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# Top management team social capital, digital technology and enterprise innovation performance

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**ABSTRACT**

Top management team (TMT) social capital plays an important role in obtaining innovation resources and improving enterprise innovation performance (EIP). However, there are few literatures on the impact of different dimensions of TMT social capital on EIP, especially in the digital era. Taking the listed companies disclosed by Shanghai Stock Exchange in 2008–2019 as samples, based on resource-based view and social network theory, a moderated mediation model is constructed. This paper examines the mechanism of TMT social capital affecting EIP, the mediating role of digital technology and the moderating role of network position. The results show that, TMT overseas capital and academic capital have significant positive effects on EIP; digital technology mediates the relationship between overseas capital, academic capital and EIP; network position moderates the relationship between academic capital and digital technology. Furthermore, the mediating role of digital technology in the relationship between academic capital and EIP is moderated by network position. The research conclusion enriches the research on TMT social capital, digital technology and EIP, and provides helpful guidance for enterprises to make full use of TMT social capital to manage digital technology and improve EIP.

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Top management team social capital; digital technology; network position; enterprise innovation performance

## 1. Introduction

Under the new development paradigm, Chinese economy has transitioned from the stage of high-speed growth to high-quality development, and innovation is the primary force guiding development. Enterprises, as the fundamental subjects of innovation, play a crucial role in fostering innovation-driven strategy. Innovation activities are characterised by complexity and uncertainty (Chen and Liu 2023), necessitating a substantial allocation of resources. Especially with the continuous digital transformation of enterprises, innovation environment becomes increasingly complex and dynamic. Top management team (TMT) is an important decision-making entity in formulating and implementing innovation strategies (Cortes and Herrmann 2021). TMT possesses various types of social capital that influence their access to innovation resources, which are beneficial for enterprises to adapt to the dynamic external environment and make decisions rapidly, and plays a decisive role in improving enterprise innovation performance (EIP) (Migliori et al. 2020).

Through a comprehensive literature review, two predominant views between TMT social capital and EIP have been identified. One view is that TMT social capital has a positive influence on EIP. For example, Zheng et al. (2019), Cui et al. (2019), Shen et al. (2020) and Zhou et al. (2022) found that TMT

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overseas capital, academic capital and financial capital have positive effects on innovation capability and EIP. Another view is that TMT social capital has a negative effect on EIP. For example, Lin et al. (2014) and Ma et al. (2019) found a significant negative effect between overseas capital, academic capital and EIP. Though the relationship between TMT social capital and EIP has been explored, views differ and only a few scholars have focused on the role of three TMT social capital on EIP. According to resource-based view, innovation cannot be separated from unique and unrepeatable resources (Grant 1996), while TMT social capital helps enterprises obtain diversified resources to promote EIP. Therefore, it is essential to explore the relationship between TMT social capital and EIP.

Meanwhile, although previous studies have examined the intrinsic mechanism between TMT social capital and EIP such as resource acquisition and integration, and R&D investment (Chen, Zhu, and Song 2018), it still needs to be explored from digital technology. In the digital era, digital technology fundamentally changes the nature of products and services (Nambisan et al. 2017), breaks through the boundaries of traditional innovation management. It is impossible to arrange innovation activities through traditional pattern with 'already known rules and steps of innovation implementation', which has posed new challenges. Although enterprises have recognised the importance of digital technology, the survey conducted by Kane et al. (2015) revealed that a considerable number of them were not prepared to deal with digital transformation. The experience and resources possessed by TMT social capital (Lian, Ye, and Liu 2019) promote the integration of digital technology into products and services, which offers a channel for TMT social capital to contribute to EIP. However, existing researches lack exploration in the relationship between TMT social capital, digital technology and EIP. According to resource-based view, we believe that digital technology plays a mediating role between TMT social capital and EIP. Diversified and heterogeneous resources owned by TMT social capital enable the enterprise to integrate digital technology into products and services, encouraging enterprises to use digital technology for information resources, as to reduce innovation activities' uncertainty and promote EIP.

