

Liu, Depeng; Hou, Renyong

Article

Impact of inbound open Innovation on Chinese advanced manufacturing enterprise performance

International journal of knowledge management

Provided in Cooperation with:

ZBW OAS

Reference: Liu, Depeng/Hou, Renyong (2023). Impact of inbound open Innovation on Chinese advanced manufacturing enterprise performance. In: International journal of knowledge management 19 (1), S. 1 - 19.

<https://www.igi-global.com/ViewTitle.aspx?TitleId=317224&isxn=9781668479001>.

doi:10.4018/IJKM.317224.

This Version is available at:

<http://hdl.handle.net/11159/653706>

Kontakt/Contact

ZBW – Leibniz-Informationszentrum Wirtschaft/Leibniz Information Centre for Economics
Düsternbrooker Weg 120
24105 Kiel (Germany)
E-Mail: [rights\[at\]zbw.eu](mailto:rights[at]zbw.eu)
<https://www.zbw.eu/>

Standard-Nutzungsbedingungen:

Dieses Dokument darf zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden. Sie dürfen dieses Dokument nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, aufführen, vertreiben oder anderweitig nutzen. Sofern für das Dokument eine Open-Content-Lizenz verwendet wurde, so gelten abweichend von diesen Nutzungsbedingungen die in der Lizenz gewährten Nutzungsrechte. Alle auf diesem Vorblatt angegebenen Informationen einschließlich der Rechteinformationen (z.B. Nennung einer Creative Commons Lizenz) wurden automatisch generiert und müssen durch Nutzer:innen vor einer Nachnutzung sorgfältig überprüft werden. Die Lizenzangaben stammen aus Publikationsmetadaten und können Fehler oder Ungenauigkeiten enthalten.

Terms of use:

This document may be saved and copied for your personal and scholarly purposes. You are not to copy it for public or commercial purposes, to exhibit the document in public, to perform, distribute or otherwise use the document in public. If the document is made available under a Creative Commons Licence you may exercise further usage rights as specified in the licence. All information provided on this publication cover sheet, including copyright details (e.g. indication of a Creative Commons license), was automatically generated and must be carefully reviewed by users prior to reuse. The license information is derived from publication metadata and may contain errors or inaccuracies.



<https://savearchive.zbw.eu/terms-of-use>

Impact of Inbound Open Innovation on Chinese Advanced Manufacturing Enterprise Performance

Depeng Li, Wuhan University of Technology, China*

Renyong Hou, Wuhan University of Technology, China

ABSTRACT

From the perspective of network embedding, this paper deeply analyzes the relationship between corporate absorptive capacity, environmental turbulence, and corporate innovation performance. Based on network embedding theory, knowledge management theory, and research data on advanced manufacturing enterprises in the middle reaches of the Yangtze River in China, this paper uses structural equation modeling for empirical analysis. (1) Environmental turbulence affects firms' innovation performance. When the external environment is highly turbulent, consumer demand can force companies to embed in external network organizations to obtain more heterogeneous resources, reduce the innovation cycle, and improve corporate innovation performance. (2) Network embedding can improve the enterprises' innovation performance through knowledge and value chains. (3) Enterprises' absorptive capacity plays an important role in improving innovation performance. Research shows that an enterprise with a stronger absorptive capacity is more able to improve its innovation performance.

KEYWORDS

Absorptive Capacity, Environmental Turbulence, Inbound Open Innovation, Innovation Performance

1. INTRODUCTION

The advanced manufacturing industry involves advanced manufacturing technology and high value-added processes (Zhang, 2018), and it has an important position in national and industrial competition. Although China has become the world's second-largest economy, the core technologies in its manufacturing sector are not as the advanced levels used internationally. Breaking through the dilemma of technological innovation and improving the innovation performance of China's advanced manufacturing enterprises have become urgent problems to be solved. In recent years, countries all over the world have focused on the development of the advanced manufacturing industry and the strategic goal of economic development, which has created a new industrial revolution. As a result,

DOI: 10.4018/IJKM.317224

*Corresponding Author

This article published as an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0/>) which permits unrestricted use, distribution, and production in any medium, provided the author of the original work and original publication source are properly credited.

developed countries around the world have formulated policies to accelerate the development of the manufacturing industry. As countries focus on “re-industrialization” and other developed countries call for their manufacturing companies to return, China has proposed the “Made in China 2025 Plan” to address the powerful impact on its advanced manufacturing industry. In today’s knowledge economy era characterized by fierce competition, an advanced manufacturing enterprise, that relies only on traditional closed innovation can no longer meet the market demand and, to innovate, requires increasing participation from external resources. Chinese enterprises that rely only on their internal resources to carry out innovation activities will face difficulties in adapting to the rapidly developing market demand. Therefore, scientific and technological enterprises begin to turn to the mode of open innovation and learn the concept of open innovation. By making full use of internal and external knowledge and resources, enterprises can improve their ability of independent innovation. Enterprises need to continuously obtain external heterogeneous resources for enterprise innovation activities to produce better products and obtain higher profits. However, how can enterprises maintain good innovation performance and whether there is an intermediate variable mechanism remain to be verified. Although the theoretical and practical research on open innovation has made positive progress, the existing research still has the following shortcomings: (1) few scholars pay attention to the impact of inbound open innovation on advanced manufacturing enterprises’ innovation performance of advanced manufacturing enterprises; (2) few scholars regard environmental turbulence as an important factor that affects enterprise innovation performance; and (3) most scholars’ research on network embedding remains from the macro perspective; these studies seldom explore the impact of network embedding on enterprise innovation performance from the perspective of knowledge mobility. Therefore, this paper adopts the network embedding perspective to explore the relationship between environmental turbulence, the strength of firm’s absorptive capacity, and a firm’s innovation performance. This paper also studies the effect of knowledge and value chains embedded on firm’s innovation performance clarifies the mechanism of embedded networks, environmental turbulence, absorptive capacity, and innovation performance, and puts forward valuable suggestions. It is hoped that the research of this paper can give a good enlightenment to the enterprises that are carrying out open innovation.

