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Research Article

Research on the influential mechanism of Digital Capabilities on the Innovation Performance of Cross-border E-commerce Enterprises

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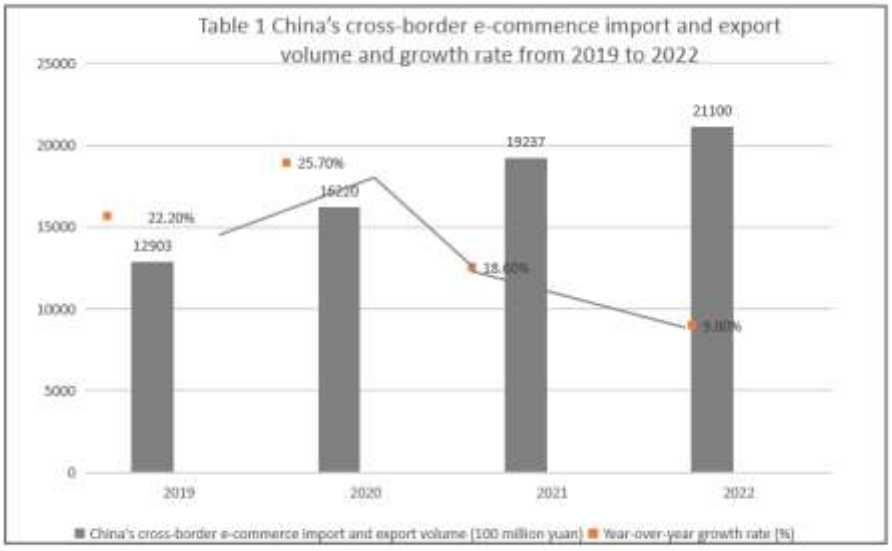
ABSTRACT

In digital economy era, enterprise digitalization is the main source of sustainable competitiveness. Cross-border e-commerce (CBE) has become the new power of China's foreign trade growth. The in-depth integration of CBE and manufacturing industry helps to stimulate the vitality of the traditional industry innovation. In accordance with the logical chain of "ability - behavior - results", this paper introduces digital capabilities and value co-creation (VCC) into the research framework, to explore the influential mechanism. After empirical analyses of 626 small and medium-sized manufacturing enterprises which engage in export with the help of platform, the results show that digital capabilities are positively related to enterprise innovation performance (EIP), VCC plays a partial mediating role, network embedding(NE) plays a positive moderating role, and the higher the degree of NE, the more obvious the mediating role of VCC.

Keywords: digital capabilities; value co-creation; innovation performance; network embedding.

Introduction

With the arrival of the knowledge economy era, innovation is becoming an important means to promote the sustainable competitive advantage. Although China have achieved great development in terms of patent applications and authorizations, there is a lack of independent innovation and core technology "neck" phenomenon, the level of innovation needs to be further improved. One of the main challenges today is adapting to technology under an industrial revolution with a digital nature (Schwab, 2017). An effective strategy to achieve the goal is to engage in digital exporting, as using e-commerce to enter new international markets (Pergelova,et al.,2019). China is the world's largest commodity trading country, and CBE has become an important driving force and a "new engine" for foreign trade growth (Guo, Sivi, et al., 2018). Facing to various uncertainties in China and abroad, CBE model has attracted traditional enterprises to transform into this new model, as to stimulate the innovation vitality of the traditional industry By the end of 2020, China's export share of CBE account for 77.6% of its market size (Chen et al., 2022). According to customs' data, in 2022, China's imports and exports of CBE reached 2.11 trillion yuan, with a growth of 9.8% by year, of which exports were 1.55 trillion yuan, an increase of 11.7% (Table 1). B2B accounts for 77.3% of export transactions and industrial products reaching 90% of exports.



Source: General Administration of Customs

However, after analyzing its development situation in China, it can be found that there are some pain points, as low-end products, low value-added commodities (Jiang Zifen et al., 2023), the predicament of strong manufacturing and weak branding (Li Tian et al., 2019), the serious homogenization of products, the reduction of large orders and so on. Therefore, CEBC need to innovate urgently their products, services and business models, and to improve their innovation performance, which is the the core issue to be resolved. Whether enterprises can transform successfully depends on the enterprise's digital capabilities, which are embedded in all process, permeated in business management process (Chi Renyong et al., 2022). According to the logical chain of "capability-behavior-result", digital capability and VCC are introduced into the research framework. The moderating effect of network embedding is also added to provide theoretical support and practical suggestions for CBE export enterprises to better realize digital transformation and development.