In addition, enterprises are embedded in the industries in which they operate, and the differences of network positions also have an impact on enterprise innovation. Social network theory suggests that enterprises that occupy a core network position have an advantage in conducting innovation activities (Bell 2005). Enterprises can analyse the state of industry environment, promote the flow, transformation and utilisation of resources, and obtain new knowledge and other resources in a timely manner by using its advantageous position (Kim 2019), which in turn can help them to gain a deeper understanding of digitisation. However, despite previous studies suggesting that network position has a moderating effect on the relationship between TMT social capital and innovation (Zheng et al. 2019; Chen, Zhu, and Song 2018), where enterprises utilise core network position to scan the external environment and facilitate resource absorption (Guan et al. 2016), and in that case, the diversified and heterogeneous resources embedded in TMT social capital enhance innovation to a greater extent, limited attention has been given to explore the moderating role of network position in TMT social capital and digital technology. This paper based on social network theory and resource-based view argues that enterprise occupying dominant network position has more innovation partners and resources, which is conducive to applying digital technology to obtain various innovation resources based on TMT social capital, realising the richness and diversity of information resources within enterprises, meanwhile, accelerating the restructuring and transformation of information resources, and boosting EIP.

Based on the above analysis, this paper aims to address the following questions. How does TMT social capital affect EIP? How does digital technology mediate the relationship between TMT social capital and EIP? How does network position moderate the relationship between TMT social capital and digital technology?

## 2. Literature review and hypotheses

### 2.1. TMT social capital and EIP

TMT social capital is a combination of inherent attributes and acquired practices that derive from a manager's education, experience and talents, especially the relationships constructed later in life (Schultz 1961), which is considered to be the sum of actual and potential resources acquired through social networks that individuals possess (Nahapiet and Ghoshal 1998). Among them, TMT social relationships reflect the degree of TMT social capital; the more social relationships there are, the richer the social resources that can be accumulated for the enterprise, as well as the new knowledge, experience and cognitive foundations (Lian, Ye, and Liu 2019). Previous studies have also classified TMT social capital into overseas capital, academic capital and financial capital based on the relationship perspective (Lian, Ye, and Liu 2019; Chen, Zhu, and Song 2018). Considering the importance of relationship resources, this paper also divides TMT social capital into overseas capital, academic capital and financial capital to analyse how TMT social capital affects EIP.

Innovation activities are full of uncertainty and complexity which require abundant of resources. TMT, as a decision-making group, has a significant contribution to the improvement of EIP. The resource-based view argues that enterprises need to possess scarce, unrepeatable and unique resources to gain core competencies (Grant 1996). Overseas capital has resources such as diversified management knowledge from overseas and globalised perspective (Yang, Xu, and Wan 2019), which means that enterprises have higher ability to search, utilise, and integrate complex resources to accurately identify technological gap, seize innovation opportunities and improve EIP. Second, overseas capital builds the connection between enterprises and overseas resources (Cui et al. 2019), which improves the alertness of identifying business opportunities, reduces uncertainty of innovation activities, increases the willingness of enterprises to engage in innovation, and ultimately promotes EIP. Finally, overseas capital owns a certain 'star effect' (Yuan and Wen 2018), which sends signals to outside, attract more overseas talents, promotes the accumulation of human resources and other resources, and provides inexhaustible power for the smooth implementation of innovation activities.

Academic capital describes social resources possessed by TMT who have served in universities, research institutions or associations. Academic capital strengthens ties between enterprises and academia, reduces the distance between those social relations that influence how enterprises behave and make decisions (Fracassi 2017), and fosters associations with other exchanges, that is conducive to integrating innovation production factors scattered by multiple forces (Zhou et al. 2022), solving the problem of innovation between organisations, and effectively improving EIP. Second, academic capital enhances the trust of cooperation, facilitates the transfer of knowledge resources, overcomes the issue of asymmetry in knowledge and other resources, mitigates the risk of impeding enterprise innovation, expands the range of enterprise resources, creates a positive feedback loop for innovation cooperation, and improves EIP (Zheng et al. 2019).

Financial capital is the social capital owned by TMT who work in financial institutions. TMT with financial backgrounds have professional theoretical knowledge in finance as well as long-term practice, leading to a strong understanding and application of theoretical knowledge (Custódio and Metzger 2014) and the ability to target and locate relevant resources, react more quickly to financial institutions credit policies, increase the anti-risk capacity (Du and Du 2013), and improve the ability to sustain innovation even in the face of innovation uncertainty. Second, financial capital establishes connections with financial institutions to obtain credit policies and investment opportunities in a timely manner, effectively alleviating financial constraints caused by asymmetric information and increasing trust between them (Zheng et al. 2019), providing the credit and other resources vital for carrying out innovation. Hence:

H1: TMT social capital (overseas capital H1a, academic capital H1b, and financial capital H1c) has a significant positive effect on EIP.

