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The Effect of R & D Investment and Knowledge Search on Innovation Performance: The New Evidence from High-Tech Enterprises in Guangxi

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Abstract

In the globalized and dynamic competitive environment, innovation performance is significant to enterprise performance. How R & D investment, knowledge search, network capability, and institutional pressure affect innovation performance are hurried to be tested. Under the view of multiple affective factors, we established the research model among R & D investment, knowledge search, network capability, and institutional pressure and innovation performance, and tested the model with using partial least squares based on data of 448 questionnaires with SMART-PLS. The findings indicate network capability has a positive effect on innovation performance; R & D investment has positive effect on Network capability; knowledge search positive effect on the Network capability; R & D investment positive effect on the innovation performance through the Network capability (mediator); knowledge search positive effect on the innovation performance through the Network capability (mediator); institutional pressure (moderator) positive effect on effect between Network capability and the innovation performance. There theoretical and practical contributions.

Keywords

R & D Investment, Knowledge Search, Innovation Performance, Network Capability, Institute Pressure

1. Introduction

In globalized and dynamic competitive environment, intense international com-

petition, fragmented and demanding markets, diverse and rapidly changing technologies make innovation gradually significant (Butollo, 2021). Offering products that cater to the wants and needs of target customers and marketing them more quickly and effectively than their competitors is more likely to create a sustainable competitive advantage (Darmawan & Grenier, 2021). Competitive advantages more depend on knowledge and technical skills and experience in creating new products (Qiu, Jie, Wang, & Zhao, 2020).

Innovation can be broadly described as the implementation of discoveries and inventions, and the process by which new results (whether products, systems, or processes) are produced (Zhuang, Williamson, & Carter, 1999). Ideally, innovation has the ability to improve performance, solve problems, add value and create a competitive advantage for the organization. The improvement of their own competitiveness, the optimization and upgrading of the industrial structure, and even the transformation of the economic development model all rely on continuous innovation (Luo et al., 2023). The process of innovation relies heavily on knowledge, nevertheless, there is a gap between the firm's knowledge and the knowledge required for innovation, firms must bring in external knowledge or develop the required knowledge to innovate successfully (Flor, Cooper, & Oltra, 2018). The division of knowledge search strategy, knowledge search strategy includes knowledge breadth search and knowledge depth search (March, 1991). The breadth and depth of knowledge search will have a nonlinear impact on innovation performance. Extensive knowledge search can enrich the original knowledge reserve of the enterprise by adding new differentiated knowledge, which can provide sufficient choices for the enterprise's problem-solving process. Through knowledge search, enterprises can widely obtain various explicit or tacit knowledge required for innovation (Cassiman & Valentini, 2016). Knowledge search is important for enterprises to supplement internal technology and resources, which can enhance the adaptability of enterprises to the environment, improve their technical capabilities and learning capabilities, and have an impact on enterprise performance (Chaochotechuang, Daneshgar, & Mariano, 2019).

Enterprises are affected by government, society and market systems, and at the same time, internal capabilities of enterprises are also key factors affecting innovation performance. Networked cooperation stimulates common learning and enhances corporate capabilities (Tsai, 2001). Networked innovations are more likely to succeed conceptualized network capability as four components-coordination, relational skills, partner knowledge, and internal communication that are distinct yet mutually supportive. For example, a firm with good relational skills should be able to acquire external knowledge, which in turn enables it to improve the knowledge of its partners. Building relationship capital may not happen naturally (Tootell et al., 2021). Developing network capabilities is an organization-wide dynamic process that is viewed as a higher-order resource (Cartwright & Davies, 2022). External policies and regulations, the market, and society form external institutional pressures. For enterprises, both the

government's command-and-control policies and market-based policies will have an impact on the innovation performance of enterprises, and there are differences in the degree and effect of the influence. It can be seen that institutional pressure affects internal and external knowledge dissemination, and transmission affects corporate innovation performance.

Previous research was carried out in one direction for the convenience of testing, so further research on the complexity of "hard" and "soft" aspects of innovation management has no more explanatory variables, including control and moderator variables (Prajogo & Ahmed, 2006). Judging from the existing literature research, there is still a certain gap in the research in related fields. In the field of research on the relationship between resource input and innovation performance, there is a lack of research that puts institutional pressure and network capabilities as influencing factors into the frame, both at the theoretical and practical levels.

The essence of innovation and development of high-tech industries is the process of improving the innovation performance of countless high-tech enterprises. Therefore, exploring the innovation process, mode and influencing factors of high-tech enterprises is the prerequisite for realizing innovation-driven development. This paper intends to take Guangxi high-tech enterprises as the research object, explore the influencing factors of innovation performance of Guangxi high-tech enterprises, verify the impact of R & D investment, knowledge search, and network capabilities on innovation performance, and establish a theoretical model based on the factors that affect the performance of Guangxi high-tech enterprises, as **Figure 1**. It explores the effects of R & D investment, knowledge search, and network capabilities on innovation performance, and the role they play in the process of affecting innovation performance, and what kind of relationship exists, and analyze whether it is established in the innovation process of Guangxi high-tech enterprises.