2. LITERATURE REVIEW

In 2003, American professor Chesbrough (2006) proposed the concept of open innovation and noted that open innovation could break through enterprises’ traditional closed innovation model to introduce external innovation capabilities. Enterprises’ competitive advantages often arise from the more effective utilization of others’ innovation results. The academic community recognizes that open innovation is divided into two aspects according to the flow direction indicated: inbound open innovation and outbound open innovation. Inbound open innovation is an activity in which enterprises integrate valuable external ideas, knowledge and technology into internal applications and commercialization (Fosfuri, 2006). Outbound open innovation is an activity through which an enterprise becomes a source of knowledge for other organizations, and exports its valuable ideas, knowledge, and resources to enable external organizations to carry out commercial activities (Dahlander, 2010). Compared with enterprises that only pay attention to using internal resources for product production and ignore external resources, enterprises that follow inbound open innovation have higher innovation efficiency and rates of return. Zhu(2017) believes that the position of an enterprise in the innovation network often reflects the opportunity of acquiring new knowledge, which is an important external environmental factor affecting the implementation effect of introverted open innovation. According to the research of Chen(2016), enterprises implementing introversion and open innovation will accelerate their internal research and development speed after getting beneficial resources, so that they can launch new products faster than their peers in the market and obtain market share and innovation performance. Numerous studies confirmed that inbound open innovation has a positive effect on enterprises’ innovation output. More than 30% of the enterprises in product

innovation achieved their own innovation goals by cooperating with external innovation entities or embedding them into their external knowledge chains to obtain heterogeneous knowledge resources.

The influence of external environmental turbulence on the enterprise has become an important factor that cannot be ignored during the enterprise development process. Goll(1997) found that external environmental turbulence can affect enterprises' organizational structures and organizational strategies. Sirmon(2007) noted that environmental turbulence could bring both threats and opportunities to enterprises. Duncan (1972) divided the environment into internal and external environments, first dividing the uncertainty of the environment into the concepts of complexity and environmental turbulence. Zhang(2014) defined environmental turbulence as the range and speed of environmental change, and divided it into dynamic environment and static environment according to the rage and speed of change. Dess(1984) noted that environmental turbulence is the rate and unpredictability of changes in a company's external environment of a company. Jauch and Kraft (1986) divided environmental turbulence into four dimensions: uncertainty of industry technology, uncertainty of market competition, uncertainty of customer demand, and uncertainty of resource endowment. Jaworski & Kohli (1993) divided external environmental turbulence into market turbulence, technical turbulence, and competitive intensity. Most scholars believe that environmental turbulence includes two dimensions: technological turbulence and market turbulence. Zhu(2011) also made an empirical study on China and showed that market and technology together caused environmental turbulence. Calantone(2003) noted that compared with mature large enterprises, innovative enterprises are more sensitive to the policy and institutional environment than mature, large enterprises, and enterprises need to adjust their organizational innovation behaviors according to the turbulence in the environment.

In 1957, Hungarian economist Karl first put forward the concept of embeddedness. In 1985, an increasing number of scholars conducted in-depth studies on the concept of embedment from different perspectives after Granovetter(1985) reinterpreted the concept of embedment from the perspective of interpersonal relationships. The advantages of the traditional closed innovation model are no longer obvious, and its innovation resources are limited. Completing a set of technological innovation activities for products within the enterprise alone is even more difficult. Therefore, knowledge-intensive advanced manufacturing enterprises, they must be embedded in the innovation network and obtain the various resources needed for innovation through a good network. At the same time, advanced manufacturing enterprises' absorptive capacity becomes very important if they want to transform external knowledge into their own innovation resources. Knowledge-intensive enterprises gradually find that external resources can bring greater value to them and improve their innovation performance more effectively as the division of labor in industrial globalization becomes increasingly detailed. If an enterprise wants to improve its innovation capabilities, the first capability that needs to be improved is the ability to acquire heterogeneous knowledge. Embedding knowledge chains can help enterprises acquire complementary knowledge and expand their own knowledge stock, so as to improve their innovation ability and produce products that can meet consumer needs (Baptista, 2007). Porter (1985) used the value chain method to analyze the sources of enterprises' competitive advantages and called the interrelated process of value creation a value chain, which was the first time that the concept of a "value chain" was put forward. Gereff (2003) further proposed the concept of a "global value chain" based on Porter. He noted that all companies need to climb to the top of the value chain, and the process of climbing pushes them into the global value chain. At the same time, value chain embedding promotes enterprise innovation through the acquisition of innovation resources and the selection of business partners. An enterprise that is embedded in an external network can promote collaboration opportunities with other enterprises but improves the ability of the enterprise to find high-quality resources. Pietrobelli (2011) noted that value chain embedding plays an important role in acquiring knowledge, improving learning capabilities, and enhancing innovation capabilities for latecomers. Cohen (1990) found that companies with high absorptive capacity are more competitive after receiving external resources and more efficiently transform external resources into their competitive advantages.

3. RESEARCH DESIGN

3.1 Proposed Hypotheses

3.1.1 *Impact of Environmental Turbulence*

As is known to all, knowledge is the most important strategic resource for every company. Advanced manufacturing companies are more sensitive to the dynamics of the external environment because they need to continuously obtain heterogeneous knowledge resources from outside the organization. Haleblian (1993) and Lichtenthaler (2009) proposed the classification of environmental turbulence, technological turbulence, and market turbulence. Technological turbulence refers to the speed of industrial-technological change and development. Market turbulence refers to customer preferences and changes in competitors and substitutes. When technological turbulence is higher, companies must accelerate technological updates to meet consumer demand for new technologies and new products. Companies are more willing to cooperate with other companies in the network organization to master the industry's leading technology and occupy more consumer markets. Enterprises have a strong thirst for heterogeneous knowledge resources. Thus, they take the initiative to absorb and learn new technologies from network organizations, which assists in improving the degree of an enterprise's embeddedness in the network, allowing it to quickly obtain the knowledge resources required by the new technology. When companies face strong market turbulence, they often choose to cooperate with other trading partners with which they have cooperative relations in order to reduce the cycle of product innovation cycle. Enterprises are more inclined to obtain innovative resources from value chain companies rather than from external third-party organizations. Therefore, the stronger the market turbulence results in a stronger impact on the degree of the enterprise's embeddedness in the value chain. Therefore, the following two hypotheses are developed:

H1a: Environmental turbulence has an obvious positive impact on the embeddedness of an enterprise's knowledge chain.

H1b: Environmental turbulence has an obvious positive impact on the embeddedness of an enterprise's value chain.