### 2.2. TMT social capital and digital technology

Digital technology refers to a set of products or services embedded in or facilitated by information and communication technology (von Briel, Davidsson, and Recker 2018). According to Nambisan et al. (2017), digital technology also refers to products or services embedded in or integrated with information technology, which mainly includes digital physical components, digital platforms and digital infrastructure. Studies on the drivers of digital technology have been conducted and found that organisational external factors such as competitive pressures and environmental restriction determine whether enterprises adopt digital technology (Ghobakhloo and Ching 2019). Meanwhile, internal factors such as managers, organisational culture and knowledge capabilities influence whether an enterprise implements digital technology (Martínez-Caro, Cegarra-Navarro, and Alfonso-Ruiz 2020).

Resource-based view suggests that the enhancement of an enterprise's core competitiveness relies on unrepeatable and unique resources (Barney 1991). Overseas capital possess cutting-edge knowledge and skills that are no longer limited to the cognitive framework of relevant domestic industry knowledge (Zhu et al. 2017), and are better able to collect and process complex information resources in the digital era, providing enterprises with knowledge and experience to use digital technology. Second, overseas capital makes it possible for TMT to possess diverse resources (Giannetti, Liao, and Yu 2015), which helps accurate development judgments, grasp of digital transformation opportunities, discovery and use of digital technology in an uncertain social environment.

Academic capital acquires knowledge and resources from academia and avoids cognitive locking (Oh, Labianca, and Chung 2006), which in turn facilitates enterprises to gain insights into the frontiers of industry development, break through industry norms, accurately identify the state of market development and R&D process and innovation direction (Sunder, Sunder, and Zhang 2017). In the digital era, it is more able to apply digital technology to enterprise management practices and enhance competitive advantage. Second, academic capital expands the scope of enterprise resources and information (Zhou et al. 2022) and enhances the control of enterprises over knowledge resources, which plays a crucial role in encouraging enterprises to engage in digital technology. Finally, academic capital can effectively integrate professional and industry knowledge resources (Zhu et al. 2017), overcome industry norms, embed digital technology in enterprise products and services, and promote enterprise development.

Financial capital allows enterprises to get a greater loan amount at a cheaper loan interest rate, ensuring enough capital resources (Cui et al. 2019) and the ability to deal with environmental uncertainties. Enterprises have sufficient capital for guaranteeing that digital technology enhance their competitive advantages in the digital era. Furthermore, financial capital strengthens the trust between enterprises and financial institutions (Du and Du 2013), making necessary resources available. In the digital context, enterprises are more inclined to apply digital technology to management practices. Hence:

> H2: TMT social capital (overseas capital H2a, academic capital H2b, and financial capital H2c) has a significant positive effect on digital technology.

### 2.3. Digital technology and EIP

It has been found that digital technology has a significant effect on enterprises' competitiveness and performance (Ferreira, Fernandes, and Ferreira 2019). In this paper, it is believed that digital technology has a positive effect on EIP based on resource-based view.

Firstly, digital technology helps enterprises in fast adapting to new surroundings (Huang et al. 2017), acquire tangible or intangible resources, which enables enterprises to utilise and transform these unique resources to innovation activities and enhances EIP (Priem and Butler 2001). Secondly, digital technology makes it easier for enterprises to communicate with one another (Amit and Han 2017), and expands their access to resources, which helps them identify valuable resources and

innovation opportunities, ultimately improving EIP. In addition to lowering the cost of looking for innovation resources, digital technology also increases the transparency of information sources (Smith, Smith, and Shaw 2017), enhancing the ability and effectiveness of enterprises to engage in innovation activities and boost EIP. Hence:

H3: Digital technology has a significant positive effect on EIP.

### 2.4. The mediating role of digital technology

With diverse resources (Giannetti, Liao, and Yu 2015) and more risk-taking, overseas capital is more inclined to adopt digital technology to market environment and obtain valuable resources related to innovation from new environment at the lowest cost (Chen, Zhu, and Song 2018), which reorganise and utilise them to promote EIP in the face of uncertain market environment. Besides, overseas capital breaks the inherent cognitive framework (Lian, Ye, and Liu 2019), and enhances the identification of digital dividends, which in turn increases enterprises' awareness of market demand and their willingness to use digital technology into products and services, ultimately promoting EIP.

Academic capital identifies, absorbs and transforms advanced knowledge resources from social relationships to which they belong, increasing the diversity and completeness of resources (Lichtenstein, Drumwright, and Braig 2004). The diversity of resources promotes the use of digital technology, which in turn enhances EIP. Additionally, academic capital allows enterprises to effectively integrate theory and practice, which is benefit for them to use digital technology to identify industry development (Zhu et al. 2017) and market resource, and eventually improve EIP.

