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# **The Impact of IOS Use and Interpersonal Ties on Digital Innovation: Insights from Boundary Spanning and Institutional Theories**

*Completed Research Paper*

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## **Abstract**

*Drawing upon the boundary spanning and institutional theories, this study investigates the influence of interorganizational systems (IOS) use and interpersonal ties between a firm and its suppliers on a firm's digital innovation and how such effects are moderated by institutional distance between the firm and its suppliers. Based on a pilot test of 123 Chinese firms, our results find that a firm's use of IOS significantly improves its digital innovation, while interpersonal ties between the firm and its suppliers do not significantly improve the firm's digital innovation. Further, we find that institutional distance between the firm and its suppliers differentially moderates the influences of IOS use and interpersonal ties on digital innovation. Specifically, institutional distance negatively moderates the impact of IOS use on digital innovation yet positively moderates the impact of interpersonal ties on digital innovation. We further discuss the theoretical contributions and managerial implications of the current study.*

**Keywords:** Digital innovation, interorganizational systems use, interpersonal ties, institutional theory, boundary spanning theory

## Introduction

*Digital innovation* – “the creation of (and consequently change in) market offerings, business processes, or models that result from the use of digital technology” (Nambisan et al. 2017, p. 224) – plays an increasingly important role in enabling firms to maintain competitive advantage especially in the rapidly changing digital business environments (Henfridsson and Yoo 2013; Leonhardt et al. 2018; Lyytinen et al. 2016; Sia et al. 2016; Svahn et al. 2017). By combining digital technologies and products/services, digital innovation has radically changed the traditional nature and structure of products/services, and thus helping firms create a novel value creation and appropriation model (Nambisan et al. 2017; Yoo et al. 2010). Yet despite the recognition of the importance of digital innovation, our understanding of what factors improve a firm’s digital innovation remains limited.

Although prior studies have examined how a firm’s internal factors, such as organizational culture (Lucas Jr and Goh 2009) and IT governance help generate digital innovation (Leonhardt et al. 2018; Yoo et al. 2010), our knowledge of how collaborating with external firms help improve a focal firm’s digital innovation is unclear. In particular, a firm’s suppliers play an important role in facilitating knowledge development and resource mobilization of the firm (Bellamy et al. 2014), and thus collaborating with the suppliers can help the firm acquire critical information and knowledge needed for digital innovation (Bidault et al. 1998). For example, some researchers argue that IOS use can help improve firm innovation (e.g., Im and Rai 2014). While some others argue that relational ties can help enhance firm innovation (e.g., Tiwana 2008). Therefore, there is a need to provide a broader and more complete perspective to investigate how IOS and ties simultaneously can influence a firm’s digital innovation.

In this study, we aim to extend this line of work by examining how IOS use and interpersonal ties between a firm and its suppliers influence the firm’s digital innovation. In order to conduct better digital innovation, firms should acquire new knowledge and information from the external partners, its suppliers in particular, to combine with their own (Barrett et al. 2011; Chi et al. 2010; Henfridsson and Yoo 2013; Selander et al. 2013; Svahn et al. 2017). According to the boundary spanning theory, boundary objects (Dong et al. 2017) and boundary spanners (Huang et al. 2013) can act as a boundary spanning role to overcome the knowledge boundary between the firm and its suppliers. In particular, IOS use, defined as the firm’s use of IT in the interorganizational process to exchange information (Bensaou 1997), is considered as a digital boundary object to help better cooperation and communication between firms (Dong et al. 2017). Meanwhile, boundary spanners are the main representatives and participants of activities in organizational boundaries (Aldrich and Herker 1977), which help firms share knowledge cross organizational boundaries (Huang et al. 2013). Although prior researchers have recognized the importance of boundary objects or boundary spanners, there is still lack of empirical understanding of how boundary objects and spanners simultaneously influence a firm’s digital innovation. In order to fill this research gap, the current research simultaneously considers both the roles of boundary objects (i.e., IOS use) and boundary spanners (i.e., interpersonal ties) and examine how they can improve the firm’s digital innovation.