3.1.2 *Relationship Between Advanced Manufacturing Enterprises' Network Embedding and Innovation Performance*

The impact of network embedding on enterprises' innovation performance has become one of the hottest research topics, given the current rapid development of global technological innovation. A large number of scholars found that network embedding is one way to most influence advanced manufacturing enterprises' innovation performance because advanced manufacturing is resource-, labor-, knowledge-, and capital-intensive. Many companies use knowledge chain and value chain embedding, conduct efficient collaborative learning, and obtain external resources to make up for their shortcomings, prompting them to continue to innovate and improve their innovation efficiency. Zhang(2010) examined the impact of network embedding on enterprise innovation performance and found that knowledge network embedding positively affects enterprise performance. Zahra & George(2002) noted that enterprises could better improve their innovation performance by acquiring new knowledge from the network. Hu(2021) found that network embedding has an important impact on enterprises' cooperative behavior, economic performance, and the play of competitive market advantages. Sun(2020) noted that network embedding is the best way to measure and influence collaborative innovation. Feng(2020) noted the regional economic level influences the relationship between open innovation and firm performance. Wei(2016) developed a research report on the relationship between Chinese enterprises' network embedding and innovation performance and found that network embedding could promote enterprises' new knowledge acquisition and use of learning ability to improve innovation performance. Knowledge embedding can help enterprises

expand their knowledge stock, seek for more heterogeneous knowledge resources throughout an organization, and broaden enterprises' knowledge flow. Therefore, when an enterprise is embedded in the network, the enterprise can not only make full use of the knowledge flow in the network, and increase its knowledge stock. Enterprises can obtain complementary knowledge resources from the organization to improve their ability to resist risks and improve their innovation performance. Liang(2015) analyzed enterprises headquartered in Fujian Province, China, and concluded that the embeddedness of regional knowledge networks significantly affects enterprises' innovation output. Research on the knowledge chain between industrial clusters shows that the enterprises and external organizations promote the former's innovation efficiency of enterprises through joint R&D cooperation. In economic activities, the industry value chain is constituted of the various links between upstream and downstream enterprises and enterprises in the industrial chain constitute the industry value chain (Deng, 2012). Every value activity in the value chain affects the realization of corporate value goals. Therefore, companies with similar values can quickly establish a sense of identity with each other. Partners can reduce unnecessary obstacles and improve the innovation efficiency of each company in the value chain to achieve the same value goal. Therefore, the value chain can not only improve the enterprises' innovation performance and further deepen the cooperative relationship between upstream and downstream enterprises in the value chain, which is conducive to ensuring that subsequent cooperation is more efficient and that all enterprises trust one another and form a virtuous circle. The hypotheses are proposed on the basis of the previous discussion.

H2a: The embedding of the knowledge chain has an obvious positive impact on enterprises' innovation performance.

H2b: The embedding of the value chain has an obvious positive impact on enterprises' innovation performance.

3.1.3 Enterprise Absorptive Capacity and Network Embeddedness

1. Cohen (1990) first provided the relevant definition of absorptive capacity, which refers to an enterprise's ability to acquire and digest heterogeneous knowledge from external networks and its ability to transform and apply knowledge internally. The definition also points out that an enterprise's ability to acquire knowledge is closely related to the network environment in which it is located and has a strong path-dependence characteristic. From a process perspective, Zahra divided an enterprise's absorptive capacity into two categories: potential and actual absorptive capacity. He believes that potential absorptive capacity is the ability of a company to acquire external knowledge and digest external knowledge when it is embedded in the network. At the same time, the company's ability to transform and apply acquired external knowledge is its actual absorptive capacity. Kim (1998) noted that an enterprise's absorptive capacity reflects its internal organization's learning and problem-solving ability. Some scholars studied enterprises' absorptive capacity from the perspective of social network theory; they noted that the external network of an enterprise is a type of social capital, and the value of this social capital is related to the enterprise's absorptive capacity (Lee, 2001). For open innovation, enterprises with high absorptive capacity can more effectively understand the meaning of information and seize market opportunities on the premise of obtaining the same key information and resources about future market development and technological change. Therefore, this paper adopts Zahra's cognitive method to define enterprises' absorptive capacity of enterprises as potential absorptive capacity and actual absorptive capacity. Zahra (2002) also pointed out that an enterprise cannot effectively identify and transform resources if it does not achieve a certain degree of absorption capacity. The acquisition and digestion of knowledge resources is a necessary prerequisite for the integration, transformation, and application of knowledge within enterprises. Therefore, this article proposes the following assumptions.

- H3:** Advanced manufacturing enterprises' absorptive capacity is composed of two categories, and potential absorptive capacity has a significant positive impact on the actual absorptive capacity.
2. Research shows that embedding the knowledge chain can help enterprises obtain knowledge resources from the outside that they lack. Moreover, embedding the knowledge chain can help enterprises integrate their knowledge resources into technological innovation resources. However, a company without the ability to absorb external knowledge cannot use this knowledge efficiently and cannot help the company improve its innovation capabilities, even if it obtains knowledge resources from the outside. For companies, knowledge is a scarce resource, and simple imitation cannot help them obtain effective knowledge resources. Network embedding can help enterprises establish an effective way to obtain knowledge resources and promote enterprises to search for necessary and valuable knowledge. As companies continue to establish deep-level cooperative relationships with other companies in the knowledge chain, they have become a must-have unit of network organizations and will more easily acquire complex and invisible knowledge resources. Because value chain partners have similar value goals, companies can more easily trust each other and exchange benefits at a deeper level. At the same time, the increasingly frequent cooperation between enterprises and other enterprises in the organization, enables these enterprises to enrich their knowledge stock, allowing them to more accurately and efficiently acquire complementary knowledge resources to improve their absorptive capacity. Such a situation is a mutually beneficial and win-win relationship for all enterprises in the value chain. Therefore, when companies choose partners, they are more inclined to opt to cooperate with value chain partners. Embedding the value chain promotes collaboration between upstream and downstream enterprises, suppliers, and distributors, makes it easier to obtain invisible knowledge resources, and improves the trust among enterprises and their absorptive capacity. Therefore, the following assumptions are made.
- H4a:** Embedding of the knowledge chain has an obvious positive impact on an enterprise's potential absorptive capacity.
- H4b:** The embedding of the knowledge chain has an obvious positive impact on an enterprise's actual absorptive capacity.
- H4c:** The value chain embedding has an obvious positive impact on enterprises' potential absorptive capacity.
- H4d:** Value chain embedding has an obvious positive impact on enterprises' actual absorptive capacity.

3.1.4 Absorptive Capacity and Enterprise Innovation Performance

Fosfuri (2008) noted that absorptive capacity is not a corporate goal blindly pursued by companies but an important component of assisting companies to improve performance and achieve technological innovation. An enterprise with a stronger potential absorptive capacity has more external innovation resources and more ways to obtain knowledge resources. Knowledge acquisition is conducive to a better understanding of customer needs to carry out more targeted technological innovation and product upgrades (Stock, 2001). In addition, knowledge resources obtained from other partners embedded in the network also assist enterprises in tapping into more technological innovation opportunities (Nieto, 2005). Potential absorptive capacity can enhance an enterprise's innovation capability by acquiring and digesting heterogeneous external resources. Compared with potential absorptive capacity, actual absorptive capacity is more biased toward the enterprise's effective transformation and application of the acquired knowledge resources through internal innovation, thereby improving the enterprise's innovation performance. Transforming knowledge resources can help enterprises avoid the duplication of work and change their organizational culture and interaction mechanism. Knowledge resources can also reduce enterprises' path dependence on knowledge acquisition and enhance their ability to innovate. The application of knowledge is a step in transforming knowledge into practical application, enabling enterprises to form a sound management mechanism and efficiently transform information and knowledge, develop the products needed by the enterprise, reduce opportunism and transaction costs, and form innovative performance. Based on the previous discussion, the following hypotheses are proposed.