Financial capital can keep abreast of the relevant policies, obtain corporate financing at a lower cost (Graham, Harvey, and Puri 2013), which can obtain more adequate financial resources and improve the ability to sustain innovation. In the digital era, enterprises are increasingly using digital technology to promote EIP. Also, it has been observed that financial capital plays a crucial role in maintaining a strong trust relationship with financial institutions (Du and Du 2013), which allows enterprises to have greater access to resources and a motivation to adopt digital technology for efficient management and EIP.

Hence: H4: Digital technology plays a mediating role between TMT social capital (overseas capital H4a, academic capital H4b, financial capital H4c) and EIP.

### 2.5. The moderating role of network position

Along with the increase of innovation uncertainty and complexity, enterprises cannot only rely on internal access to resources needed for innovation (Zhu et al. 2017). The 'closed door' approach to innovation is no longer suitable in digital era, and enterprises have to establish contacts with other enterprises to seek cooperation. Network position refers to relationship between enterprises (Lu et al. 2021), reflecting the degree of access to or control over information resources. According to Chen, Zhu, and Song (2018), successful innovation relies on the establishment and maintenance of effective networks. The ability of enterprises to identify, acquire, utilise and integrate resources is influenced by their network position (Zhu et al. 2017). In this paper, we use network centrality to evaluate the moderating impact of network position in the relationship between TMT social capital and digital technology. Network centrality refers to the degree to which an enterprise occupies a central position within its industry network (Bell 2005), as well as the degree of access to and control over resources. The higher network centrality, the greater number of other enterprises directly connected to the enterprise.

Social network theory suggests that an enterprise in the core network position owns rich network resources, has access to more novelty and diversity of information resources, and acquire resources more efficiently (Guan et al. 2016). Meanwhile, enterprises exert greater control over information resources when they occupy a core network position (Kim 2019), which in turn helps them gain

insights into industry development dynamics in the digital context. TMT social capital can accelerate the integration and transformation and promote digital technology when the enterprise is in the core network position. In addition, enterprises need to rely on external resources for core competitiveness. When an enterprise occupies a core network position, it frequently communicates and interacts with other enterprises (Pan, Zhao, and Ding 2019), which reduces information asymmetry and resource acquisition costs, and helps enterprises to obtain a wide range of diverse resources and identify innovation opportunities. In that case, TMT social capital is more able to promote the reorganisation of knowledge and resources and promote digital technology. Hence:

H5: Network position plays a moderating role in the relationship between TMT social capital (overseas capital H5a, academic capital H5b, financial capital H5c) and digital technology, that is, when network position is high, TMT social capital has a stronger positive effect on digital technology; and when network position is low, TMT social capital has a weaker positive effect on digital technology.

## 3. Research design

### 3.1. Sample and data collection

This paper selects listed companies disclosed on the Shanghai Stock Exchange (www.sse.com.cn) from 2008 to 2019, with manufacturing industry and combining China Stock Market & Accounting Research (CSMAR) database, Chinese Research Data Services Platform (CNRDS), and the annual reports and corporate social responsibility reports. Sample selection procedure is as following: exclude ST category companies, companies with less than one year of listing and missing information on key variables such as innovation, and finally obtain 5492 valid samples, with a total of 772 listed companies in the manufacturing industry.

### 3.2. Dependent variable

The dependent variable is EIP. We use the total number of patents for invention, patents for utility model, patents for industrial design to measure EIP (Zheng et al. 2019). Since it takes 6–18 months from patent application to patent disclosure, EIP is treated with a one-year lag, that is, when the dependent variable is in the $t + 1$ year, the corresponding independent variable, mediating variable, moderating variable and control variable are in the t year. Therefore, the number of patents in 2009–2019 corresponds to TMT social capital, digital technology, network position in 2008–2018, as well as other control variables.

### 3.3. Independent variables

The independent variables are overseas capital (OC), academic capital (AC) and financial capital (FC). We measure academic capital by the total number of TMT members holding positions in universities, scientific research institutions or associations; we measure overseas capital by the total number of TMT members working overseas or studying abroad; besides, we measure financial capital by the total number of TMT members working in financial institutions (Chen, Zhu, and Song 2018; Zheng et al. 2019).

### 3.4. Mediating variable

The mediating variable is digital technology (DT). Following Nambisan et al. (2017) and von Briel, Davidsson, and Recker (2018), there are three forms of digital technology: digital artefacts digital platforms, and digital infrastructures. This paper uses relevant expressions disclosed in corporate annual reports and corporate social responsibility reports to measure digital technology (Wang and Du 2021). If the enterprise uses digital components, digital platforms or digital infrastructure, it is 1, otherwise is 0.