Furthermore, when firms collaborate with suppliers in different geographical locations across the supply chain, it will cause differences in the institutional environment between them, namely the institutional distance (Yang et al. 2012). Since it is difficult for cooperative firms to understand the heterogeneous information shared by collaborating firms in different institutional environments (Ambos and Ambos 2009; Hens 2012), it is generally believed that the larger institutional distance could reduce the effectiveness of information sharing between the firms (Yang et al. 2012). Researchers have argued that information shared from different geographic locations is not easy to understand across different institutional environments (Dong et al. 2017; Zhou and Benton Jr 2007). However, while it is difficult for organizations to absorb and understand this different and novel knowledge through IOS coding (Dong et al. 2017), the close ties between boundary spanners might help organizations to absorb and understand the novel knowledge brought from different institutional environments (Cuervo-Cazurra and Anrique Un 2010; Tortoriello and Krackhardt 2010). Therefore, we posit that the institutional distance between the firm and its suppliers negatively moderates the relationship between IOS use and digital innovation but positively moderates the relationship between interpersonal ties and digital innovation.

To this end, drawing upon the boundary spanning theory, we propose that IOS use and interpersonal ties could significantly improve a firm’s digital innovation. Furthermore, by adopting the perspective of

institutional theory, we investigate how the institutional distance between the firm and its suppliers differentially moderates the effects of IOS use and interpersonal ties on digital innovation. By conducting a survey research in China, our results indicate that IOS use and interpersonal ties have different effects on the firm's digital innovation and their effects are further differentially moderated by the institutional distance between the firm and its suppliers. In doing so, our research aims to contribute to the existing literature in three main ways. First, by adopting the perspective of boundary spanning theory, we consider how IOS use (i.e., boundary objects) and interpersonal ties (i.e., boundary spanners) simultaneously influence a firm's digital innovation. By simultaneously considering the roles of boundary spanners and boundary objects, our results find that they have different impacts on the firm's digital innovation. Second, by integrating the insights from the boundary spanning and institutional perspective, our study further explores how the institutional distance between the firm and its suppliers moderates the effects of IOS use and interpersonal ties on digital innovation. The distinctive moderating effects thus enhance our understanding of the institutional boundary conditions under which the effects of boundary objects (i.e., IOS use) and spanners (i.e., interpersonal ties) vary. Third, considering that the previous studies have predominantly emphasized the institutional distance in a national context, our study also contributes to the digital innovation literature by confirming the importance of sub-institutional distance.

## **Theoretical Framework**

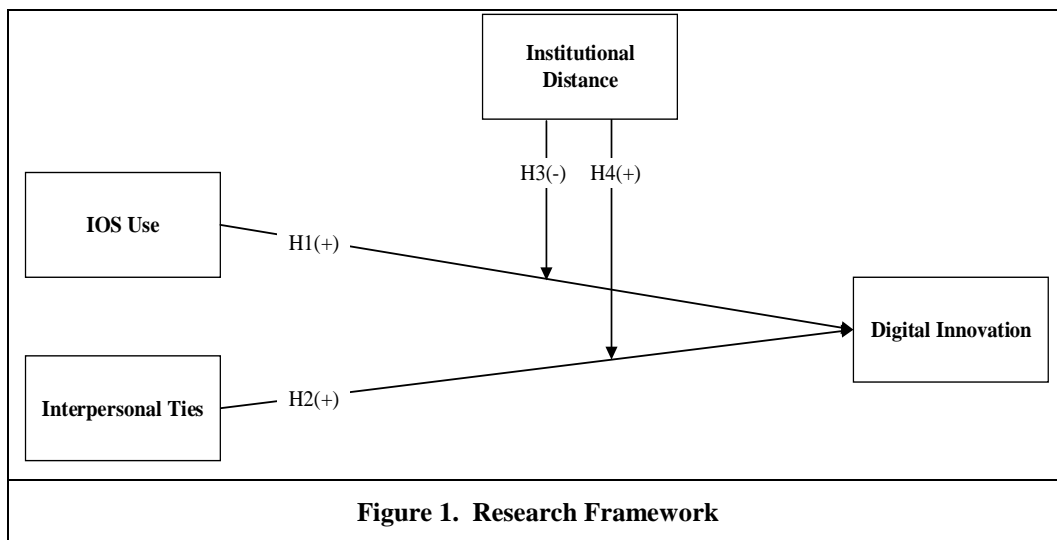
### ***Boundary Spanning Theory***

The boundary spanning theory shows that the firm can cross the boundary of knowledge by boundary spanning objects and spanners (Carlile 2002; Star and Griesemer 1989). When collaborating with partners in the supply chain across different geographic locations, the firm needs to cross the obstacle resulting in knowledge embedding to cross the boundary between supply chain partners (Tortoriello et al. 2011). Specifically, boundary objects refer to "artifacts or other forms of reification around which communities of practice can organize their interconnections" (Wenger 1998, p.107). Boundary objects are thought to allow knowledge and information to be shared among organizational or community boundaries because they are stable enough to maintain common characteristics across boundaries (Star and Griesemer 1989). Boundary spanners are defined as the personnel that connected to each other between organizations and their communication can facilitate the flow of information and knowledge (Levina and Vaast 2005; Tortoriello et al. 2011). Boundary spanners can make the social and economic exchanges between cooperating firms smoothly (Huang et al. 2013), and thus facilitating the share of knowledge and information more efficiently and effectively (Aldrich and Herker 1977).

