18***		168.38***		159.99		177.23	

Notes: This table reports the OLS results with standard error clustered in year. *ROA* means return on assets, which is measured as the ratio of profit after taxes to total assets. *TBQ* is Tobin's Q, which is the sum of the market value of the equity and the book value of the debt over the book value of asset. *INN* represents innovation index, which comprises textual-based innovation-level data. *VAIC* is the value-added IC based on Pulic (2000), which is made up of HC, SC and financial capital. *FSIZE* refers to firm size, which is measured as the natural logarithm of total assets. *FAGE* is the natural logarithm of days of establishment. *FLEV* is the ratio of total liabilities to total assets. *BSIZE* is the natural logarithm of the total number of directors at the board level. *BIND* is the ratio of independent directors to total directors at the board level. ***, ** and * denote 1%, 5% and 10% significance levels, respectively.

Robustness Checks

This study performs several robustness checks in different settings. Firstly, it follows Boeker and Goodstein (1993) and re-estimates the models through logistic regression. We replace *ROA* with a dummy variable, that is, *ROA_Dum* that has a value of one if *ROA* is greater than median *ROA*, and zero otherwise. The results are reported in Table 4, and the estimation results remain qualitatively the same. Consistently, the findings corroborate our prediction that the higher the innovation level, the higher the firm performance level. Similarly, the re-estimated model also shows that profit is found to be high in firms with high IC investment.

Secondly, we perform a sensitivity test to adjust standard errors for clustering (Thompson, 2011). The study employs OLS regression with standard error clustered in year to avoid the potential problem of within-year autocorrelation, which can bias the standard errors and the *t*-statistics of pool regressions. We use *TBQ* as another proxy of firm performance for the final robustness test. *TBQ* is the sum of the market value of the equity and the book value of the debt over the book value of asset. We find similar results with different regression tests and proxies. Thus, the findings are robust to the estimation results of Table 3. Consistently, the results also confirm the moderating effect of IC on the association between innovation and firm performance.

Table 4
Robustness checks

	DV = *ROA_Dum*				DV = *TBQ*	
Variable	Coefficient	Wald-statistic	Coefficient	Wald-statistic	Coefficient	*t*-statistic
Constant	−3.8241***	22.663	−3.6495***	20.535	24.3180***	7.24
INN	0.0477*	3.795	−0.0473*	3.395	−0.1002***	−3.93
VAIC	0.2279***	342.444	0.1476***	118.463	0.0513***	3.78
INN×VAIC			0.3642***	87.744	0.0816***	3.73
FSIZE	0.4107***	307.104	0.4104***	307.223	−1.2171***	−5.55
FAGE	−0.4534***	44.491	−0.4255***	38.823	0.3733**	2.83
FLEV	−4.2092***	960.550	−4.2507***	974.799	−0.4003	−1.43
BSIZE	0.9154***	35.170	0.8988***	33.689	0.4095**	2.81
BIND	−0.6863	1.633	−0.6075	1.275	3.1079***	3.12
Year effect	Yes		Yes		Yes	
Industry effect	Yes		Yes		Yes	

(*Continued on next page*)

Table 4 (*Continued*)

Variable	DV = *ROA_Dum*				DV = *TBQ*	
	Coefficient	Wald-statistic	Coefficient	Wald-statistic	Coefficient	*t*-statistic
Nagelkerke R^2	0.1940		0.2036			
Log likelihood	10,560.19		10,462.99***			
Adj. R^2					0.1836	
F-statistic					206.53	

Notes: This table reports the logistic regression where the DV is *ROA_Dum* and the OLS results with standard error clustered in year with *TBQ* as the DV. *ROA_Dum* is a dummy variable with a value of one if *ROA* is greater than median *ROA*, and zero otherwise. *ROA* means return on assets, which is measured as the ratio of profit after taxes to total assets. *TBQ* is Tobin's Q, which is the sum of the market value of the equity and the book value of the debt over the book value of asset. *INN* is the innovation index, which presents textual-based innovation-level data. *FSIZE* represents firm size, which is measured as the natural logarithm of total assets. *VAIC* is the value-added IC based on Pulic (2000), which is made up of HC, SC and financial capital. *FAGE* is the natural logarithm of days of establishment. *FLEV* is the ratio of total liabilities to total assets. *BSIZE* is the natural logarithm of the total number of directors at the board level. *BIND* is the ratio of independent directors to total directors at the board level. ***, ** and * denote 1%, 5% and 10% significance levels, respectively.