### 3.5. Moderating variable and control variables

The moderating variable is network position (NP). We measure network position by network centrality (Zheng et al. 2019). This paper uses the data disclosed in CSMAR whether a corporate director is a director of another company (if yes, then it is 1, otherwise is 0) to construct network position relationship matrix, and use UCINET6.0 software to process the data to calculate network centrality, which is an indicator of network position.

Previous studies have shown that EIP is affected by factors such as enterprise age (Age, i.e. the duration from the establishment to the observation year),enterprise size (Size, i.e. total income of the enterprise), ownership concentration degree (OCD, i.e. shareholding ratio of the largest shareholder), duality (DUA, i.e. if the president and general manager are the same person, it is 1, otherwise it is 0), state ownership (STA, i.e. if the enterprise is state-owned, it is 1, otherwise it is 0), board size (BS, i.e. the total number of board members), supervisor size (SS, i.e. the total number of supervisors), independent director size (IDS, i.e. the total number of independent directors), TMT size (TMTS, i.e. the total number of TMT members) (Lian, Ye, and Liu 2019).

## 4. Results

### 4.1. Descriptive statistics and correlation analysis

This paper uses STATA16.0 to conduct the mean value, standard deviation and correlation analysis of each variable, as shown in Table 1. The correlation results reveal a significant correlation among the variables, with all correlation coefficients being below 0.562.

### 4.2. Empirical analysis

#### 4.2.1. Direct effect test

This paper uses STATA16.0 to test the relationship between TMT social capital, digital technology and EIP. The results are shown in Table 2. It can be seen from Model 2 and Model 3 that overseas capital and academic capital have a significant positive effect on EIP, which support H1a and H1b. However, Model 4 shows that financial capital has a significant negative effect on EIP, which does not support H1c. Digital technology has a significant positive effect on EIP in Model 5, supporting H3. It is observed that overseas capital and academic capital have a significant positive effect on digital technology in Model 7 and Model 8, which support H2a and H2b. However, Model 9 does not support H2c, indicating that financial capital has no significant positive effect on digital technology.

#### 4.2.2. Mediation effect test

The BOOTSTRAP method is applied to test the mediating role of digital technology. The results are shown in Table 3.

The results from Table 3 indicate that both direct and indirect effects of overseas capital and academic capital on EIP are significant, providing support for H4a and H4b. However, both the direct and indirect effects of financial capital on EIP are insignificant. H4c is not supported.

The SOBEL test is adopted to verify the mediating effect of digital technology. It is found that Z value of the direct and indirect effects of overseas capital and academic capital on EIP are respectively 4.957 and 4.908, 4.784 and 6.783, both larger than 1.960, which support H4a and H4b. However, *Z* values of the direct and indirect effects of financial capital on EIP are respectively 0.859 and −1.289, both smaller than 1.960. H4c is not supported.

**Table 1.** Descriptive statistics and correlation analysis.

| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 Age | 1 | | | | | | | | | | | | | | |
| 2 Size | 0.006 | 1 | | | | | | | | | | | | | |
| 3 DUA | 0.036** | −0.007 | 1 | | | | | | | | | | | | |
| 4 STA | −0.047*** | 0.134*** | −0.024 | 1 | | | | | | | | | | | |
| 5 OCD | −0.223*** | 0.183*** | −0.074*** | 0.127*** | 1 | | | | | | | | | | |
| 6 BS | 0.043** | 0.089*** | 0.0002 | 0.198*** | 0.017 | 1 | | | | | | | | | |
| 7 SS | 0.017 | 0.117*** | −0.013 | 0.279*** | 0.037** | 0.476*** | 1 | | | | | | | | |
| 8 IDS | 0.038** | 0.015 | 0.017 | 0.054*** | −0.001 | 0.687*** | 0.299*** | 1 | | | | | | | |
| 9 TMTS | −0.174*** | 0.078*** | 0.039** | 0.163*** | 0.018 | 0.213*** | 0.176*** | 0.112*** | 1 | | | | | | |
| 10 OC | 0.006 | 0.069*** | 0.031* | −0.107*** | 0.077*** | 0.032* | 0.010 | −0.020 | 0.247*** | 1 | | | | | |
| 11 AC | 0.015 | 0.001 | 0.009 | 0.030* | −0.009 | 0.114*** | 0.093*** | 0.077*** | 0.292*** | 0.275*** | 1 | | | | |
| 12 FC | −0.011 | 0.001 | 0.039** | −0.114*** | −0.079*** | 0.071*** | 0.021 | 0.059*** | 0.149*** | 0.107*** | 0.153*** | 1 | | | |
| 13 DT | 0.181*** | 0.066*** | −0.006 | −0.109*** | −0.007 | −0.009 | −0.024 | 0.029* | −0.125*** | 0.062*** | 0.075*** | −0.021 | 1 | | |
| 14 NP | 0.035** | 0.030* | 0.020 | 0.001 | 0.009 | 0.062*** | 0.031* | 0.072*** | 0.066*** | 0.043** | 0.047*** | 0.037** | 0.047*** | 1 | |
| 15 EIP | 0.058*** | 0.562*** | −0.027* | 0.080*** | 0.081*** | 0.086*** | 0.101*** | 0.042** | −0.001 | 0.086*** | 0.057*** | 0.003 | 0.189*** | 0.015 | 1 |
| Mean | 16.720 | 9.11e + 09 | 0.032 | 0.523 | 0.366 | 10.306 | 4.383 | 3.751 | 6.661 | 0.211 | 0.364 | 0.203 | 0.230 | 0.041 | 27.859 |
| SD | 5.027 | 3.31e + 10 | 0.176 | 0.500 | 0.151 | 2.616 | 1.734 | 1.304 | 3.851 | 0.665 | 0.854 | 0.539 | 0.421 | 0.225 | 90.924 |