H5a: Potential absorptive capacity has an obvious positive impact on enterprise innovation performance.

H5b: Actual absorptive capacity has an obvious positive impact on corporate innovation performance.

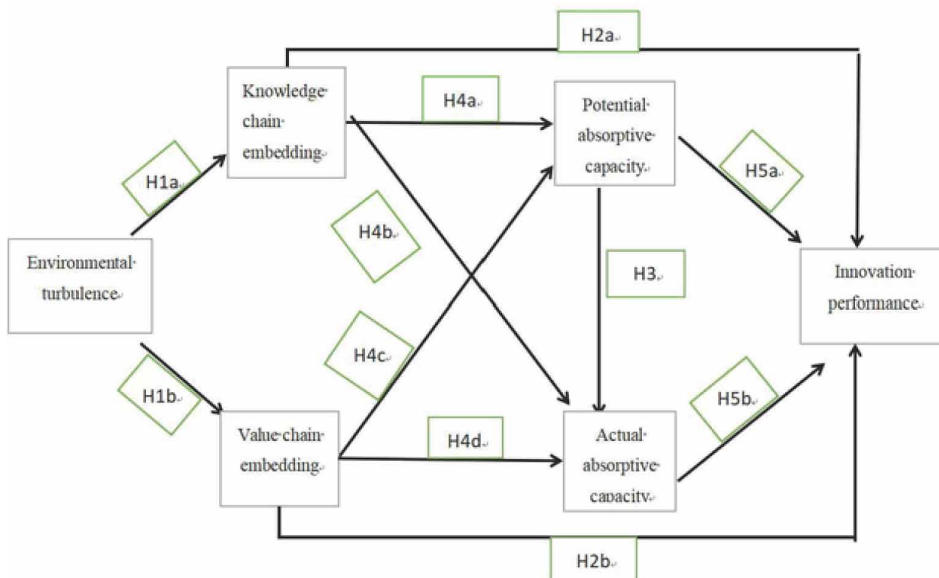
To summarize, this paper proposes a model to be examined including the environmental turbulence and network embedding of external influencing factors, as well as the enterprise's absorptive capacity and innovation performance of internal influencing factors. (Figure 1)

3.2 Measured Variable

This study uses the Likert scale to design the questionnaire, and the interviewees choose the option, from 1 (very bad/less) to 5 (very good/more) that best fits the actual situation.

1. **Environmental turbulence (EI):** He (2008) was primarily used to measure the environmental dynamics to set up the items, starting from customer preference (EI1), product update rate (EI2), industry technology change speed (EI3), and the impact of technological changes on enterprise development (EI4). These four items are used to measure the turbulence of the environment.
2. **Network embedding degree:** Based on the literature review, the degree of network embedding is measured using the two dimensions of value chain embedding and knowledge chain embedding. In terms of measuring the embeddedness of the value chain, the research of Tiwana (2004) indicated that the measurement starts from the frequency of communication with partners (VCE1), the depth and breadth of cooperation with partners (VCE2), and the relationship between innovation partners (VCE3), organizational cultural conflicts between innovation partners (VCE4), and communication barriers between innovation partners (VCE5) are used to measure the value chain's network embeddedness (VCE). At the same time, according to Zhu (2009), we asked questions such as the proportion of external knowledge obtained (KCE1), the degree of knowledge sharing between innovation partners (KCE2), the ease of obtaining external knowledge (KCE3), and the degree of scarcity of external knowledge (KCE4).

Figure 1. Mechanism model to be tested



3. **Absorptive capacity:** As part of the design of the questionnaire, absorptive capacity includes two categories, potential absorptive capacity and actual absorptive capacity, as referenced in the research of Zhang (2015). According to Jansen (2005) and others, acquisition and digestion capacities were used to reflect potential absorptive capacity. Conversion and application capacities were used to measure actual absorptive capacity. Specifically, the number of participating industry associations (PAC1), frequency of interaction with external companies (PAC2), acquisition cost of external resources (PAC3), acquisition cycle of external resources (PAC4), and the company's ability to understand the heterogeneous knowledge in the network (PAC5) were used to measure potential absorptive capacity. Additionally, external knowledge learning cycle (AAC1), resource identification efficiency (AAC2), frequency of use of new technologies (AAC3), product innovation (AAC4), application of new knowledge to related products and the ability to serve (AAC5), and other items were used to measure the actual absorptive capacity.
4. **Measurement of innovation performance:** Innovation performance refers to the evaluation of the efficiency of an enterprise's technological innovation activities. Gemunden (1996) proposed that innovation performance should be measured from the two dimensions of product innovation and process innovation. Product innovation refers to the research and development of new products and market share, among others; process innovation includes labor cost reductions, productivity increases, and order delivery time increases. Specifically, new product sales status (EIP1), new product technical content (EIP2), new product market share (EIP3), and customer satisfaction (EIP4) are used to measure innovation performance.

3.3 Sample Data Collection

The data for this study come from advanced manufacturing companies in the urban agglomeration areas in the middle reaches of the Yangtze River in China. The urban agglomeration area in the middle reaches of the Yangtze River is a fast-growing area for China's high-tech enterprises. Urban agglomeration has at least one or more core cities with international competitiveness, and urban distribution has reached a high density, with good transportation and communication infrastructure. The city cluster in the middle reaches of the Yangtze River includes Wuhan, Changsha and Nanchang, three core cities with strong manufacturing industries, and all ordinary industrial cities. In other regions of China, manufacturing mainly revolves around traditional industries, such as textiles, home appliances, and traditional manufacturing. Companies in this study are mainly knowledge-intensive industries, such as electronic information, advanced manufacturing, and biomedical manufacturing industries. In terms of distribution channels, 300 advanced manufacturing companies were selected as samples, and questionnaires were distributed via e-mail to obtain the relevant data. Of the 300 companies, 220 questionnaires were returned, for a 74% response rate. After screening, 167 questionnaires were valid, for an effective response rate of 56%. In terms of distribution targets, among those who filled out the questionnaire, 70% were senior managers in advanced manufacturing enterprises, 20% were middle managers, and 10% were basic managers. Thus, the comprehensiveness and validity of the research data were ensured. Among the survey samples, the high-end equipment manufacturing industry accounted for 22%, the new energy automobile industry 16%, the biomedical industry 14%, the instrumentation equipment industry 11%, and the computer industry 10%.