2. Literature Review and Hypotheses Development

Network competence is the ability to establish, handle, and utilize relationships or close relationships with external parties, the ability to interact with other

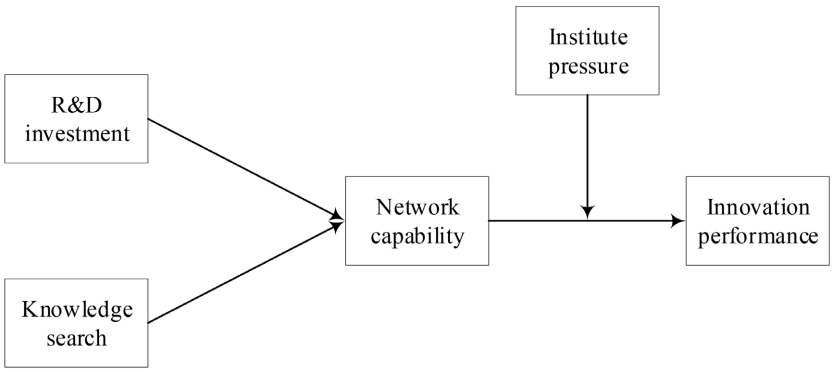

Figure 1. Research models.

organizations, and the ability to discover, develop, and manage relationships (Wilson & Daniel, 2007). Innovation performance is not only a process concept, but also means the inconsistency of environmental requirements, production process requirements, changes in industries and markets, changes in demographics, and changes in consumers' perceptions of products and services (Drucker, 1993). Coombs (1996) conducted a case study on the innovation strategy of large enterprises, and proposed that innovation performance is the result of enterprise R & D investment and process learning, and it is a very effective key indicator for measuring the innovation activities of R & D talents. S. Zhao and Li (2023) believes that with the development of modern network capabilities, corporate innovation performance will also be affected. This paper analyzes the impact of network capabilities on innovation performance from the two dimensions of innovation subject and resource allocation efficiency.

Network capabilities affect the resource allocation efficiency of enterprises, thereby promoting the innovation performance of enterprises. With the continuous improvement of network capabilities, the mobility of resource elements and the convenience of obtaining external information, resources and funds will also increase, forming an efficient innovation system for the rational flow and allocation of resources and information, improving the resource allocation efficiency of enterprises, and ensuring It improves innovation vitality and improves regional innovation performance (Zhao & Li, 2023). Schneckenberg (2015) believes that it is necessary to establish a flexible innovation system to ensure the rational flow of resources and information, so as to ensure the vitality of innovation. The system can also improve the development level of regional innovation network and enhance innovation ability. Therefore, with the improvement of network capabilities, the degree of openness of regional networks also increases, and it is more convenient for enterprises to obtain external resources, the efficiency of resource allocation is improved, innovation activities are further created and integrated, and innovation performance is improved (Hou, Hong, Wang, & Zhou, 2019).

To sum up, the improvement of network capabilities can strengthen the connection between innovation subjects, promote the sharing of information among innovation subjects, accelerate the flow of information, improve the efficiency of resource allocation, and promote the innovation performance of enterprises.

Therefore, this study proposes the following hypotheses:

H1: Network capability positively affects innovation performance.

R & D investment is the basis for enterprises to create new products, new processes, new designs, and new technologies, and plays an important role in improving the technological level and performance of enterprises (Hao et al., 2020). R & D investment depends on internal and external factors. Internal factors: the R & D investment of a firm is affected by firm characteristics such as firm size, cash flow and diversification and external factors: such as market Competition and technological opportunity (Levin, Cohen, & Mowery, 1985).

Hao et al. (2020) believe that the intensity of R & D investment will affect the relevance of each knowledge element in the knowledge network, affect the flow of information, and then affect the knowledge network structure and network capabilities.

Hao et al. (2020) believe that the R & D investment of enterprises affects the network capabilities of enterprises by affecting the knowledge network structure. With the increase of R & D investment, the R & D capability of the enterprise is improved, the stock of knowledge is increased, and the correlation between nodes in the knowledge network is also increased, that is, the network capability is enhanced. Connect knowledge base elements through structural holes to make information flow more smoothly. At this time, the process of research and development is moving closer to the market, and the risk of innovation is reduced. Therefore, the increase in R & D investment optimizes the structure of knowledge networks and improves the network capabilities of enterprises.

When R & D investment is at different intensities, it has different impacts on network capabilities. Using a sample of 269 companies listed on the main board of the electronic information industry from 2010 to 2019, using the threshold panel data model, Hao et al. (2020) studied the nonlinear relationship between knowledge network structural holes and short-term and long-term innovation performance of enterprises, and the threshold effect of R & D investment intensity is discussed. When the intensity of R & D investment is between 1.96% and 15.96%, network management ability has a significant positive impact on short-term innovation performance. When the intensity of R & D investment is between 5.72% and 10.64%, network management ability has a significant positive impact on long-term innovation performance. Lower R & D investment intensity can make network management ability promote short-term innovation performance, but to make network management ability have a positive impact on long-term innovation performance, R & D investment intensity needs to be increased by more than 5.72%. When the intensity of R & D investment is not higher than 15.96%, network management capability has a significant positive impact on short-term innovation performance, but to maintain a positive impact on long-term innovation performance, R & D input intensity should not exceed 10.64% (Dai & Cheng, 2013). Therefore, enterprises should be guided to optimize network management capabilities according to the intensity of R & D investment, so as to improve short-term and long-term innovation performance of enterprises.