Note, $N = 5492$, *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$, the same as below.

**Table 2.** Regression analysis.

| | EIP | | | | | | DT | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Variable | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 | Model 9 | Model 10 | Model 11 |
| Constant | 0.625*** | 0.635*** | 0.672*** | 0.714*** | 0.582*** | −0.258* | −0.249* | −0.247* | −0.245* | −0.258* | −0.251* |
| Age | 0.011* | 0.011* | 0.010* | 0.009 | 0.006 | 0.033*** | 0.033*** | 0.032*** | 0.032*** | 0.033*** | 0.032*** |
| Size | 4.94e-11*** | 4.85e-11*** | 4.92e-11*** | 4.90e-11*** | 4.69e-11*** | 1.32e-12*** | 1.32e-12*** | 1.33e-12*** | 1.33e-12*** | 1.32e-12*** | 1.32e-12*** |
| DUA | 0.309* | 0.296 | 0.312* | 0.335* | 0.272 | −0.001 | −0.001 | −0.001 | −0.001 | −0.001 | −0.001 |
| STA | −0.028 | −0.003 | −0.007 | −0.040 | 0.012 | −0.010 | −0.010 | −0.008 | −0.008 | −0.010 | −0.011 |
| OCD | 0.005** | 0.005*** | 0.005** | 0.004** | 0.005** | −0.127*** | −0.122*** | −0.124*** | −0.126*** | −0.127*** | −0.127*** |
| BS | −0.021 | −0.021 | −0.022 | −0.018 | −0.020 | 0.008 | 0.008 | 0.008 | 0.008 | 0.008 | 0.009 |
| SS | −0.020 | −0.020 | −0.023 | −0.026 | −0.018 | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 |
| IDS | 0.069* | 0.073* | 0.069* | 0.067* | 0.064* | −0.016 | −0.015 | −0.017 | −0.017 | −0.016 | −0.019 |
| TMTS | −0.007 | 0.003 | −0.006 | −0.002 | 0.013 | −0.008*** | −0.010*** | −0.011*** | −0.011*** | −0.008*** | −0.011*** |
| OC | | 0.154*** | 0.115* | 0.130* | | | 0.026* | 0.021* | 0.022* | 0.029** | |
| AC | | | 0.258*** | 0.287*** | | | | 0.028*** | 0.029*** | | 0.026** |
| FC | | | | −0.206*** | | | | | −0.012 | | |
| DT | | | | | 0.581*** | | | | | | |
| NP | | | | | | | | | | 0.070** | 0.033 |
| OC*NP | | | | | | | | | | −0.035 | |
| AC*NP | | | | | | | | | | | 0.049* |
| $R^2$ | 0.054 | 0.056 | 0.068 | 0.074 | 0.074 | 0.055 | 0.058 | 0.062 | 0.060 | 0.059 | 0.063 |
| Samples | 5492 | 5492 | 5492 | 5492 | 5492 | 5492 | 5492 | 5492 | 5492 | 5492 | 5492 |

**Table 3.** Mediation effect test.

| | Effect | β | S.E. | Z | LLCI | ULCI |
|---|---|---|---|---|---|---|
| OC→DT→EIP | Direct effect | 7.838*** | 1.909 | 4.957 | 4.096 | 11.579 |
| | Indirect effect | 1.446*** | 0.340 | 4.908 | 0.780 | 2.112 |
| | Total effect | 9.284*** | 1.600 | 5.802 | | |
| AC→DT→EIP | Direct effect | 5.877*** | 1.178 | 4.784 | 3.568 | 8.187 |
| | Indirect effect | 1.670*** | 0.299 | 6.783 | 1.085 | 2.256 |
| | Total effect | 7.547*** | 1.239 | 6.093 | | |
| FC→DT→EIP | Direct effect | 1.627 | 1.753 | 0.859 | −1.808 | 5.062 |
| | Indirect effect | −0.435 | 0.334 | −1.289 | −1.090 | 0.219 |
| | Total effect | 1.192 | 1.923 | 0.620 | | |

Note: LLCI and ULCI are respectively lower limit and upper limit of 95% confidence level.