4. EMPIRICAL ANALYSIS

4.1 Reliability and Validity Analysis

The purpose of reliability analysis is to test the reliability and validity of the questionnaire. The test results are not correct and wrong, but only used to prove whether the questionnaire is reliable. Because the reliability will be affected by some subjective factors of the respondents themselves, there may be errors with the objective situation. Therefore, the value of reliability can only represent the reliability

of the questionnaire. The higher the reliability of the questionnaire, the more reliable the questionnaire data. This paper uses the Cronbach's α coefficient and factor analysis to measure the reliability and validity of the variables. After the calculation(Table1), the α value of each variable is greater than 0.60, indicating that the data collected using this scale are reliable and have high consistency, meeting the reliability requirements of the research. Validity analysis is to test the validity of the scale and check whether the data of the questionnaire conforms to the content of the question. Generally, factor analysis is used to analyze the validity, but not every item can be factor analysis. Therefore, before factor analysis, KMO and Bartlett should be tested, and $KMO \geq 0.7$ is generally required; if $KMO < 0.5$, it is not appropriate. Through calculation, we can figure out from the scale reliability and validity analysis(table

Table 1. Reliability and Validity Analysis results

Variables _v	Items _v	Factor Loading _v	Variance Contribution Rate _v	Cronbach's α Value _v	KMO _v	Bartlett Value _v
Environmental Instability(EI) _v	1·EI1 _v	0.732 _v	69.55% _v	0.704 _v	0.734 _v	0 _v
	2·EI2 _v	0.714 _v				
	3·EI3 _v	0.684 _v				
	4·EI4 _v	0.652 _v				
Value Chain Embeddedness(VCE) _v	1·VCE1 _v	0.673 _v	67.77% _v	0.719 _v	0.741 _v	0 _v
	2·VCE2 _v	0.691 _v				
	3·VCE3 _v	0.704 _v				
	4·VCE4 _v	0.688 _v				
	5·VCE5 _v	0.632 _v				
Knowledge Chain Embeddedness(KCE) _v	1·KCE1 _v	0.667 _v	66.75% _v	0.693 _v	0.726 _v	0 _v
	2·KCE2 _v	0.672 _v				
	3·KCE3 _v	0.651 _v				
	4·KCE4 _v	0.713 _v				
Potential Absorptive Capacity(PAC) _v	1·PAC1 _v	0.681 _v	69.58% _v	0.673 _v	0.704 _v	0 _v
	2·PAC2 _v	0.722 _v				
	3·PAC3 _v	0.715 _v				
	4·PAC4 _v	0.697 _v				
	5·PAC5 _v	0.652 _v				
Actual Absorptive Capacity(AAC) _v	1·AAC1 _v	0.701 _v	70.92% _v	0.685 _v	0.719 _v	0 _v
	2·AAC2 _v	0.712 _v				
	3·AAC3 _v	0.679 _v				
	4·AAC4 _v	0.692 _v				
	5·AAC5 _v	0.763 _v				
Enterprise Innovation Performance(EIP) _v	1·EIP1 _v	0.802 _v	79.71% _v	0.784 _v	0.776 _v	0 _v
	2·EIP2 _v	0.793 _v				
	3·EIP3 _v	0.785 _v				
	4·EIP4 _v	0.811 _v				

1) that the KMO value of EI is 0.734; the KMO value of VCE is 0.841; the KMO value of KCE is 0.726; the KMO value of PAC is 0.704; the KMO value of AAC is 0.719 and the KMO value of EIP is 0.784. As we know, $KMO > 0.7$ and Batlet values are all 0, and both factor loading and variance contribution rate are both greater than 0.5, indicating that the sample data meet the validity requirements.

4.2 Hypothetical Test

For the analysis of confirmatory factors, value-added fitting index is usually used to measure. Therefore, seven fitting indexes including χ^2/df , DFI, AGFI, RMSEA, NNFI, IFI, and CFI were used to evaluate the fitting results. The Specific criteria are: $0 < \chi^2/df < 3$, $0 < RMSEA < 0.08$, GFI, AGFI, NNFI, IFI and CFI need to be greater than 0.9 and less than 1. when these conditions are met, it indicates that the model has a good fit. Because of the numerous hypotheses in this study, this paper uses SPSS AMOS 21 to construct and test the model to be tested. The fitting result of the model to be tested basically meets the requirements, but the overall fit is not ideal; therefore, this paper uses regression weights to re-optimize the model, deletes the mismatched paths, and significantly improves the adaptation index. Table 2, and table4 provide the fitting results, path coefficients, and significance levels. The results show that environmental turbulence has an obvious positive relationship with knowledge chain and value chain embedding, supporting hypotheses H1a and H1b. Value chain and knowledge chain embedding have an obvious positive relationship with enterprise innovation performance, establishing H2a and H2b.

In terms of absorptive capacity, potential absorptive capacity has an obvious positive relationship with actual absorptive capacity, establishing hypothesis H3. An obvious positive correlation exists between actual absorptive capacity and innovation performance, especially the ability to apply transformed knowledge resources in the actual absorptive capacity, thus supporting hypothesis H5b.

However, regarding potential absorptive capacity, an enterprise's ability to acquire and digest knowledge cannot significantly improve the enterprise's innovation performance, which does not establish H5a. Knowledge chain embedding has no obvious positive relationship with potential absorptive capacity, and H4a is not supported. However, knowledge chain embedding has an obvious positive relationship with actual absorptive capacity, establishing H4b. Value chain embedding has an obvious positive relationship with potential absorptive capacity, supporting H4c. At the same time, the relationship between value chain embedding and actual absorptive capacity is not significant; therefore, H4d is not established. Therefore, we eliminate these paths, which are respectively $KCE \rightarrow PAC$, $VCE \rightarrow AAC$ and $PAC \rightarrow EIP$ (Table 4).

4.3 Discussion

This paper uses questionnaire survey methods to conduct empirical research on the relationship among environmental turbulence, network embedding, corporate absorptive capacity, and corporate innovation performance.