To sum up, different R & D investment intensities have different effects on network capabilities, and the impact of R & D investment on network capabilities has a threshold effect. Therefore, this study proposes the following hypotheses:

H2: R & D investment positively affects network capability.

Reform economists consider knowledge seeking to be an organizational problem-solving activity and emphasize the role of search in helping organizations find sources of diversity, thereby enabling them to create new combinations of

technical and other knowledge (Nelson & Winter, 1982). Katila and Ahuja (2002) and Laursen and Salter (2006) divided knowledge search into search depth and search range breadth. The main external knowledge sources of knowledge search include users, suppliers, universities, research institutions, competitors, etc. In knowledge search, with or without formal agreements or contracts, some scholars divide knowledge acquisition channels into formal and informal acquisition ways and use knowledge acquisition methods to further define search breadth and depth (Chen, Zhang, & Wang, 2022). According to Ruan and Chen (2017), formal external knowledge is described as forming partnerships through formal agreements or contracts with suppliers, customers, peer companies, public institutions, etc. Informal external knowledge searches are non-contractual or beyond-contractual methods, such as informal contact with employees and reverse engineering. Laursen and Salter (2006) believe that the more extensive ways for enterprises to obtain information through knowledge search, the stronger the network capabilities of enterprises. Therefore, there is an impact relationship between knowledge seeking and network capabilities. Prashantham, Zhou, Dhanaraj, and Review (2020) believe that knowledge search can be divided into two dimensions: breadth and depth. This study studies the impact of knowledge search on network capabilities from the depth and breadth of knowledge search.

In the external environment of the enterprise, the network capability of the enterprise will be affected by the extensive knowledge search. Lew and Sinkovics (2013) believe that the network capabilities of enterprises may become an important source of valuable external knowledge outside the boundaries of enterprises to make up for the exhaustion or difficulties encountered by enterprises in the development or improvement of innovation capabilities or performance in existing fields. This kind of external knowledge obtained through extensive external knowledge search is an important opportunity for enterprises to improve innovation ability and innovation performance by promoting the creation of external new technologies, so the network capability of enterprises will change with the change of extensive knowledge search (Lew & Sinkovics, 2013). Other studies have shown that extensive knowledge search can significantly improve network capabilities, thereby improving the incremental innovation capabilities of enterprises (Mitsuhashi & Min, 2016).

The depth of knowledge search affects network capabilities. The impact of the firm's structural status on facilitating the firm's knowledge search process depends on the firm's network capabilities (Arranz, Arroyabe, & Fernandez de Arroyabe, 2020). In the process of enterprises promoting knowledge search, deep knowledge search will affect the embeddedness in network capabilities and help enterprises to improve their competitiveness (Basole, Ghosh, & Hora, 2018). Shi, Zheng, Zhang, and Liang (2020) show that when the relationship between the enterprise's deep knowledge search activities and the enhancement of innovation capabilities is strong, the enterprise's technological proximity and network capa-

bilities are higher.

To sum up, the breadth and depth of enterprise knowledge search will affect the enterprise's network capability, the deeper the knowledge search intensity, the stronger the network capability.

Therefore, this study proposes the following hypotheses:

H3: Knowledge search positively affects network capability.

Research and development (R & D) are a key determinant of long-term productivity and welfare (Jones & Williams, 2000). Spithoven and Teirlinck (2015) pointed out that the association between network resources and R & D investment is important, and if firms engage in other forms of network resources, they will also be interested in R & D outsourcing to supplement internal R & D activities. Vesalainen and Hakala (2014) pointed out that the network capability of enterprises refers to the ability of enterprises to establish, process and utilize relationships. Therefore, there is a correlation between network capability and R & D investment.

R & D investment has a positive impact on network capabilities. F. Wang, Chen, Wang, Lutao, and Vanhaverbeke (2014) believe that R & D investment affects network capabilities, and R & D investment does promote network capabilities. Zhu, Zhao, and Abbas (2020) indicated that R & D investment significantly and positively moderates the impact of innovation on network capabilities. Network capabilities have a positive effect on innovation performance. Hao et al. (2020) proposed that knowledge network capabilities have a significant positive impact on long-term innovation performance. The knowledge owned by the enterprise includes both the knowledge acquired from the network formed by voluntary cooperative innovators and the knowledge created by the enterprise itself. Knowledge, the greater the knowledge network capability, the greater the strength of the enterprise to implement the diversified innovation strategy. Kim, Lee, Park, Oh, and Economy (2011) proposed that enterprises' direct investment in technological innovation (per capita R & D investment, the ratio of R & D investment to sales, the ratio of R & D employees to total employees, etc.) innovation, number of patents, innovation indicators) have positive effects , and consider the importance of a comprehensive set of R & D capabilities (including learning and external network functions) when measuring the impact of R & D on firm innovation performance. Garousi Mokhtarzadeh, Amoozad Mahdiraji, Jafarpanah, Jafari-Sadeghi, and Cardinali (2020) pointed out that network capabilities, inter-organizational knowledge mechanisms, and inter-organizational learning have significant positive effects on performance. Parida and Örtqvist (2015) show that higher levels of financial slack combined with higher network and ICT capabilities produce the highest levels of innovation performance.