### ***Institutional Distance***

The institutional theory provides a theoretical perspective for researchers to identify and examine the effects of the legitimacy of organizational conducts, including culture, social environment and rules (Bruton et al. 2010; Lai et al. 2006; Litan et al. 2008). Institutions are social structures that define codes of conduct, form the firm's expectations of other roles, and inform the limits of choice of business behavior (Dacin et al. 2007; Scot 2008). Institutional distance is defined as the gap between two independent institutional environments (Dong et al. 2016). The concept of institutional distance was initially used to measure the differences in the institutional environment between the parent and subsidiary companies of multinational firms (Kostova 1999). Institutional distance exists not only between countries (Wu 2013), but also within a country or a region (Kostova et al. 2008; Phillips et al. 2009). In fact, existing literature has recognized that there may be differences in institutional conditions in different regions of a country, especially in some emerging developing countries, such as China (Peng et al. 2008). This is basically the result of different geographical norms, different cultural traditions in different places, and decentralized management systems in these countries (Wright et al. 2005).

In the current study, by drawing upon the boundary spanning theory, we regard IOS use as boundary objects and interpersonal ties as boundary spanners and investigate how IOS use and interpersonal ties between a firm and its suppliers influence the firm's digital innovation. By adopting the perspective of institutional theory, we further examine how institutional distance between the firm and its suppliers moderates the effects of IOS use and interpersonal ties on digital innovation. We show our conceptual model in Figure 1.



## Hypotheses Development

### ***IOS Use and Digital Innovation***

The firm's ability to transform and explore knowledge may determine its level of innovation, such as the new problem resolution and the rapid response to market demand (Du Plessis 2007). The sharing of knowledge can provide new ideas for the development of new business opportunities, thus benefiting the firm's innovative activities (Wang and Wang 2012). In particular, digital innovation is usually a flexible innovation process, characterized by shorter development cycles and rapid adaptation to market changes (Abrell et al. 2016). Compared with common innovation, digital innovation needs firm to acquire knowledge and information in a timely and effective manner. As such, through the use of IOS that based on IT, firms can share knowledge and information quickly with their partners in the supply chain (Dong et al. 2017). Digital innovation requires firms to use cooperative IT infrastructures, which can support firms to manage and coordinate different knowledge resources (Yoo et al. 2010). Meanwhile, firms can deploy IOS to share explicit knowledge and information between firms by configuring the system in a variety of business functions that are needed for digital innovation. For example, the firms uses IOS with its suppliers that can help map the mutually interdependent tasks between partners into identifiable activity blocks (Kumar and Van Dissel 1996), thus facilitating to better understand the information that can help the firm to operate effectively. Moreover, using IOS can process a large number of data, multiple interpretations of information, and generate diverse knowledge (Malhotra et al. 2005; Rai et al. 2009). It also allows firms to better interpret events and uncertainties between organizations, thereby increasing the mutual understanding of trends and uncertainties they face (Im and Rai 2013). As such, by using IOS with suppliers, the firm can acquire different diversity of knowledge (Yoo et al. 2010), and thus helping recombine existing knowledge and resources with digital technologies to generate better digital innovation (Avital and Te'Eni 2009). Thus, we hypothesize that:

**Hypothesis 1:** A firm's IOS use with its suppliers has a positive impact on its digital innovation.

### ***Interpersonal Ties and Digital Innovation***

The process of digital innovation may lead to coordination contradiction in the interaction of different roles (Abrell et al. 2016). Apart from through digital technologies, firms can also share and transform knowledge with each other through boundary spanners in a timely and effective manner (Haas 2015). Specifically, as the main helm of the firm, the senior managers have the decision-making power of the strategic level of the firm (Park and Luo 2001), so they can share the information and knowledge about the development strategy of the firm, the choice of the target market and so on (Westphal et al. 2006). The top managers will develop and maintain their relationships with their partners in order to obtain