Table 2. Results of goodness of fit

Fit Measure	χ^2	χ^2/df	GFI	AGFI	RMSEA	NNFI	IFI	CFI
Fitted Value	183.459	2.956	0.948	0.961	0.0631	0.924	0.957	0.926
Standar d-values	/	>2	GFI>0.9	AGFI>0.9	RMSEA<0.05	NNFI>0.9	IFI>0.9	CFI>0.9
Fitting situation	Well	Well	Well	Well	Well	Well	Well	Well

Table 3. Results of hypotheses testing

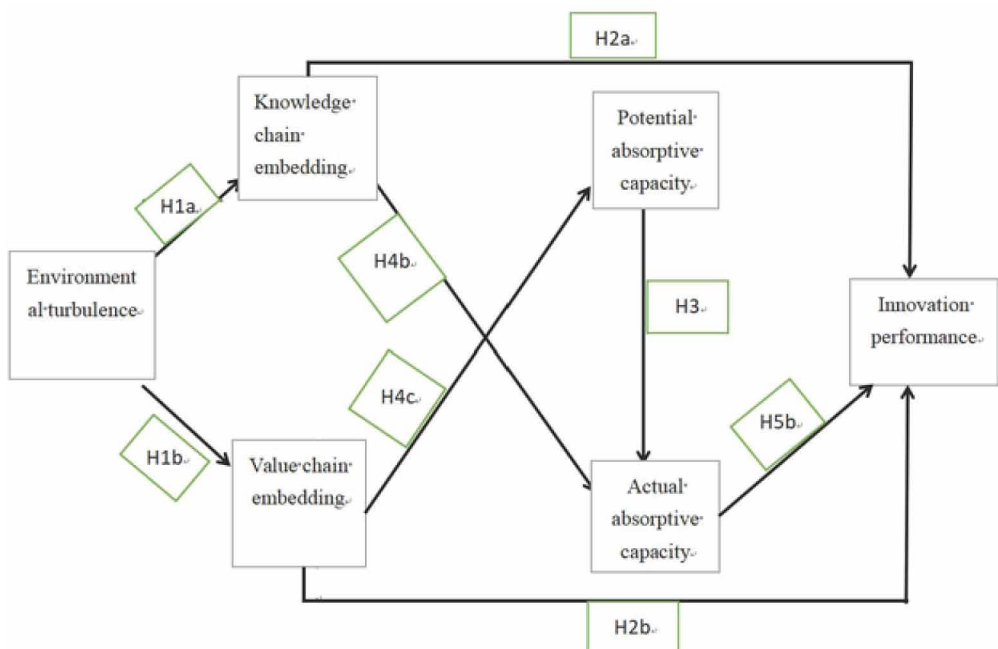
Paths _o	Path Coefficient _o	P-Value _o	Hypothesis _o	Results _o
EI→KCE _o	0.363** _o	0.000 _o	H1a _o	supported _o
EI→VCE _o	0.527** _o	0.015 _o	H1b _o	supported _o
KCE→EIP _o	0.428** _o	0.000 _o	H2a _o	supported _o
VCE→EIP _o	0.573* _o	0.000 _o	H2b _o	supported _o
PAC→AAC _o	0.376** _o	0.053 _o	H3 _o	supported _o
KCE→PAC _o	- _o	- _o	H4a _o	unsupported _o
KCE→AAC _o	0.641* _o	0.042 _o	H4b _o	supported _o
VCE→PAC _o	0.397** _o	0.026 _o	H4c _o	supported _o
VCE→AAC _o	- _o	- _o	H4d _o	unsupported _o
PAC→EIP _o	- _o	- _o	H5a _o	unsupported _o
AAC→EIP _o	0.420* _o	0.000 _o	H5b _o	supported _o

Note: ** means $p \leq 0.01$, * means $p \leq 0.05$

Table 4. Modification of the proposed model

Changes in χ^2 value _o	-57.363 _o	-25.736 _o	-13.743 _o
Delete path _o	KCE→PAC _o	VCE→AAC _o	PAC→EIP _o

Figure 2. Modified mechanism model



1. Environmental turbulence and corporate network embedding have an obvious positive relationship, and environmental turbulence affects firm innovation performance. When companies face low environmental turbulence, then consumer demand and preferences are relatively stable, enterprises' innovation activities of enterprises can be carried out step by step, and enterprises do not strongly depend on network embedding. However, when companies face strong environmental turbulence, they need to actively collaborate with partners between organizations to respond to consumer demand for innovative products. Enterprises actively embed in the organization and obtain heterogeneous knowledge resources, which can help them shorten the product innovation cycle and improve their innovation performance of enterprises. Therefore, environmental turbulence has an obvious positive impact on the embedding of the knowledge chain. When the value chain is embedded and the companies face strong environmental turbulence, their original knowledge and technology of the enterprise cannot meet consumers' needs. Therefore, companies must maintain broader and deeper cooperation with external entities to obtain complementary knowledge resources for innovation. Therefore, environmental turbulence has an obvious positive impact on the value chain embedding.
2. An enterprise embedded in either a knowledge chain or a value chain can improve its innovation performance. Network embedding is conducive to enterprises taking the lead in applying new technologies, launching new products, and realizing commercial value in the industry. Knowledge network embedding can help companies broaden the scope of the knowledge search, increase the company's knowledge stock, and enable companies to quickly apply the acquired complementary knowledge resources, thereby achieving improvements in innovation efficiency. Embedding the value chain mainly promotes enterprise innovation by being embedded in the organizational network. The enterprise is embedded in the network and can have a cooperative relationship with other network members. A close cooperative relationship is conducive to enterprises' technological innovation and the rapid and efficient flow of information resources, such as technology and knowledge among enterprises and cooperative organizations, thereby significantly enhancing enterprises' ability to innovate.
3. Network embedding has partial significant related effects on absorptive capacity, and the action methods are different. The data show that knowledge chain embedding affects an enterprise's actual absorptive capacity, but has little effect on potential absorptive capacity. Value chain embedding acts more on potential absorptive capacity rather than actual absorptive capacity. Because the sample used in this study comes from the advanced manufacturing industry in the urban agglomeration in the middle reaches of the Yangtze River, an overly strong localized network leads to the closure and rigidity of the local cluster production system, causing a slow state of knowledge flow and forming a "hollow cluster". Without the entry of more heterogeneous knowledge resources, the entire ecosystem's knowledge resources are in a state of a stock game. Therefore, the knowledge chain does not significantly affect the potential absorptive capacity; instead, it acts more on the actual absorptive capacity to enhance the enterprise's innovation capability. Value embedding usually emphasizes a relationship's quality, trust, and reciprocity during the organizational information exchange process and its effect on corporate behavior. The closer the relationship between the enterprise and the customers in the network, the higher the degree of information sharing between them, the stronger the trust relationship between them, and the more conducive they are to complex knowledge and technology transfers. Therefore, value chain embedding has an obvious relationship with potential absorptive capacity.
4. Absorptive capacity, as an intermediary variable, promotes enterprises' innovation performance. Whether as a source or receiver of knowledge, an enterprise's open innovation activities and the formation of innovation performance depend on potential and actual absorptive capacities. This study found that companies in advanced manufacturing industries with resource-intensive, knowledge-intensive, and capital-intensive attributes, and with stronger actual absorptive capacity can better improve their innovation performance. Compared with companies that lack higher