Network capability is affected by R & D investment and has an effect on innovation performance. Kim et al. (2011) proposed that the measurement of corporate performance should not be based solely on the intensity of R & D investment, but should consider a wider range of factors including learning and

external network capabilities. Spithoven and Teirlinck (2015) indicated that the host country's huge high-skilled network capability enhanced the parent company's ability to discover advantages and opportunities in the business environment. Therefore, the parent company was more motivated to increase international R & D investment and absorb new foreign technologies. Network capabilities played an important role in corporate innovation. There is a moderating effect between performance and R & D investment. Therefore, we propose the following hypotheses:

H4: Network capability has mediating effects between R & D investment and innovation performance.

From an organizational point of view, capability can be understood as "an organization's ability to perform a set of coordinated tasks and utilize organizational resources to achieve a specific end result" (Helfat & Peteraf, 2003). The concept of network capability originated from the increasingly networked living environment of enterprises. It emphasizes that enterprises can obtain resources and create value more effectively through the development and use of networks and network relationships. Hakansson (1987) proposed the concept of network capabilities at first.

At present, academia and enterprise managers are paying more attention to the network capabilities of enterprises. Network capabilities have two dimensions: network management capabilities and network construction capabilities. While traditionally the focus has been on technical capabilities and their impact on firm success, recent research has included network management capabilities (Day, 1994). Nordin, Ravald, Moller, and Mohr (2018) define network management capabilities as the set of activities undertaken by the core firm to define and enable the evolution of the network to support the emergence of new business domains and the future position of the core firm within them. From a business perspective, resources are an essential part that needs to be mobilized by providing convincing explanations to guide innovation and further develop the field. The network construction ability refers to the ability of the focus enterprise to improve the network structure configuration. Knowledge search requires the integration and absorption of enterprise network capabilities. Z. Zhao, Lin, Shen, Zhang, and Huang (2020) believe that continuous knowledge search will lead to redundant enterprise resources, so various capabilities of enterprises need to be pruned and absorption. S. Zhao and Li (2023) found that direct and dense connections in the network provide more resource sharing and information spillover benefits than indirect connections, because they bring more opportunities for innovation and require enterprises to develop own network capabilities to identify and integrate knowledge-seeking content. Searching for knowledge requires enterprises to use their network capabilities to identify their available creative value, and to motivate enterprises to carry out knowledge transfer, knowledge integration and knowledge creation, thereby improving the innovation performance of enterprises (Pemsel, Wiewiora, Müller, Aubry, & Brown, 2014).

Network capabilities positively affect innovation performance. First, in terms of network construction capabilities, firms use their capabilities to enable them to establish good relationships with partners, thereby promoting innovation performance. In the context of increasing technological complexity, establishing a network with different partners can enable companies to use external relationships to jointly explore innovative development activities (Parida & Ortqvist, 2015). Network capabilities create sustainable win-win situations among partners and make them more likely to engage in joint innovation activities (Walter et al., 2006). However, firms that lack the necessary networking capabilities inhibit their ability to benefit from networking due to opportunistic behavior (Parida & Ortqvist, 2015). Additionally, companies are more interested in partnering with companies that already have network capabilities, because the likelihood of a successful relationship is higher due to the ease of aligning goals and incentives. Second, there is a positive correlation between corporate network management capabilities and innovation performance. In enterprises, forming and managing external relationships provides information and knowledge, which can guide enterprises to explore and develop new areas of cooperation and promote market innovation (Lam, Nguyen, Le, & Tran, 2021). Moreover, performing network management tasks with the necessary qualifications may facilitate a more market-oriented internal innovation process, since information about markets can be obtained within firms through inter-organizational relationships (Masa'deh, Al-Henzab, Tarhini, & Obeidat, 2018).

To sum up, the enterprise's external knowledge search requires the integration and reorganization of network capabilities, thereby promoting the development of network capabilities. Enterprise network capabilities can also promote the development of innovation performance. In short, network capabilities play a mediating role in the mechanism of knowledge search on innovation performance. Therefore, we propose the following hypotheses:

H5: Network capability has mediating effects between knowledge search and innovation performance.