#### *4.2.3. Moderation effect test*

Model 10 shows that the moderating effect of network position on the relationship between overseas capital and digital technology is not significant. H5a is not supported. Besides, Model 11 demonstrates that the moderating effect of network position on the relationship between academic capital and digital technology is significant. H5b is supported.

A diagram, shown in Figure 1, is drawn to display the moderating effect of network position. In the case of high network position, academic capital has a stronger effect on digital technology, while in the case of low network position, academic capital has a weaker effect on digital technology.

### *4.3. Exploratory analysis*

This paper applies STATA16.0 and BOOTSTRAP method to further test the moderated mediation effect. The results are shown in Table 4. The impact of overseas capital on EIP through digital technology is significant, regardless of network position. Moderated mediation effect is not supported. However, in the case of low network position, the mediating effect of digital technology between academic capital and EIP is not significant, while in the case of high network position, academic capital has a significant impact on EIP through digital technology, supporting moderated mediation effect.

To further verify the significance of moderated mediation effect, the SOBEL test is adopted. The moderation of network position on the path of 'OC→DT→EIP' does not support moderated mediation effect, as Z values of 2.920 and 2.770 are larger than 1.960. Besides, in the moderation

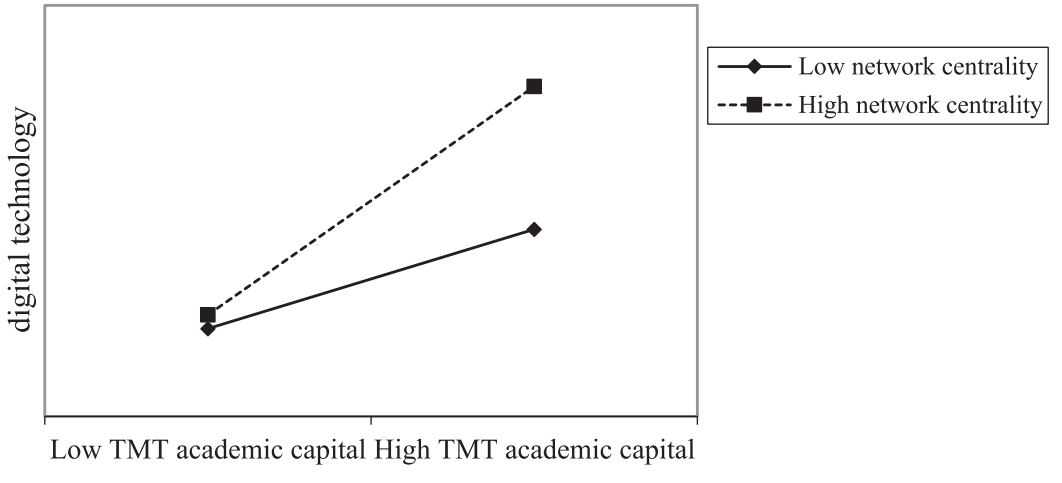


**Figure 1.** Moderating effect of network position.

**Table 4.** Moderated mediation test.

| Independent variable, OC | $\beta$ | S.E. | $Z$ | LLCI | ULCI |
|---|---|---|---|---|---|
| Low NP | 1.720** | 0.589 | 2.920 | 0.642 | 2.912 |
| Medium NP | 1.549*** | 0.402 | 3.850 | 0.812 | 2.387 |
| High NP | 1.378** | 0.497 | 2.770 | 0.517 | 2.439 |
| Independent variable, AC | β | S.E. | Z | LLCI | ULCI |
| Low NP | 0.829 | 0.449 | 1.840 | −0.010 | 1.757 |
| Medium NP | 1.373*** | 0.329 | 4.170 | 0.747 | 2.068 |
| High NP | 1.916*** | 0.465 | 4.120 | 1.048 | 2.921 |

Note: LLCI and ULCI are respectively lower limit and upper limit of 95% confidence level.

of network position on the path of 'AC→DT→EIP', Z value is 1.840 in the case of low network position, smaller than 1.960, while *Z* value is 4.120 in the case of high network position, larger than 1.960, further supporting moderated mediation effect.