external resources so as to innovate continuously (Gao et al. 2008). Meanwhile, effective communication between purchasing and sales staff, as they deal with operational business, can help them share information about the market and customers (Huang et al. 2013). The exchange and relationships between firms are embedded in the interpersonal ties of the boundary spanners (Huang et al. 2013). As such, interpersonal ties of boundary spanners can be used as an informal channel for communication through which people can reduce their psychological distance when they perform the role of boundary spanners (Adobor 2006). Informal contacts between boundary spanners will increase trust between them (Ferrerias-Méndez et al. 2015), which facilitates the exchange of knowledge and increase of knowledge acquisition. In particular, developing countries such as China often lack transparent access to information, firms thus need to rely on interpersonal ties to obtain knowledge and information (Wright et al. 2005). Strong ties can be conducted through a solid and informal channel for smooth communication and effective knowledge transfer, and thus help boundary spanners better perform the role of information exchange (Uzzi 1997). Effective knowledge transformation and combination is a key factor that affects a firm's digital innovation (Svahn et al. 2017; Yoo et al. 2010). Thus, we propose that:

**Hypothesis 2:** A firm's interpersonal ties with its suppliers have a positive impact on its digital innovation.

### ***The Moderating Effect of Institutional Distance***

Although boundary objects like IOS are steady adequate to keep a common identity between different organizations, they are thought to enable knowledge sharing across functional, organizational or community boundaries (Dong et al. 2017). However, with standardized boundary objects, cross-boundary knowledge sharing may be inefficient if the social environment where the two sides are located is too different. In other words, the different social environments of supply chain partners will make it difficult for actors in their respective "thought" worlds to communicate effectively with each other (Carlile 2002; Dong et al. 2017). Moreover, because different institutional environments have their own cognitive models, social norms and expectations, firms that cooperate with each other using standardized IOS will encounter problems in sharing knowledge across their respective institutional environments and thus might be not conducive to the firm's digital innovation. Moreover, institutional distance means different institutional logic among channel partners who share knowledge with each other (Dong et al. 2017; Yang et al. 2012). The existence of such institutional distances could lead partners in an complicated institutional environment that is not consistent with their local institutions, which need additional efforts to understand and interpret the information shared through the IOS (Dong et al. 2017). Therefore, under a large institutional distance between a firm and its suppliers, the effectiveness of information and knowledge shared through IOS on digital innovation might be reduced. Therefore, we propose that:

**Hypothesis 3:** The institutional distance between a firm and its suppliers negatively moderates the effect of IOS use on its digital innovation.

Digital innovation is the recombination of existing physical products and digitalization in a new way, which requires firms to have new knowledge and ideas (Yoo et al. 2010). The greater the institutional distance between firms and suppliers, the greater the cultural practices and laws and regulations in which firm and suppliers are located (Dong et al. 2017), which can lead to different ways of thinking between firms and suppliers. Based on boundary spanning theory, firms' boundary spanners can help gain knowledge from geographically distant partners by spanning knowledge boundaries (Granovetter 1977). Close interpersonal ties between firm and its suppliers help firms get more familiar with each other and easily accessible to novel and heterogeneous knowledge from suppliers (Grawe et al. 2015). Since the close ties can help build mutual trust between the firms and suppliers (Cuervo-Cazurra and Anrique Un 2010; Uzzi 1996), the firms can better understand the novel and hard-to-understand knowledge from the institutionally distant partners (Ozer and Zhang 2015). In addition, digital innovation requires firms to go beyond the traditional process and product category (Nambisan et al. 2017). Different rules and norms in different environments will cultivate different cognitive frame (Vasudeva et al. 2013). In this situation, tight interpersonal ties provide firms the opportunity to acquire new cognitive frame and thus generate better digital innovation (Verganti 2009). Thus, we hypothesize:

**Hypothesis 4:** The institutional distance between a firm and its suppliers positively moderates the effect of interpersonal ties on its digital innovation.

## Research Methods

### Sampling and Data Collection

We did a questionnaire survey in China to test our research hypotheses. Since China has provided a strong impetus to the development of the global economy (Cai et al. 2010; Zhao et al. 2011), many foreign companies are also more and more involved in China's economic development process. China is thus a very suitable background for supply chain and IT-related research. We conducted the survey mainly in the Yangtze River Delta region, which is the most economically developed region in China. In order to obtain a representative sample, we worked with our collaborative marketing research company. This sample mainly includes private firms, state-owned firms, and foreign firms and also represented a wide range of industries, including the automotive industry, finance and insurance, commodity manufacturing, electronics manufacturing, mechanical manufacturing, and steel industry.