For institutional theory, DiMaggio and Powell (1983) focus on social influence on conformity and how it shapes organizational behavior. Institutions "are the rules of the game in society, or more formally, the constraints designed by humans that shape human interactions" (North, 1990). In order to gain legitimacy, minimize uncertainty, and increase the intelligibility of organizational actions and activities, organizations must abide by institutionalized regulations (Jeong & Kim, 2019). According to the study of DiMaggio and Powell (1983), institutional pressure comes from the institutional environment, which forces enterprises to adopt common views and rules. To analyze why firms, adopt similar behaviors, i.e., "isomorphic" processes, they further divide institutional pressures into three categories: normative, imitative, and coercive pressures. These sources of stress are: customers, suppliers and competitors. Under institutional pressure, corporate innovation will change. According to institutional theory, Dacin (1997) and Suchman (1995) believe that institutional pressure comes from environmental

factors. In order to obtain legitimacy and market status, enterprises are forced to participate in some special social or commercial activities, such as innovation assimilation. innovation has a corresponding impact. Institutional constraints include access to resources and social legitimacy. Institutional pressures are also involved when it comes to network capabilities. In most developing countries, government support and social legitimacy are crucial for business. Related to informal interests, social legitimacy helps organizations gain social resources, such as power networks (Li, Poppo, & Zhou, 2008). Therefore, institutional pressure can moderate the impact mechanism of innovation performance and network capability.

Under the premise of little institutional pressure and government encouragement, the impact of corporate network capabilities on driving innovation performance. With government encouragement, more and more companies are pursuing product innovation by collaborating with universities and research institutes. Previous research has shown that organizations with high social legitimacy are more likely to gain social confidence and a stronger brand image which may help them innovate. Due to the participation of network capabilities, the improvement of enterprise innovation performance is very significant. Since a firm's successful innovation depends on understanding customers through market information processing, obtaining market intelligence helps firms adjust their product portfolios to improve their innovation performance.

When isomorphic pressure and institutional pressure change, the existing capabilities and innovation activities of enterprises will change accordingly. Social legitimacy reflects "a general perception or assumption that an entity's behavior is desirable, appropriate, or appropriate within some socially constructed system of norms, values, beliefs, and definitions" (Suchman, 1995). When the institutional pressure increases, enterprises adjust their business activities in order to meet the legality. Matusik and Hill (1998) argue that in a competitive environment, firms face enormous relative pressure to achieve greater efficiency through lower margin-margin prices or higher value creation. Companies also need to expand their knowledge and capabilities and modify existing products and services to improve the efficiency of their operations. According to institutional theory, the performance of green innovative enterprises is often related to institutional factors (Wu, Xu, Niu, & Tao, 2022; Yao, Zeng, Sheng, & Gong, 2021). Due to external government pressure, competitors should actively respond by adjusting their active environmental strategic capabilities according to the requirements of the external environment (Garcés-Ayerbe, Rivera-Torres, & Murillo-Luna, 2012). In emerging markets, due to the underdeveloped institutional infrastructure, the government continues to affect resource allocation, thereby affecting corporate activities (Wang, Hong, Kafouros, & Wright, 2012). According to institutional theory, external isomorphic pressures from competitors, trading partners, and customers may usually affect firms' interpretation of the environment, especially their innovative behavior and decision-making.

To sum up, the promotion of innovation performance by corporate network

capabilities is moderated by institutional pressure. When institutional pressure is low, firms use network capabilities to actively drive innovation performance. However, when the institutional pressure is high, enterprises have to adjust their corporate activities to adapt to social legitimacy, so that the influence of network capabilities on innovation performance is weakened. Based on this, it can be concluded that institutional pressure regulates the impact of corporate network capabilities on innovation performance. Therefore, we propose the following assumptions:

H6: Institute pressure moderates the effect of network capability on innovation performance.

3. Materials and Methods

3.1. Sample and Procedure

This research investigates the situation of 6869 high-tech enterprises in Guangxi. Through the form of online questionnaire, Wenjuanxing (https://www.wjx.cn/), a total of 448 pieces of data were collected, and the cycle of questionnaire distribution was 7 days. 448 participants respond our questionnaires. 69.4% are males, 73.9% are bachelors, and 58.3% of all respondents range from 40 s to 50 s. Half of respondents worked 6 to 10 years. 85.5% are senior managers. 52.7% from private company, 21.2% from public company, 17.6% from foreign-funded company, and others from joint venture company. 44.4% of all respondents' company run over than 10 years, and 64.5% hire over than 100 employees.

3.2. Measures

R & D investment

A significant portion of recent R & D investments may be spent on finding ways to comply with various new environments and other regulatory constraints (Griliches, 1980). Jarallah and Kanazaki (2012) calculate R & D intensity by means of the natural logarithm of the ratio between R & D expenditure and the total share of sales. Ruirui Su (2015) pointed out that under normal circumstances, the special expenditure for new product development and the total annual R & D expenditure of the enterprise are allocated by the enterprise management personnel. The intensity of R & D investment can be calculated by dividing the R & D expenditure by the sales revenue express. This study uses the research Hagedoorn and Cloodt (2003) as a reference. In order to better study R & D investment, we introduce the indicator of R & D intensity and adopt Hagedoorn and Cloodt (2003) For the 4 items, use 4 dimensions to measure R & D intensity, for example, "R & D personnel investment (number of R & D personnel/total number of employees)" to measure R & D intensity.