## 5. Research findings and discussion

### 5.1. Research findings

Based on the resource-based view and social network theory, this paper explores the relationship among TMT social capital, digital technology with EIP. The findings show that there is a significant positive effect of overseas capital and academic capital on EIP; digital technology mediates the role between overseas capital, academic capital and EIP. The moderating role of network position in the relationship between social capital and digital technology is also examined. In addition, network position also moderates the effect of academic capital on EIP via digital technology.

However, financial capital has a significant negative effect on EIP, which could be explained by the fact that China's capital market is not well-functioning and has not yet become an actual financial channel for innovative activities. Further, while financial capital brings additional financial resources, it tends to prioritise short-term behaviour and is reluctant to invest in long-term activities such as innovation. Also, One possible reason why digital technology does not play a mediating role between financial capital and EIP is that China's capital market is still immature, hindering financial capital's access to resources related to digital technology and further contribute to EIP. Besides, the moderating role of network position in the relationship between overseas capital and digital technology is not significant, which may be explained by the fact that the path of overseas capital influencing digital technology is related to the traits of executives themselves.

### 5.2. Theoretical implications

We contribute to the existing literature in three ways. First, we provide new empirical evidence for the relationship between TMT social capital and EIP, which is a controversial topic. Previous studies have reached conflicting results over the effects of TMT social capital. Cui et al. (2019) believed that social capital promotes EIP, while Ma et al. (2019) held the opposite view. This paper finds that there is a significant positive effect of academic capital, overseas capital on EIP, which supports the views of Cui et al. (2019). Besides, this paper also finds that financial capital has a significant negative effect on EIP, consistent with Ma et al. (2019). Our study classifies TMT social capital as academic capital, overseas capital and financial capital, explaining why there exists inconsistency in the impact of TMT social capital on EIP.

Secondly, we investigate the mediating role of digital technology in social capital and EIP, which enriches the research related to digital technology, social capital and EIP. Previous studies on digital technology have mostly focused on concepts (Nambisan et al. 2017), organisational capabilities and strategies (Forman and van Zeebroeck 2019), and less on how TMT social capital applies digital technology to enhance EIP. This paper enriches the research related to digital technology where

enterprises adopt digital technology to make transformations (Fichman, Dos Santos, and Zheng 2014) and achieve EIP. Besides, although the effect of academic capital on EIP via digital technology also differs from that of overseas capital on EIP via digital technology, it has been verified that both academic capital and overseas capital can provide diversified resource and promote digital technology for EIP.

Finally, we further add to the literature on the intersection of network position and digital technology. Our study finds that when an enterprise is in a core network position, it can obtain heterogeneous resources from other enterprises to broaden restructuring opportunities (Grant 1996), which will have an impact on social capital and digital technology. At the same time, study also found that network position moderates the path that academic capital affects EIP via digital technology, which further indicates network position, as a contingency variable, is essential in innovation process.

### 5.3. Practical implications

Firstly, enterprises should strengthen social capital to enhance EIP. For large enterprises, they should focus on introducing and cultivating composite talents with overseas or academic backgrounds to break through industry constraints and promote digital transformation. For small and medium-sized enterprises, they should exchange and cooperate more with overseas or academic social capital to promote sustainable development.

Secondly, enterprises should enhance the breadth and depth of digital technology application to achieve digital technology-driven innovation. Enterprises that have already used digital technology should increase their investment, embed it into products and services, strengthen its application and promote transformation of innovation. For enterprises that have not yet used digital technology, they should change their mindset and consciously learn to use digital technology to reduce information asymmetry between enterprises and market and promote EIP.

Thirdly, enterprises should grasp the advantages of network position, obtain diversified information resources, boost social capital to stimulate the use of digital technology, and ultimately promote EIP. Enterprises in a core network position, taking advantage of the position they are in, integrate various types of social capital, leverage digital technology for collaboration and communication, absorb and control resources, and ultimately enhance competitive advantage. Enterprises at the edge of network position, are supposed to learn management experience and practical methods from centre enterprises in order to improve the disadvantageous position. Besides, enterprises should adopt digital technology to understand the strengths and weaknesses of other enterprises, so as to promote long-term development.

### 5.4. Limitations and prospects

This paper has certain limitations. First, merely manufacturing enterprises are selected in this paper in order to control the industry differences, but the applicability to other industries may not be distinguished. Second, this paper uses dummy variable to measure digital technology, and questionnaires or other secondary data can be explored in the future.

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