We obtained the names and addresses of these firms, as well as the names and contact details of their managers. We chose senior managers because they had a lot of knowledge about IOS use, interpersonal ties, and digital innovation. Further, as key executives in a firm, they have a lot of responsibility for how the firm uses IOS and interpersonal ties to drive digital innovation. Considering that using a single respondent questionnaire is not a reasonable model for firm-level research (Huo et al. 2014; Kim 2014) and in order to reduce common method bias, we thus sent out two questionnaires for different managers for each firm in the current study. Specifically, we sent the questionnaires regarding operation-related constructs, such as interpersonal ties and institutional distance to the operational department manager and sent the questionnaires regarding IT-related constructs, such as IOS use to the IT department manager of each firm. Meanwhile, during the questionnaire survey, we carefully explained to the respondents what digital innovation is, in order to ensure that respondents better understand our context and the specific measures.

In this study, all selected respondents were first invited to participate. The invitation letter explained how we get their contact information and showed our research purpose. Questionnaires were sent to potential respondents who accepted our invitation. To encourage them to answer, we called and emailed the respondents to answer our questionnaires. Eventually, we distributed 550 questionnaires and finally received 123 valid questionnaires, with a response rate of 22.4%, which was comparable with previous similar studies (Wong et al. 2011). In addition, when we called firms that didn't answer the questionnaire, we found that they didn't want to participate in our research because they didn't have the time or the unwillingness to provide confidential information. To test for possible non-response bias, we compared the Chi-squares from the first 25% of the respondents to that of the final 25% and found no significant difference between these two groups on control variables. This result suggested that non-response bias was not a serious issue in this study (Armstrong and Overton 1977). We present the demographic information of the sample in Table 1.

		N	Percentage (%)
Region	Anhui	73	59.3
	Jiangsu	9	7.3
	Zhejiang	9	7.3
	Shanghai	7	5.7
	Others	25	20.3
Industry	Automotive industry	30	24.4
	Machinery and equipment manufacturing	30	24.4
	Electronics manufacturing	9	7.3
	Commodity processing industry	7	5.7

	Steel industry	9	7.3
	Others	38	30.9
Ownership	State Owned	69	56.1
	Privately Owned	31	25.2
	Foreign Owned	23	18.7
Firm size	<100	31	25.2
	100-299	27	22.0
	300-499	16	13.0
	500-999	7	5.7
	1000-1999	3	2.4
	≥2000	39	31.7

## Measures

First of all, we developed an English questionnaire by adopting/adapting the validated measures in the existing literature. Our questionnaire used a 7-point scale and selected a range of 1 (“strongly disagree”) to 7 (“strongly agree”) to measure the items. We first prepared the English questionnaire, then we translated the English questionnaire into Chinese by two independent translators, and then translated the Chinese questionnaire back into English to ensure the accuracy of the translation (MacKenzie et al. 2011).

*Digital innovation.* Based on the existing research, we developed a four-items to measure digital innovation (Leonhardt et al. 2018). The example items included how the firm employed IT to facilitate innovations to new product/service development processes, leveraged IT to improve our ability to make disruptive innovations to business processes (Jansen et al. 2006; Oshri et al. 2015).

*Interpersonal ties.* According to the existing research, interpersonal ties was defined as the close and systematic interpersonal relationship between boundary spanning personnel in social activities and private gatherings (Adobor 2006; Uzzi 1997). Following prior studies (Ambler et al. 1999; Huang et al. 2013), we measured the degree of participation of boundary spanners in social activities between the two sides. For example, we used items “leaders of both sides always invite each other to participate in various activities for socialization”.

*Institutional distance.* We evaluated the institutional distance within the country between the firm’s and its major supplier’s region. For the institutional distance within a country, we used the perceptual method to measure the difference between the firm and its major supplier in the supply chain environment according to the existing literature (Yang et al. 2012). In order to adapt the inter-national measures of institutional distance to the sub-national context in our study, we have adjusted some of the items based on the extant literature (Dong et al. 2017).

*IOS use.* We adapted the items from existing studies (Im and Rai 2013). For example, the items captured how IT is used to carry out operational activities, coordinating related activities and achieving consistency in compliance with process standards (Malhotra et al. 2005).