2 Theoretical Background and Research Design

2.1 Dynamic Capability Theory

Dynamic capability emphasizes that enterprises can have sustainable competitive advantages only if they make full use of their resources and form dynamic capabilities to respond to environmental changes (Teece 1997; 2007). Among them, dynamic capability refers to the ability of enterprises to purposefully create, expand, or change their resource base (Helfat et al., 2009). Despite the fact that studies related to the resource-based view point out that firms which are limited in the resources can have and need to cooperate with external resource holders (Pfeffer and Salanck, 1978), but the main emphasis in the cooperation process is on the control of resources (Hallen, 2014; Jansen, 2006). Dynamic capabilities can help organizations collect and process information in the shortest possible time, integrate digital resources, rationally help organizations make business decisions, dynamically manage the organization's database, achieve organizational innovation (Perry-Smith & Mannucci, 2017), creating new business value for organizations (Rialti et al., 2019).

2.2 Digital capabilities

Digital capabilities are seen as the main source of competitiveness and the foundation of digital transformation for enterprises. Scholars have defined its meaning from multiple perspectives, such as competence, strategy, and value. Khin&Ho (2018) consider it as the skills and knowledge of firms to manage digital technologies for new product development. Warner&Wager (2019) define it as the collection of routines for strategizing by leveraging digital assets to create differentiated value. This paper agrees with Annarelli, et al., (2021)'s study that defines it as the organizational ability of a firm to extensively combine digital assets and business resources, to leverage digital networks, to innovate products, services, and processes for organizational learning and value creation, and to gain sustained competitive advantage through managerial innovation. Regarding its dimensions, there are studies from the aspect of digital technology (Lenka, Parida, & Wincent, 2017; Ritter & Pedersen, 2020), from the role and impact of abilities as well (Jing Hao, Liu Ya, & Xu Xianying ,2017). In this paper, digital capability is divided into three dimensions: digital perception capability (DP), digital connectivity capability (DC) and digital analytic capability(DA). DP refers to the enterprise's hardware platform and software system as a carrier, digital production, process digitization and service digitization. DC refers to the ability of exponential products to connect with the Internet, reflecting the interconnection of all things. DA refers

to the ability of enterprises to identify and screen out effective data, use analytical models and hardware tools, etc.

2.3 Digital Capability and Enterprise Innovation Performance

The enterprise can use new technology to embody its products or services, redesign the internal supply chain to optimize the business process, or find new partners to realize the business model of the technological innovation. The application of digital technology can provide enterprises with a new way of value creation. The integration of information technology and physical components facilitates the development of new processes and products (Zhang, Sheng&Yang, Qian, 2021). DP enables enterprises to apply digital technology to production, service, and sales, thus optimizing the process, improving the efficiency of information collection and organization and the efficiency of enterprise information transmission. DC can quickly open up the internal links and enhance the connection between the enterprise and the consumers and the value chain (Guan Yungfang et al., 2022). DA can promote the enterprise to optimize the knowledge management mode, externalize the participation in open innovation and systematically improve the supply capacity, which makes the diversity and scientificity of enterprise resource allocation, thus enhancing the enterprise's innovation strength in product innovation, operation innovation and system innovation, which is ultimately manifested in the enhancement of the enterprise's innovation performance.

Based on this, the following hypotheses can be made:

H1a: Digital perception capability is positively related to enterprise innovation performance.
H1b: Digital connectivity capability is positively related to enterprise innovation performance.
H1c: Digital analytic capability s positively related to enterprise innovation performance.