potential absorptive capacity, high-tech enterprises with higher potential absorptive capacity likely bring more internal knowledge redundancy to enterprises if they carry out high-intensity open innovation activities that increase the cost of the enterprise, thus reducing its innovation performance. On the one hand, when an enterprise can quickly to identify innovation opportunities, it can take the lead in applying new technologies and launching new products or services in the industry to improve its innovation performance. On the other hand, when an enterprise identifies an opportunity internally, it can quickly integrate internal and external resources to make better use of the value of resources.

5. CONCLUSION AND SUGGESTS

5.1 Conclusion

In general, from the perspective of network embedding, this paper studies the impact of environmental turbulence and absorptive capacity on enterprise innovation performance. Enterprises absorb valuable ideas and technology patents from outside the organization to carry out commercialization activities, assisting them in breaking through the limitations of closed innovation, providing abundant ideas and technologies for enterprise innovation, and assisting in reducing the cost of innovation and improving the enterprise's innovation performance. This paper uses the advanced manufacturing enterprises in China as a sample and empirical research methods to reach the following conclusions. First, when environmental turbulence is strong, network embedding has a positive impact on enterprises' innovation performance. When companies face high environmental turbulence, consumer demand changes rapidly. Companies must actively embed themselves into network organizations to obtain complementary knowledge resources, which helps reduce product innovation cycles and master dominant technologies. Moreover, companies should develop deeper and more extensive partnerships with partner companies and cooperate to enhance their innovation performance and quickly capture market share. In this way, the core technology of enterprises can be updated timely to avoid the elimination of their competitive advantages and improve the innovation performance of enterprises. Second, this paper explores how network embedding affects enterprises' innovation performance and analyzes its mechanism of action. Knowledge chain embedding usually affects enterprise innovation performance through actual absorptive capacity. However, value chain embedding plays an influential role more by acting on potential absorptive capacity. Third, improvement measures were proposed on the basis of the unique characteristics of China's advanced manufacturing industry. Although China's advanced manufacturing industry is not small, weaknesses still exist as a knowledge-intensive industry, such as inadequate core technology and insufficient brand influence. Acquiring external knowledge is an indispensable link for companies to improve their innovation performance and avoid the "tunnel vision" caused by the over-reliance on the company's knowledge. Therefore, China's advanced manufacturing companies still need to be embedded in external organizations and continue to absorb, introduce and imitate their excellent advanced technology. Knowledge diversification can help enterprises obtain relatively rich internal knowledge resources.

5.2 Suggestions

1. Enterprises need to actively integrate into network organizations, continuously expand their stock of knowledge, and strengthen their ability to resist risks when the external environment changes rapidly. When the environmental turbulence is relatively stable, companies must actively integrate into the network organization, broaden and deepen their business relationships with partners, and establish their corporate brand effects. The amount of knowledge stock determines the company's ability to resist risks. When environmental turbulent is not stable, a company with enough knowledge stock will be able to significantly reduce its R&D cycle and increase efficiency in response to changes in consumer demand. Therefore, when environmental turbulence is stable,

companies cannot stop the “steps” of acquiring heterogeneous knowledge resources even if they can innovate incrementally.

2. Increase enterprises' opportunities to communicate with external network organizations, establish a good industrial cluster relationship, and make enterprises more open and actively embedded in external networks. Regional coordination and industry cluster development are necessary for developing a new pattern of advanced manufacturing development. Because knowledge is hidden, enterprises need to be more open and actively embed themselves into external networks to obtain knowledge resources and improve their innovation performance. Many knowledge resources are rooted in a unique culture. Therefore, more innovative resources can be obtained by establishing a good mutual trust mechanism and actively integrating into different enterprises' values and organizational cultures.
3. Increase the enterprise's internal absorptive capacity quickly absorb external knowledge and realize the transformation of knowledge into products, and enhance the enterprise's innovation ability. Improve the enterprise's internal technical level enhance the capabilities of the technical and managerial personnel, and establish a sound and complete innovation mechanism. Enterprises can enhance the training activities of internal employees to improve the comprehensive quality of employees. Help enterprises reduce the time cost and opportunity cost in the process of identifying opportunities, and improve the efficiency of opportunity utilization. Inbound open innovation can enable enterprises to absorb external knowledge resources, increase their stock of knowledge and enhance the knowledge flow among them. Reasonable integration of all the resources of the enterprise, whether explicit resources or invisible resources. In addition, inbound open innovation can improve enterprises' technological innovation ability help them achieve technological breakthroughs, and assist them in quickly occupying the consumer market and developing first-mover advantages.

5.3 Research Deficiencies

1. The sample data collected in this paper comes from the central region of China. The collected data may be affected by geographical location, and the subsequent research can be discussed from the perspective of the whole China.

2. This paper only focuses on advanced manufacturing enterprises, and does not do extensive research on other types of enterprises.