Knowledge search

Pavitt (2002) knowledge search was firstly proposed by Nelson and Winter to describe the problem-solving activities to improve existing knowledge and product technology, and was later applied in the field of strategic management to ex-

plain the impact of external knowledge sources on enterprises. Laursen and Salter (2006) used two dimensions of knowledge breadth and knowledge depth to measure, using the number of different external knowledge sources to measure knowledge breadth, and the frequency of knowledge source exchanges to measure knowledge depth. Grimpe and Sofka (2009) divided breadth knowledge search into reactive search and prospective search. This study starts from the two dimensions of deep knowledge search and breadth knowledge search, adopts the research and related scales of Grimpe and Sofka (2009) integrates the above research using Six items are measured, and the specific item is "enterprises attach great importance to discovering knowledge in existing fields from outside the organization".

Network capability

Vesalainen and Hakala (2014) stated that network capability is the core of customer capability formation. Huanyong Ji (2017) measured network capabilities from three dimensions: network vision, network construction and network management. Zhaoquan Jian, Min Li, and Sai Ye (2018) measured network capabilities from two dimensions of network management tasks and network management qualifications. This study evaluates from the two dimensions of network construction ability and network management ability, and uses Ritter (1999) to measure network ability. Take one item "in your company, the relationship between managers and employees there are great channels for feedback and communication".

Institutional pressure

Darus, Mad, Nejati, and finance (2015) believes that external pressure from stakeholders such as shareholders, customers, and the government will affect the social responsibility report of financial institutions. Voinea and van Kranenburg (2018) measure all indicators on a 5-point scale, using two items to measure pressure on the political system and three items to measure exogenous variable pressure on regulators. An exploratory factor analysis based on principal factor analysis, utilizing a publicly available search volume index, was used to assess stressful institutions (Garrone et al., 2018). Ashraf, Arshad, Yan, and Management (2018) divide the main sample into two sub-samples of countries with weak and strong political institutions, and use the political constraint index to measure stressful institutions. This study adopted previous researchs and adopted regulatory pressure, compulsory pressure, imitation pressure three dimensions are used to measure institutional pressure, and six items are used to measure institutional pressure.

Innovation performance

Cordero (1990) proposed that managers of enterprises investing in R & D should evaluate their performance, and proposed a performance evaluation model for R & D investment enterprises. Chi Renyong (2003), Ninghua Qu (2010), Yingsi Zhao (2014), Zhijun Chen and Qinnan Miao (2014) measured 15 items from three angles of innovation source scale, innovation relationship quality,

and innovation relationship stability. This study refers to the above-mentioned literature, adopts the mearsuements of Jiang Keshen and Zhu Hui (2015) and Zhengang Zhang et al. (2016). For example: number of patents, publications, and new product quality and stability compared to competitors.

3.3. Analytical Approach

Data analysis was done using partial least squares structural equation modelling (SEM) with Smart-PLS4 (https://www.smartpls.com/). PLS-SEM was chosen because it has the ability to examine the relationship between several variables simultaneously. Our model examines five variables.

4. Results

4.1. Measurement Tests

The characteristics and distribution of data as **Table 1**. Standard deviations, means, kurtosis, and skewness indicate normal. There are no outliers. The means of all items range from 2.900 to 4.205 which in the range of min and max answers. The values of standard deviations are rational. The values of Kurtosis and Skewness in range of −3 and 3 which means the items distributes normality (Hair Jr., Hult, Ringle, & Sarstedt, 2021).

Construction reliability and validity are tested. Construct indicator reliability and construct internal consistency reliability are tested separately. Construct reliability assesses the level of internal consistency of the measures used Jöreskog's composite reliability rho and Cronbach's alpha were used as the metrics. As **Table 2**, the values of Cronbach's alpha are higher than 0.7 which means the construct reliability is good. The values of Rho_A are higher than 0.6 also state the high construct reliability (Hair Jr. et al., 2021).

Convergent validity of the constructs was established as the average variance extracted (AVE) for every construct was above the 0.40 minimum acceptable threshold, meaning the constructs explain more than 40% of their indicator's variance.

Discriminant validity is assessed through the Fornell-Larcker and the Hetero trait–Monotrait Ratio (HTMT) and cross-loadings. The value less than 0.9, as **Table 3**, which means discriminant validity is normal (Hair Jr. et al., 2021).

In addition, collinearity among latent variables using the VIF values, as **Table 2**, the values of VIF less than 5 which means there are no collinearity problems.

4.2. Hypotheses Test

The structural model was examined using the path coefficients, t-statistics, and *p*-values for significance.

As **Figure 2**, with using PLS-SEM, the path coefficients are tested. There are positive and significant effects among latent variables. The *p*-values of each effect are lower than 0.01 (*** means value lower than 0.01) which means the paths are significance.

Table 1. Descriptive statistics of variables.