2.4 The mediating role of value co-creation

Once the concept of VCC is put forward, it has received extensive attention and achieved fruitful research results. Scholars have explored it from multiple perspectives, such as marketing, management, and innovation ecosystems. The adoption of VCC in different industries also shows the proliferation of different concepts, customers from the passive target of marketing activities, transformed into a contributor and creator in the process of value creation (Vargo and Lusch, 2004, Tapscott and Williams, 2006), with further research, the participation of stakeholders has gained the attention of scholars, and the object of co-creation has also been expanded from the interaction between enterprises and individuals to enterprises and enterprises.The main body of co-creation has also evolved to a dynamic and complex multinational network, and the co-creation has shifted from the product to the value, and finally to the brand (Sarkar & Banerjee,2023). In digital era, firms face more complex competitive environments and need more heterogeneous resources to meet market demands. The digital capabilities enhance their connectivity, generate more cross-border synergies, and thus acquire more data resources and gradually form sustainable development advantages. The digitization of products or services has a significant impact on the value creation of enterprises (Rachinger et al., 2018). Customers are considered as resources in the innovation process, where customers provide ideas to develop new products or services. With the development of Internet technology, customer participation has shifted from offline to online, through the information network platform, customers can more conveniently join in the development of new products, which can improve the efficiency of innovation (Fang, Palmatier & Evans, 2008; Souder, Buisson & Garrett,1997), and the innovation performance of the enterprise is the result of innovation, i.e., the results of innovation activities carried out by enterprises to bring the results of the feedback, so customer engagement will have a positive impact on EIP. With in-depth research, VCC based on business ecosystem as a carrier has become a new paradigm for market competition, as well as CBE ecosystems (Xue Chaocai, 2023). In different industries, suppliers are recognized as the main source of innovation and market knowledge (Kim & Wilemon, 2002). In a manufacturing outsourcing environment, core firms and outsourced suppliers establish a highly trusting partnership, where both parties act jointly based on common goals and effective coordination mechanisms and respond quickly and efficiently to customer needs in a shorter period of time. VCC by suppliers can shorten product development cycles, reduce development costs, improve, and enhance product quality, increase the effectiveness of R&D, thus enhance firms' innovation performance.

Based on this, the hypotheses can be made as following:

H2a-H2c: Digital perception (connectivity, analytic) capabilities have a significant positive effect on customer engagement value co-creation.
H3a-H3c: Digital perception (connectivity, analytic) capabilities have a significant positive impact on supplier engagement value co-creation.
H4a-H4b: Customer (supplier engagement) value co-creation mediates the relationship between digital capabilities and innovation performance.

2.5 The moderating role of network embedding

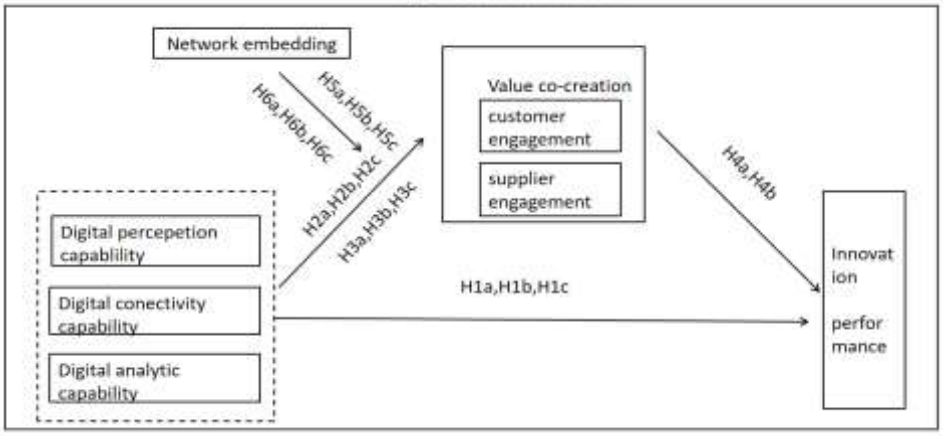
NE was first proposed by Granovetter in 1985. Bonner, Kim & Cavusgil (2005) define it as "the extent to which trust, mutuality, and flexibility are utilized to facilitate a firm's alliance relationships". Scholars

classify it into relational and structural embeddedness (Granovetter, 1992). A good structural embedding is conducive to functional complementarity, ability matching, synchronous value creation among value co creators, as well as a good dynamic transmission mechanism. While relational embeddedness emphasizes the trust, the frequency of interactions, and the degree of relationship with the partner firms (Wei & Xu, 2014).The degree of relational embeddedness reflects the position of enterprises in the network and can bring rich resources for VCC activities (Bao Fengnai & Peng Zhengyin, 2015), as the strength of inter-organizational relationships increases, the cognitive gap between managers and the uncertainty among participating subjects due to organizational differences can be effectively reduced, contributing to the realization of inter-organizational VCC（Liu, Xiaolang, Liu, Shanshi, & Wang, Hongli, 2016) and form closer cooperative relationships with each other, which helps to co-create new value in subsequent cooperation. In conclusion, the higher the degree of embeddedness in the enterprise's network, the easier to access digital resources within the network, as to realize accurate matching of resources and capacity.
Thus, the following assumptions are proposed:

H5a-H5c: Network embedding positively moderates the influence of digital capabilities (perception, connectivity and analytic) on customer engagement value co-creation.
H6a-H6c: Network embedding positively moderates the influence of digital capabilities (perception, connectivity and analytic) on supplier engagement value co-creation.

Based on the assumptions, a theoretical model of cross-border e-commerce enterprises' digital capability and EIP is constructed (as shown in the figure 2).

Figure 2 Theoretical model



3 Research Methods

3.1 Questionnaire Design and Data Collection

This paper adopts the questionnaire survey method to collect data. In order to guarantee the reliability and validity, the questionnaire was distributed to top managers (CEOs, CDOs etc.) and middle managers (in charge of product development departments, e-commerce department). From August to November 2023, data collection was conducted in two stages. First, a pre-survey was conducted in Henan and 80 valid questionnaires were recovered and analyzed for reliability and exploratory factor analysis. The results showed that the scale had good reliability and validity. Then the formal research was conducted in Guangdong, Shandong, Henan, Fujian, and Zhejiang provinces, of which the import and export value accounted for more than 65% of the total and are located in the northern, central and southeastern regions of China. 750 questionnaires were distributed. Beside the invalid samples, 626 valid questionnaires were obtained, with a validity rate of 83.5%. The electronic questionnaires were randomly distributed to enterprises and the date are collected mainly by Questionnaire Star.

3.2 Variable Measurement

The measurement of each variable was modified according to the actual situation of CBEC in China and reference to the studies of scholars. The scale of digital capabilities was determined as 14 question items, with reference to the studies of Nasiri, et al., (2020), Chi, Renyong & Zhu, Rui (2022), Yi et al.,(2022), Seven questions are proposed to measure EIP, according to studies of Frenz&Ietto-Gillies (2009); Mardani, (2018);Xie Hongming et al. (2012). For

customer engagement VCC, it is classified into three types, including information sharing, responsible behavior, and interaction, with a total of five items(Fang et al.,2008; Yao, 2016;Yi & Gong, 2013). For supplier engagement VCC, it is designed as 9 topic items with the DART model (Prahalad & Ramaswamy, 2004, Ren Jifan et al., 2014). Regarding NE, reference to Gilsing (2008); Uzzi (1997), it is measured with 5 question items.

3.3 Homogeneous variance

There may be a problem of common methodological variation, because of the same subjects or data sources, similar measurement situations, common item contexts, and the item's own characteristics (Podsakoff et al., 2003). In order to minimize the impact of common methodological variation, this paper uses program control and post tests to ensure the authenticity of the data，like anonymity and psychological isolation (Pang Tai-kwang et al., 2006). And Harman's one-way test was used to test the homogeneity of the data. After testing, the results show that the amount of variation that can be explained by the first factor is 34.884%<50%, so there is no significant homogeneous variance problem.

4 Empirical research

4.1 Reliability and validity test

The Statistics software was used to test the reliability of the sample, and the results are shown in Table 3. The Cronbach's alpha of each scale is higher than the critical value of 0.7, which indicates that the scales in this paper have good reliability. All the CR value of variables are higher than 0.7, and the AVE value is higher than 0.5, which indicates the good convergent validity (Fan Jingbo,2018). The square root of the AVE of any variable is greater than the value of the correlation coefficient with the other factors, so the discriminant validity of the factors within each variable is good (Fornell & Larcker,1981).