*Control variables.* Our sample also included some control variables that may affect a firm’s digital innovation, such as IT governance, ownership, firm size, region, and industry category. IT governance reflects the degree of which the firms carry out the well-balanced and necessary governance mechanisms and (Wu et al. 2015). We controlled the IT governance, which as an internal factor that could affect a firm’s digital innovation (Leonhardt et al. 2018). We used items, e.g., “our company has a steering committee at executive or senior management level responsible for determining IT development prioritization” to measure it (Wu et al. 2015). In controlling the industry category, we used dummy variables, industry 1 for the automotive industry, industry 2 for machinery and equipment manufacturing, industry 3 for electronics manufacturing, industry 4 for the commodity processing industry, industry 5 for the steel industry, and others as a baseline. Firm ownership can be also an important factor that may influence a firm’s digital innovation. Compared with domestic firms, foreign firms are at a disadvantage in utilizing relationships (Huang et al. 2013). Therefore, the type of firm ownership should be regarded as a



control variable. For ownership dummy variables, we used ownership 1 for state-owned firms, 2 for private firms, and foreign firms as a baseline. We also adopted dummy variables to control the area where the firm is located, region 1 for Anhui, region 2 for Jiangsu, region 3 for Zhejiang, region 4 for Shanghai, and others as a baseline. Firm size is an important indicator of structural flexibility and bargaining power of a firm, it thus might have an important influence on the organizational behaviors (Dröge et al. 2003). Therefore, we chose the number of employees as the size of the firm as the control variable.

### **Common Method Bias**

Common method bias may threaten the effectiveness of our research. In order to reduce this bias, we put similar questions in different places in the questionnaire design, avoiding the respondents from thinking in the same way for a long time. This arrangement can reduce this bias to a certain extent (Zhao et al. 2011). In addition, our questionnaire is a matched questionnaire, by the operations manager and IT manager to fill out, which can also reduce the effect of common method bias on the study. After the survey, we did Harman's single factor test to verify whether there is a general factor can explain the majority of the variance (Podsakoff et al. 2003; Podsakoff and Organ 1986). Our factor analysis showed that the first factor only explained 25.1% of the variance and less than 40% accounting for the majority of variance, which further suggested that common method bias was not likely to be a main problem of our research.

### **Reliability and Validity**

We also tested the construct reliability and validity of the measurement. As shown in Table 2, we assessed Cronbach's alpha and composite reliability, values ranging from 0.865 to 0.959 and from 0.918 to 0.964, higher than 0.70 (Lance et al. 2006), respectively, indicating a good reliability of the measurements. We further tested construct validity by convergent and discriminant validity. The convergent validity was tested based on the average variance extracted (AVE), which were greater than the recommended level 0.5 (Fornell and Larcker 1981). Further, all loadings were greater than 0.60, thus confirming the convergent validity of the measures (Flynn et al. 2010). We evaluated discriminant validity by comparing the shared variances with the square root of the AVE (Hair et al. 2011). In Table 3, the square root of the AVE of all constructs exceeds the correlations between constructs, supporting the discriminant validity of our measures. And Table 3 displays the descriptive statistics and correlation of all variables.

**Table 2. Confirmatory Factor Analysis Results**

Items	Loading	Composite Reliability	Cronbach's Alpha	AVE
Institutional distance	0.775~0.883	0.964	0.959	0.730
Interpersonal ties	0.897~0.918	0.947	0.922	0.816
Digital Innovation	0.855~0.927	0.947	0.925	0.818
IOS use	0.865~0.906	0.918	0.865	0.788
IT governance	0.876~0.896	0.937	0.910	0.789

Notes: AVE=Average Variance Extracted.

**Table 3. Descriptive Statistics and Correlations**

Variables	Mean	S.D.	1	2	3	4	5	6	7	8
1. IOS use	5.102	0.930	<b>0.885</b>							
2. Interpersonal ties	4.930	1.361	0.464**	<b>0.903</b>						
3. Institutional distance	5.037	1.152	0.436**	0.402**	<b>0.854</b>					
4. Digital innovation	4.892	1.215	0.691**	0.376**	0.370**	<b>0.904</b>				

5. IT governance	4.890	1.333	0.628**	0.525**	0.350**	0.587**	<b>0.888</b>			
6. Ownership	-	-	0.185*	0.124	0.037	0.148	0.056	-		
7. Location	-	-	0.213*	0.180*	0.212*	0.125	0.102	0.228*	-	
8. Industry	-	-	-0.153	-0.163	-0.224*	-0.172	-0.075	0.085	-0.213*	-
9. Firm Size	-	-	0.115	-0.145	0.051	0.239**	0.161	-0.082	-0.079	-0.133

Notes: \*p<0.05, \*\*p<0.01. Bold diagonal elements are the square root of the AVE.