Items	Mean	Min	Max	SD	Kurtosis	Skewness
DK1	3.973	1	5	0.845	0.172	−0.640
DK2	4.062	1	5	0.827	0.722	−0.854
DK3	4.254	1	5	0.772	0.467	−0.853
WK1	4.125	1	5	0.817	0.524	−0.801
WK2	4.071	1	5	0.858	0.496	−0.819
WK3	4.094	1	5	0.796	0.328	−0.702
IN1	2.893	1	5	1.385	−1.281	0.046
IN2	3.768	1	5	0.896	0.814	−0.758
IN3	2.509	1	5	1.313	−0.972	0.438
IN4	3.978	1	5	0.759	0.152	−0.455
IN5	3.984	1	5	0.852	0.483	−0.710
IN6	4.020	1	5	0.841	0.478	−0.693
IP1	3.902	1	5	0.866	0.312	−0.596
IP2	3.871	1	5	0.914	0.170	−0.638
IP3	3.757	1	5	0.948	−0.503	−0.412
IP4	3.685	1	5	0.978	−0.177	−0.542
IP5	3.940	1	5	0.801	0.696	−0.675
IP6	3.839	1	5	0.887	0.058	−0.566
IP7	3.915	1	5	0.867	0.536	−0.722
RD1	3.574	1	5	0.986	−0.555	−0.283
RD2	3.442	1	5	1.090	−0.781	−0.229
RD3	2.900	1	5	1.144	−0.853	0.171
RD4	4.136	1	5	0.851	0.834	−0.961
RD5	4.163	1	5	0.867	0.843	−1.022
WC1	4.205	1	5	0.696	1.256	−0.781
WC2	3.958	2	5	0.813	−0.466	−0.372
WC3	3.656	1	5	0.967	−0.518	−0.351
WC4	3.906	1	5	0.879	0.061	−0.608
WC5	3.984	1	5	0.934	0.010	−0.727
WC6	3.853	1	5	0.989	0.087	−0.743
WM1	4.114	1	5	0.792	0.803	−0.773
WM2	3.844	1	5	0.979	−0.115	−0.643
WM3	4.058	1	5	0.819	0.296	−0.719
WM4	4.071	1	5	0.850	1.268	−0.968
WM5	4.228	1	5	0.806	1.078	−1.028

Table 2. Item loading and construct reliability.

Items	Factor loading	VIF	CA	Rho_A	CR	AVE
Knowledge search (KS)			0.746	0.749	0.825	0.441
DK1	0.587	1.201				
DK2	0.691	1.383				
DK3	0.707	1.425				
WK1	0.684	1.353				
WK2	0.676	1.387				
WK3	0.634	1.300				
Institutional pressure (IN)			0.766	0.658	0.719	0.441
IN1	0.346	1.194				
IN2	0.695	1.307				
IN3	0.066	1.180				
IN4	0.726	1.320				
IN5	0.639	1.233				
IN6	0.710	1.284				
Innovation performance (IP)			0.801	0.803	0.855	0.458
IP1	0.608	1.286				
IP2	0.728	1.622				
IP3	0.687	1.454				
IP4	0.645	1.358				
IP5	0.702	1.488				
IP6	0.642	1.338				
IP7	0.715	1.571				
R & D investment (RD)			0.751	0.807	0.808	0.464
RD1	0.607	1.908				
RD2	0.668	1.935				
RD3	0.487	1.497				
RD4	0.798	1.458				
RD5	0.797	1.411				
Network Capability (NM)			0.782	0.787	0.834	0.416
WC1	0.577	1.303				
WC2	0.649	1.465				
WC3	0.484	1.211				
WC4	0.516	1.208				

Continued

WC5	0.572	1.281
WC6	0.595	1.369
WM1	0.562	1.273
WM2	0.501	1.200
WM3	0.608	1.336
WM4	0.517	1.200
WM5	0.577	1.299

Note. CA is Cronbach's alpha; CR is composite reliability; AVE is average variance.

Table 3. Discriminant validity.

	IN	IP	KS	NM	RD
IP	0.890				
KS	0.804	0.779			
NM	0.867	0.897	0.898		
RD	0.551	0.589	0.584	0.598	
IN × NM	0.346	0.223	0.306	0.399	0.191

Note. IN is institute pressure; IP is innovation performance; KS is knowledge search; NM is network capability; RD is research and development investment.

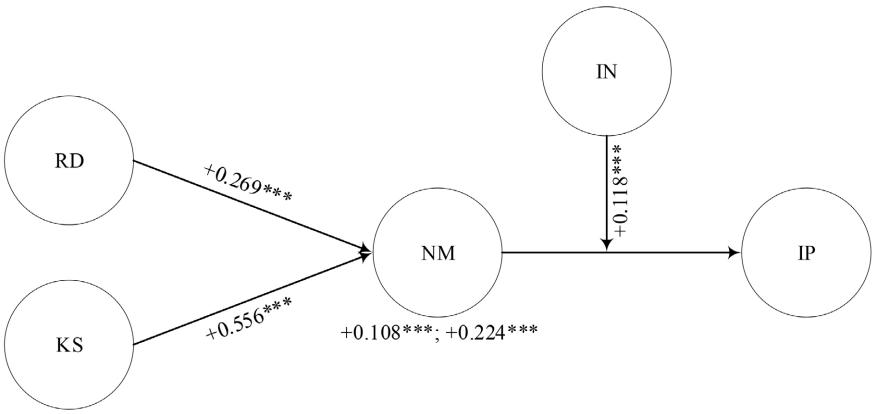

Figure 2. Structural model.