Table 3 Reliability and vadility analysis

variable	Items	Corrected Item-Total Correlation(CITC)□	Cronbach Alpha if Item Deleted	Cronbach α	CR	AVE
Digital capabilities	DP1	0.779	0.896	0.914	0.914	0.
	DP2	0.748	0.9			
	DP3	0.77	0.897			
	DP4	0.759	0.899			
	DP5	0.74	0.901			
	DP6	0.753	0.899			
	DC1	0.727	0.839	0.874	0.874	0.63 4
	DC2	0.717	0.843			
	DC3	0.75	0.83			
	DC4	0.722	0.841			
	DA1	0.698	0.846	0.872	0.872	0.63
	DA2	0.719	0.838			
	DA3	0.749	0.826			
	DA4	0.735	0.832			
Value co-creation	CE1	0.766	0.874	0.9	0.9	0.64 2
	CE2	0.752	0.877			
	CE3	0.748	0.878			
	CE4	0.75	0.878			
	CE5	0.737	0.881			
	SE1	0.763	0.932	0.939	0.939	0.63 1
	SE2	0.774	0.932			
	SE3	0.753	0.933			
	SE4	0.753	0.933			
	SE5	0.788	0.931			
	SE6	0.757	0.932			
	SE7	0.79	0.931			
	SE8	0.766	0.932			
	SE9	0.758	0.932			
Innovatio	EIP1	0.749	0.905	0.917	0.918	0.61

n perfor mance	EIP2	0.77	0.902			4
	EIP3	0.738	0.906			
	EIP4	0.713	0.908			
	EIP5	0.755	0.904			
	EIP6	0.729	0.907			
	EIP7	0.763	0.903			
Network embed ding	NE1	0.771	0.93	0.937	0.937	0.65 2
	NE2	0.786	0.929			
	NE3	0.768	0.93			
	NE4	0.766	0.93			
	NE5	0.788	0.928			
	NE6	0.784	0.929			
	NE7	0.793	0.928			
	NE8	0.77	0.93			

4.2 The direct effect

This paper constructs a structural equation model（SEM) of digital capabilities and EIP, which is used to test the causal relationship between the variables (Hoe, 2008a), as shown in the Figure 4. Theχ2/df is 1.095< 3, indicating a good model fit (Kline, 1998). The GFI, NFI, TLI, CFI are all above 0.9, and the RMSEA is 0.012<0.05 (Kelly & Walton, 2021). All the fitting indexes are in accordance with the research standard（Table 5), so it can be assumed that this model has a good fit. Through path analysis, it is seen that DP has a significant positive effect on EIP (β=0.149, P<0.05), so H1a is supported. DC has a significant positive effect on EIP (β=0.209, P<0.05), so H1b is supported. There is a significant positive effect of DA on EIP (β=0.228, P<0.05), so it supports H1c, and the main causal effect is established.