**Hypothesis Testing**

Before testing our hypothesis, we conducted the Durbin-Wu-Hausman test to examine the possible endogeneity in the current study (Davidson and MacKinnon 1995). Specifically, by following prior studies (Cai et al. 2011), we used the mean of IOS use and interpersonal ties of the rest of firms in the same region as the instrumental variables for the firm’s IOS use and interpersonal ties. We first regressed IOS use and interpersonal ties on all control variables and the corresponding instrumental variables, respectively, and then used their residuals as additional regressors in the hypothesized equations. The residuals for the two regression models were not significant ( $\beta = 0.163, t= 1.723, p>0.05$ ;  $\beta = -0.157, t=-1.626, p>0.05$ ), suggesting that endogeneity was not the main problem in our study.

We then used a hierarchical moderated regression analysis to test our hypotheses. To minimize the possibility of multicollinearity, we mean-centered dependent variables, independent variables and moderator variables to regenerate interactive terms (Aiken et al. 1991). The results were shown in Table 4. We only put control variables in Model 1, added independent variables in Model 2, added moderate variable in Model 3, and put all variables in Model 4 including interaction terms. Hypothesis 1 predicts that the use of IOS has a positive impact on digital innovation. The results of Model 2 verified this hypothesis ( $\beta = 0.445, p<0.001$ ). Hence, H1 was supported. Hypothesis 2 hypothesized that the interpersonal ties between boundary spanners of the firm and its suppliers has a positive effect on the digital innovation of the firm. However, the result of Model 2 showed the relationship between interpersonal ties and digital innovation was not significant ( $\beta = -0.015, p > 0.10$ ), and thus H2 was not supported. Hypothesis 3 predicts that the institutional distance has a negative moderating effect on the relationship between IOS use and digital innovation, the results of Model 4 verified this view ( $\beta = -0.183, p<0.05$ ). Therefore, H3 received support. Hypothesis 4 assumes that the institutional distance has a positive moderating effect on the relationship between the interpersonal ties between boundary spanners and digital innovation. This hypothesis was verified by Model 4 ( $\beta = 0.211, p<0.01$ ). To further explain those moderating effects, we drew it in Figures 2 (a) and 2 (b). Figure 2 (a) indicated a negative moderating role of institutional distance on the relationship between IOS use and digital innovation. Specifically, digital innovation increases more significantly with IOS use increases when the institutional distance was low. As our expectation, Figure 2 (b) indicated digital innovation increases with interpersonal ties increases when institutional distance is high while decreases with interpersonal ties increase when institutional distance is low, which confirms the positive moderating effect of institutional distance on the relationship between interpersonal ties and digital innovation.

	Digital innovation			
	Model 1	Model 2	Model 3	Model 4
<i>Controls</i>				
Industry dummy 1	0.078	0.068	0.063	0.026
Industry dummy 2	0.049	0.003	0.000	-0.069
Industry dummy 3	0.081	0.027	0.019	-0.020
Industry dummy 4	0.071	0.041	0.036	0.019
Industry dummy 5	0.111	0.016	0.014	-0.001

Ownership dummy 1	-0.221	-0.159	-0.157	-0.129
Ownership dummy 2	0.079	0.056	0.068	0.051
Firm size	0.150	0.127	0.122	0.109
Region 1	-0.074	-0.012	-0.007	-0.017
Region 2	0.104	0.105	0.103	0.099
Region 3	-0.005	0.014	0.015	0.012
Region 4	-0.139	-0.075	-0.076	-0.083
IT governance	0.531***	0.271**	0.271**	0.288**
<i>Main effects</i>				
IOS use (H1)		0.445***	0.431***	0.326**
Interpersonal ties (H2)		-0.015	-0.027	0.005
<i>Moderator</i>				
Institutional distance (InsD)			0.054	0.133
<i>Interactions</i>				
IOS use*InsD (H3)				-0.183*
Interpersonal ties*InsD (H4)				0.211**
R <sup>2</sup>	0.517	0.612	0.614	0.645
F	7.481	9.548	9.003	9.092
Note: *p < 0.05, **p < 0.01, ***p < 0.001; coefficients are standardized.				