REFERENCES

- Baptista, R. (2007). *Clusters, Innovation and Growth: A Survey of the Literature*. Oxford University Press.
- Calantone, R., Garcia, R., & Droge, C. (2003). The effects of environmental turbulence on new product development strategy planning. *Journal of Product Innovation Management*, 20(2), 90–103. doi:10.1111/1540-5885.2002003
- Chen, Z.M. (2016). Research on the relationship between external knowledge source connection, open innovation and firm innovation performance. *Scientific and Technological Progress and Countermeasures*, 33(10), 59-65.
- Chesbrough, H., & Crowther, A. K. (2006). Beyond high tech: Early adopter of open innovation other industries. *R & D Management*, 36(3), 229–236. doi:10.1111/j.1467-9310.2006.00428.x
- Cohen, W. M., & Levinthal, D. A. (1990). Absorptive Capacity: A New Perspective on Learning and Innovation. *Administrative Science Quarterly*, 35(1), 128–152. doi:10.2307/2393553
- Dahlander, L., & Gann, M. (2010). How open is innovation. *Research Policy*, 39(6), 699–709. doi:10.1016/j.respol.2010.01.013
- Deng, L. (2012). *Study on the development strategy of China's logistics industry from the perspective of "dual industry linkage"* [Dissertation]. Capital University of Economics and Business.
- Dess, G. G., & Davis, P. S. (1984). Porter's generic strategies as determinants of strategic group membership and organizational performance. *Academy of Management Journal*, 27(3), 467–455. doi:10.2307/256040
- Duncan, R. (1972). Characteristics of organizational environments and perceived environmental uncertainty. *Administrative Science Quarterly*, 17(2), 313–327. doi:10.2307/2392145
- Feng, C. L., & Cheng, Y. (2020). Meta-analysis of Open Innovation and Enterprise Performance. *Scientific Research Management*, 12(01), 108–118.
- Fosfuri, A. (2006). The licensing dilemma: Understanding the determinants of the rate of technology licensing. *Strategic Management Journal*, 27(12), 1141–1158. doi:10.1002/smj.562
- Fosfuri, A., & Tribo, J. A. (2008). Exploring the antecedents of Potential Absorptive Capacity and Its Impact on Innovation Performance. *Omega*, 36(2), 173–187. doi:10.1016/j.omega.2006.06.012 PMID:18680889
- Gemunden, H. G., Ritter, T., & Heydebrek, P. (1996). Network configuration and innovation success: An empirical analysis in German high-tech industries. *International Journal of Research in Marketing*, 13(2), 449–462. doi:10.1016/S0167-8116(96)00026-2
- Gereffi, G., & Memdovic, O. (2003). *The global apparel value chain: What prospects for upgrading by developing countries*. United Nations Industrial Development Organization.
- Goll, I., & Rasheed, A. (1993). Rational decision making and firm performance: The moderating role of the environment. *Strategic Management Journal*, 18(7), 583–591. doi:10.1002/(SICI)1097-0266(199708)18:7<583::AID-SMJ907>3.0.CO;2-Z
- Granovetter, M. (1985). Economic action and social structure: The problem of embeddedness. *American Journal of Sociology*, 91(3), 481–510. doi:10.1086/228311
- Haleblian, J., & Finkelstein, S. (1993). Top management team size, CEO dominance, and firm performance: The moderating roles of environmental turbulence and discretion. *Academy of Management Journal*, 36(4), 844–863. doi:10.2307/256761
- He, Y. (2015). The Review and Prospect of Open Innovation Research. *Science of Science and Management of Science and Technology*, 36(3), 3–12.

- Hu, C.P., & R., X.L. (2021). The servicing strategic transformation performance of manufacturing enterprises: An explanation from the perspective of network embeddedness. *Technology and Economy*, 7(2), 71–75.
- Jansen, P., Bosch, V., & Volberda, J. (2005). Managing potential and realized absorptive capacity: How do organizational antecedents matter. *Academy of Management Journal*, 48(6), 999–1015. doi:10.5465/amj.2005.19573106
- Jauch, L. R., & Kraft, K. L. (1986). Strategic Management of Uncertainty. *Academy of Management Review*, 11(4), 777–790. doi:10.2307/258396
- Jaworski, B. J., & Kohli, A. K. (1993). Market orientation: Antecedents and consequences. *Journal of Marketing*, 57(3), 53–70. doi:10.1177/002224299305700304
- Juan, L., & Chen, G. (2015). A study on multiple network embeddedness and knowledge creation performance of cluster firms. *Studies in Science of Science*, 33(1), 90–97.
- Kim, L. (1998). Crisis Construction and Organizational Learning: Capability building is catching-up at Hyundai Motor. *Organization Science*, 9(4), 506–521. doi:10.1287/orsc.9.4.506
- Lee, C., Lee, K., & Pennings, J. M. (2001). Internal Capabilities, External Networks, and Performance: A Study on Technology based Ventures. *Strategic Management Journal*, 22(67), 615–640. doi:10.1002/smj.181
- Lichtenthaler, U. (2009). Absorptive capacity, environmental turbulence, and the complementarity of organizational learning processes. *Academy of Management Journal*, 52(4), 822–846. doi:10.5465/amj.2009.43670902
- Nieto, M., & Quevedo, P. (2005). Absorptive capacity, Technological Opportunity, Knowledge Spillovers, and Innovation Effort. *Technovation*, 25(10), 1141–1157. doi:10.1016/j.technovation.2004.05.001
- Pietrobelli, C., & Rabellotti, R. (2011). Global value chains meet innovation systems: Are there learning opportunities for developing countries. *World Development*, 29(7), 1261–1269. doi:10.1016/j.worlddev.2010.05.013
- Polanyi, K. (1957). *The great transformation: The Political and Economic Origins of Our Time*. Beacon Press by Arrangement with Rinehart & Company, Inc.
- Sirmon, D. G., Hitt, M. A., & Ireland, R. D. (2007). Managing firm resources in dynamic environments to create value: Looking inside the black box. *Academy of Management Review*, 32(1), 273–292. doi:10.5465/amr.2007.23466005
- Stock, G. N., Greis, N. P., & Fischer, W. A. (2001). Absorptive Capacity and New Product Development. *The Journal of High Technology Management Research*, 12(1), 77–91. doi:10.1016/S1047-8310(00)00040-7
- Sun, Y. B., & Liu, J. Y. (2020). Network Embeddedness and Enterprise Cooperative Innovation Performance: The Mediating Effect of Alliance Trust. *Science and Technology Management Research*, 6(12), 187–196.
- Tiwana, A. (2004). An empirical study of the effect of knowledge integration on software development performance. *Information and Software Technology*, 46(13), 899–906. doi:10.1016/j.infsof.2004.03.006
- Xiang, Y., Jiang, W., & Zheng, X. (2016). Mechanism of multiple embedded on cluster's innovation Empirical study of two clusters in Zhejiang Province. *Science Research Management*, 37(10), 102–111.
- Zahra, S. A., & George, G. (2002). Absorptive capacity: A review, reconceptualization, and extension. *Academy of Management Review*, 27(2), 185–203. doi:10.2307/4134351
- Zhang, F. L. (2018). Analysis on Basic Characteristics and Development Path of Advanced Manufacturing industry. *Zhongzhou Academic Journal*, 257(5), 39–45.
- Zhang, X. Y., Zhu, H. M., & Wu, X. M. (2014). Research on the influence of financial redundant structure on firm performance under dynamic environment regulation. *Soft Science*, 28(8), 125–129.
- Zhang, Z. G., Chen, Z. M., & Li, Y. J. (2015). A study on the relationship between open innovation absorptive capacity and firm's innovation performance. *Science Research Management*, 36(3), 43–49.
- Zhu, C. H., & Chen, J. (2009). The mechanism between explorative and exploitative technological learning. *Science Research Management*, 30(3), 23–26.