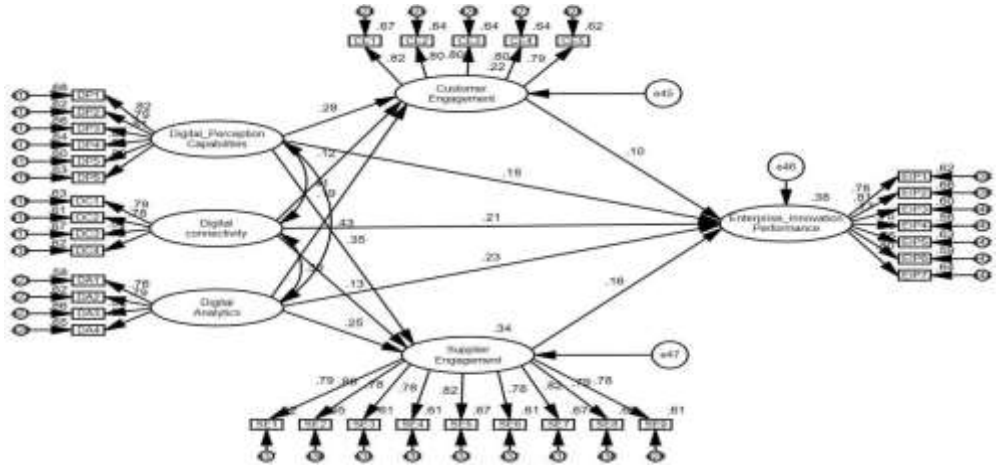


Figure 4 SEM of the study

Table 5 Pearson Correlation

	Mean	Std. Deviation	Digital Perception Capabilities	Digital connectivity	Digital Analytics	Customer Engagement	Supplier Engagement	Network Embedding	Enterprise Innovation Performance
Digital Perception Capabilities	3.254	1.049	1						
Digital connectivity	3.312	1.044	0.370**	1					
Digital Analytics	3.333	1.054	0.387**	0.345**	1				
Customer Engagement	3.340	1.036	0.369**	0.274**	0.311**	1			
Supplier Engagement	3.305	1.022	0.470**	0.342**	0.407**	0.361**	1		
Network Embedding	3.298	1.039	0.391**	0.364**	0.412**	0.382**	0.398**	1	
Enterprise Innovation Performance	3.361	1.002	0.417**	0.404**	0.432**	0.335**	0.424**	0.448**	1

* p<0.05 ** p<0.01

4.3 Moderating effects

The results show that, in model 2, NE has significant positive regulating effect (t=6,277, p=0.000<0.05) in the path of influence of DP on customer VCC, NE has significant positive regulating effect (t=4.813, p=0.000<0.05) in the path of influence of DC on customer VCC as well. It also has a significant positive moderating effect on the influence path of DA on customer VCC (t=4.732, p=0.000<0.05). Network

embedding has a significant positive moderating effect on the path of influence of DP on suppliers' participation VCC (t= 6.881, p=0.000<0.05). It has a significant positive moderating effect on the path of influence of DC on supplier engagement (t= 5.950, p=0.000<0.05), and NE has a significant positive moderating effect on the path of influence of DA on suppliers' participation VCC (t=6.021, p=0.000<0.05).

4.4 Moderated mediating effect

Based on 5000 Bootstrap replicated sampling, Process program was used to conduct the test of the mediating effect. VCC play a partial mediating role between the dependent and independent variables, as CI does not include 0 at 95% confidence interval. When the degree of network embedding is low, it contains 0 at the 95% confidence interval (Table 6). When the degree of network embedding is high, it does not contain 0 (Liu, Songbo, et al., 2023; Zhou & Liu, 2023), indicating that when the degree of NE is higher, the mediation effect of customer VCC is more obvious, thus H5 is supported. H6 is proved at the same way,

with the higher degree of NE, the more obvious mediation effect of supplier VCC.

Table 6 Conditional Indirect Effect

Mediating variables	Level	level value	Effect	BootSE	BootLLCI	BootULCI
Customer Engagement	Low level（-1SD）	2.259	-0.004	0.013	-0.032	0.02
	Average value	3.298	0.046	0.011	0.026	0.068
	High level（+1SD）	4.336	0.096	0.02	0.059	0.136
	Low level（-1SD）	2.259	-0.008	0.014	-0.034	0.02
	Average value	3.298	0.035	0.01	0.017	0.056
	High level（+1SD）	4.336	0.078	0.018	0.047	0.114
	Low level（-1SD）	2.259	-0.001	0.013	-0.025	0.024
	Average value	3.298	0.038	0.01	0.02	0.061
	High level（+1SD）	4.336	0.078	0.017	0.046	0.11
	Low level（-1SD）	2.259	0.021	0.016	-0.008	0.052
	Average value	3.298	0.092	0.015	0.066	0.126
	High level（+1SD）	4.336	0.163	0.024	0.12	0.217
Supplier Engagement	Low level（-1SD）	2.259	0	0.016	-0.035	0.031
	Average value	3.298	0.068	0.013	0.044	0.095
	High level（+1SD）	4.336	0.135	0.02	0.096	0.179
	Low level（-1SD）	2.259	0.016	0.016	-0.012	0.047
	Average value	3.298	0.079	0.014	0.055	0.108
	High level（+1SD）	4.336	0.143	0.022	0.104	0.185

Note: BootLLCI refers to the lower limit of the 95% interval, BootULCI refers to the upper limit of the 95% interval, Bootstrap type: percentile bootstrap method

5.Conclusion and Discussion

Based on Dynamic Capability Theory, this paper analyzes the influence and mechanism of digital capabilities on EIP, and draws the following conclusions through empirical evidence: (1) Digital capability has a significant positive influence on EIP; (2) Customer and supplier participation VCC play a partial mediating role between digital capabilities and EIP; (3) Network embedding positively regulates digital capabilities and VCC, which means when the degree of NE is higher, the effect of digital capabilities on VCC is tronger, and the moderating effect will be reflected in the mediating effect of VCC.