CONCLUSION

Discussion of Findings

This study examines the influences of innovation and IC on firm performance and the moderating effect of IC on the association between IC and firm performance. An innovation index, which comprises textual-based innovation-level data, is used to estimate the firm innovation levels of 19,152 firm-year observations of publicly listed Chinese firms from 2007 to 2019. This study performs regression analyses of the association among innovation, intellectual and IC, which is proxied by VAIC™. Firm performances are also tested using various regression techniques.

We find that firms with high innovation levels perform well. The study supports the idea of Wadho and Chaudhry (2018) that innovation creates competitive advantages and improves productivity. Our findings confirm that firms with high innovation levels can utilise their value-added novelty in the socioeconomic field and this factor can increase expected firm returns directly. The results are also incorporated with the belief where innovation is described as a crucial component of competitiveness. The overall findings corroborate the notion that innovation enhances firm performance level.

With respect to the main focus on the moderating effect of IC on the association between innovation and firm performance, this study confirms the moderating effect of IC on the association between innovation and firm performance. The results support the idea of Ko and Lu (2010) that firms should fully utilise resources in developing innovative services for competitiveness. Moreover, resource-based theory holds that the conditions of resources, which can bring competitive advantages to enterprises, are valuable, scarce, inimitable and irreplaceable (Barney, 1991). That is, whilst innovation is the lifeblood of firms to perform well, the investment of IC has substantially strengthened the positive impact of innovation on firm performance. Hence, innovation activities, as a main driver of firm performance, require the support of IC to endow competitive firm position.

Research Implications

Theoretical implications

The study contributes to literature that uses Schumpeter theory in explaining the role of innovation in firm performance. Firstly, the positive association between innovation and firm performance demonstrates that when a firm innovation level is increased, its performance level improves. Secondly, with respect to resourced-based theory, this research offers empirical evidence that IC is considered one of the valuable resources to improve firm performance. Moreover, IC is found as a helping hand to strengthen the positive association between innovation and firm performance. Therefore, the value encompassed by IC is pivotal because innovative and novel ideas have significant and positive effects on firm performance.

Managerial implications

Our findings have important managerial implications. In conjunction with other studies indicating that innovation has a positive impact on firm performance (Hizarci-Payne et al., 2021; Lee et al., 2019; Walker et al., 2015), our results imply that innovation is likely to improve firm performance. Therefore, the government or policymakers should set policies for firms to enhance firm innovation activities for boosting their competitiveness and sustainability. In this era of knowledge economy, the government may also provide a framework to promote IC usage, as it is a tool for value creation.

Bringing in innovative professionals and experts to provide new ideas to embark innovation activities is crucial for the management. Moreover, managers should continue to look for radical ways to change or improve product and process or service innovation for performance and survival. Innovative activities may include product and process innovations, R&D activities, patents or patent citations and new product or process announcements. Furthermore, firms must well integrate innovation activities with resources, particularly in IC to improve firm performance. Resource involvement, especially from IC, should be utilised in innovation activities effectively.

Limitations and Future Research Directions

This study also has several limitations. Firstly, it focuses only on publicly listed firms in China. Although this limitation may cast an issue of generalisation to the whole economy, this research focusing on one country can measure the performance of sample companies on the same country. Future studies may consider making a cross-country comparison that is heterogeneously different in the nature of a country's policy and structure. Secondly, defining innovation activities using secondary data is relatively difficult. Here, the innovation index, which involves textual-based data that measure the frequency of innovative related words that appear in firm financial reports, is used. Future research may consider examining the innovation activities through R&D expenditure or primary data, which can provide insights from different perspectives in the same area.

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NOTES

1. http://www.wingodata.cn/#/cn/pages/wenben?id=2&type=4&wenben=0)
2. Despite the criticism of the VAIC model, its continuous applications across multiple disciplines (Bhattacharjee & Akter, 2022; Dalwai & Salehi, 2021; Smriti & Das, 2018; Yousaf, 2022) suggest its usefulness as a proxy of intellectual capital.

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