As Table 4, the hypotheses are tested with SMART-PLS. Network capability (NM) positively affects the innovation performance (IN), the estimate value is 0.403 and the *p*-value is under than 0.000, hypotheses 1 is accepted. R & D investment (RD) positively affects the Network capability (NM), the estimate value is 0.269 and the *p*-value is under than 0.000, hypotheses 2 is accepted. Knowledge search (KS) positively affects the Network capability (NM), the estimate value is 0.556 and the *p*-value is under than 0.000, hypotheses 3 is accepted. R & D investment (RD) positively affects the innovation performance (IN) through

Table 4. Hypothesis testing.

Hypotheses	Paths	Original sample	Sample mean	Standard deviation	*t* statistics	*p* values	Decision
	IN → IP	0.355	0.355	0.058	6.169	0.000	
	KS → IP	0.069	0.068	0.050	1.390	*0.165*	
	RD → IP	0.138	0.138	0.043	3.199	0.001	
H1	NM → IP	0.403	0.405	0.058	6.921	0.000	accepted
H2	RD → NM	0.269	0.270	0.044	6.143	0.000	accepted
H3	KS → NM	0.556	0.559	0.041	13.584	0.000	accepted
H4	RD → NM → IP	0.108	0.109	0.023	4.676	0.000	accepted
H5	KS → NM → IP	0.224	0.226	0.038	5.902	0.000	accepted
H6	IN x NM → IP	0.118	0.120	0.053	2.243	0.025	accepted

the Network capability (NM), the estimate value is 0.108 and the *p*-value is under than 0.000, hypotheses 4 is accepted. Knowledge search (KS) positively affects the innovation performance (IN) through the Network capability (NM), the estimate value is 0.224 and the *p*-value is under than 0.000, hypotheses 5 is accepted. Institutional pressure (IN) positively affects effect between Network capability (NM) and the innovation performance (IN), the estimate value is 0.118 and the *p*-value is under than 0.05, hypotheses 5 is accepted. In addition, the effect of knowledge search on innovation performance is insignificance, the *p*-value is 0.165 which bigger than 0.05 (sloped).

5. Conclusion, Implications and Limitations

5.1. Conclusion

Under the competitive environment, and with the impact of big data, knowledge information, network capability, innovation performance is key factor to firm performance. We collected 448 questionnaires from high-tech enterprises in Guangxi, China, and used SMART-PLS to test the research model of this research. As results, network capability has positive effect on innovation performance; R & D investment has a positive effect on Network capability; knowledge search positive effect on the Network capability; R & D investment positive effect on the innovation performance through the Network capability; knowledge search positive effect on the innovation performance through the Network capability; institutional pressure positive effect on effect between Network capability and the innovation performance. In addition, R & D investment and institutional pressure have a positive effect on innovation performance.

5.2. Theoretical Implications

This paper makes a number of theoretical contributions. First, the new study contributes to the body of literature previously accessible on innovation perfor-

mance by offering a more detailed understanding of innovation, investment, knowledge search, and network capabilities. Our research fills a theoretical gap brought about by a lack of studies on investment, knowledge search, and network capacity. The theoretical holes in the links between investment, knowledge search, and network capacities are also filled by our analysis. Second, input output analysis is a fresh research angle on the related topic of innovation. Initial contributions to economic study were made by input-output analysis. It is a pioneer in the field of innovation studies, extending this idea via research. Third, it aids in the development of new research.

5.3. Practical Implications

According to the study's findings, R & D spending has no discernible impact on innovation output, which has several application-specific implications. First, it's not always true that greater investment leads to more innovation. The capacity of the company to shift investments to innovative performance is necessary. The second factor in enhancing innovation performance is knowledge search. By enhancing the network management or building capabilities that act as mediating factors, it can influence innovation performance. Third, network skills are crucial for enhancing innovation performance and transferring the effects of other relevant variables. The performance of a corporation depends on its network capacity (Ketchley & El-Rayyes, 2021).

5.4. Limitations and Future Research Directions

The managers of high-tech companies were the target group for the study's sample, therefore only their perspectives can be supported by the findings. To increase representativeness, there should be participation from a variety of high-tech businesses. In addition, Israel (1992) believed that the credibility of sample sampling depends on many factors, such as data analysis and sample precision, reliability level and validity level. This study adopts a reliability level of 0.05. Although it is a general sampling practice, judging from the data collection, the more data, the higher the accuracy. Although the sample size of this study reached the general sampling level, the larger the sample size will be better. Future study should use a larger sample size due to the short research time. Through the capacities of the organization, a variety of elements have the capacity to influence innovation performance. More aspects need to be examined in next studies. There are several ways to apply the research view of input output analysis to related research.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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