5.1 Theoretical Contributions

First, it further elaborates the relationship between digital capabilities and EIP of CBEC. Although the existing literature analyzes the conceptual connotation of digital capabilities at the theoretical level, but there is no systematic theory and lack of uniform measurement scales and a paucity of empirical research results (Jun et al., 2021; Li Shuwen et al., 2021). This paper explores the impact of the three dimensions of digital capabilities on EIP on the basis of refining the common dimensions, summarizes the general law of digital capabilities that gather digital technology and data resources, and is conducive to the construction of the theory. Second, it further explains the intrinsic mechanism of digitalization affecting EIP. The two dimensions of VCC both partially mediate the relationship between digital capabilities and EIP. Compared with other countries, the biggest advantage of Chinese market is the number of users, suppliers. Digital capabilities can drive firms to utilize digital platforms, aggregate virtual resources, engage in strategic dialogues with domestic and foreign partners, establish trust, design risk-sharing, and increase relationship flexibility. Therefore, this paper carries out research through different dimensions of value co-creation subjects, which is conducive to promoting the evolution of the theory of VCC to a multi-subject perspective. It also reveal the underlying logic of enterprise innovation performance construction and enrich the multiple mediation paths. Third, the boundary conditions for the role of digital capabilities are further clarified by introducing NE. Firms' position, status, and relationships in network determine the quantity and quality of resources they aggregate, integrate, and allocate in the network, which in turn

affects their decision-making behavior in digital networks (Chi, R.Y.&Zhu, R., 2022). The structural differences in network embeddedness affect firms' access to and reconfiguration of resources, while structure, and knowledge strengthens the interaction between network subjects and facilitates trust and cooperation among firms (Lavie, 2007; Soh, 2010). Therefore, CBEC should pay full attention to NE in local country and destination countries, supplemented by platform integration capabilities, driven by multi-directional synergies, to realize the organic collaboration of all subjects and the common development of multiple subjects in the process of VCC.

5.2 Management Implications

Enterprises should increase the construction of digital infrastructure and use digital technology to realize digital transformation. CBEC should make full use of the functions of data linking, information aggregation and reconfiguration of digital platforms, maximize the value of data resources through digital platforms, in order to meet various needs. The evaluation index system of platform selection for SMEs should be constructed, with objective scoring evaluation (Wu Zhencai, 2019), and adjust the platform selection at the right time according to the changes. Enterprises should encourage multi-body VCC. They should actively guide customers and suppliers to participate in the activities of value co-creation, to create a good interactive environment, and to establish a sound incentive mechanism to mobilize the enthusiasm and creativity of stakeholders through material and non-material incentives,so that stakeholders participate in the product design, production and service process, to increase the two sides of the interaction and cooperation. Enterprises should enhance the frequency and density of contact with partners in the network (suppliers, distributors, overseas customers, service organizations, etc.) and gain an advantageous position. CBEC should establish long-term and effective network relationships with their partners, focusing on the potential value and dependence of partners to stimulate creativity (Xie Xuemei&Wang Hongwei, 2020). Therefore, enterprises should build a good network environment to improve the quality of relational and structural embedding so that digital capabilities can be fully utilized.

5.3 Limitations and Prospects

This paper argues that digital capabilities permeate the value chain of SMEs and affect EIP through VCC, it and has certain theoretical and practical significance, but there are still some limitations. Firstly, the number of samples, types of enterprises and study areas are limited due to the time and cost constraints, the samples can be further expanded by selecting regions or countries with different levels of economic development in the future, to verify that the model is rationality in a multinational context. Second, this study only examines the impact of VCC from the enterprise level, it can be analyzed from the view of industry and organizational characteristics to improve the findings. Once again, this study adopts cross-sectional data, which can't reflect the dynamic changes in innovation performance during the implementation of digital capabilities, future research can observe the growth of enterprises from a dynamic perspective and be conducted from the development indicators such as collaborative innovation performance green innovation performance, with a view to examining the dynamic effects.

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