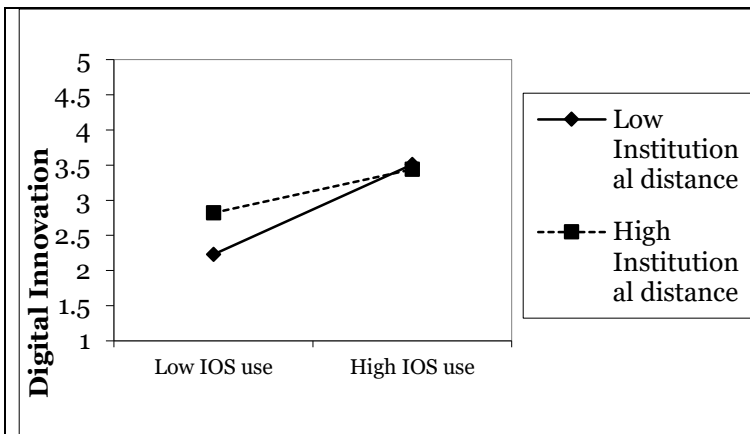


Figure 2 (a). Moderating Effect of Institutional Distance between IOS Use and Digital Innovation

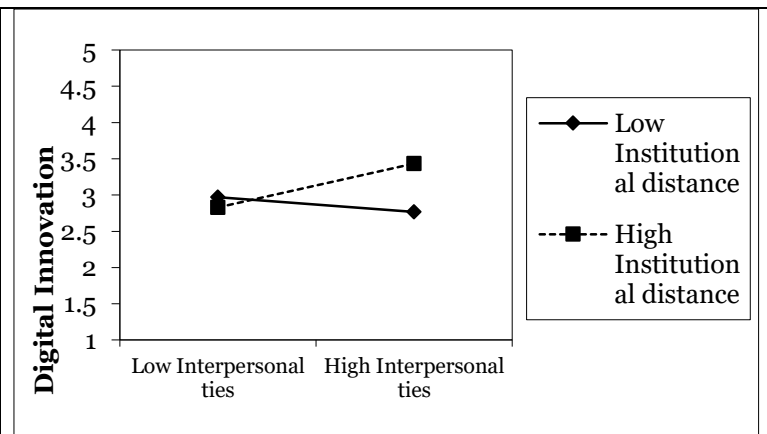


Figure 2 (b). Moderating Effect of Institutional Distance between Interpersonal Ties and Digital Innovation

## Discussion and Implications

### Discussion of Results

The aim of this study is to offer a deeper comprehending of how to improve a firm’s digital innovation by leveraging the use of IOS and interpersonal ties, as well as how such effects are moderated by the institutional distance between the firm and its suppliers. Through the study of a matched-pair questionnaire data, our results basically support our hypotheses. Specifically, from the perspective of boundary spanning theory, we find that the use of IOS can significantly improve the firm’s digital

innovation (Dong et al. 2017). However, we do not find a significant impact of interpersonal ties on digital innovation. For the unsupported Hypothesis 2, a possible explanation may be discussed from the dark side of close ties. Specifically, when the ties between boundary spanners are very close, the frequent communication between boundary spanners may lead to group thinking among them (Villena et al. 2011). This leads to homogenization of ways of thinking between firms and suppliers, resulting in less exploration of innovative problem solutions (Bendoly and Swink 2007). Tight social ties limit managers' cognitive ability to process information and reduce their motivation to access it (Villena et al. 2011). Close ties also limit companies' openness to external information and knowledge and reduce the efficiency of acquisition (Zhou et al. 2014). Therefore, although the close interpersonal ties between boundary spanners can help firms to obtain knowledge and information to promote digital innovation, this close relationship will also bring adverse effects to the innovation activities and operations of firms. We call for future research to further explore the relationships between interpersonal ties and digital innovation.

In addition, combined with institutional theory, we also study the moderating effects of institutional distance between the firm and its suppliers on the relationship between IOS use and interpersonal ties and digital innovation. For the sharing of knowledge and information through IOS, the institutional distance will hinder the transmission of information and knowledge between firms through the IOS. However, with regard to the sharing of knowledge and information through boundary spanners (Huang et al. 2013), the close interpersonal ties between boundary spanners can help firms absorb this new knowledge and ideas from institutionally different suppliers better, thus increasing the digital innovation of the firm.

### ***Theoretical Contributions***

The current study makes several contributions to the existing literature. Firstly, by integrating the boundary spanning theory, the study examines the impact of IOS use and interpersonal ties on digital innovation. Previous studies on the flow of knowledge and information spanning the boundary have been carried out either from the point of view of boundary spanning objects (Al-Busaidi and Olfman 2017; Dong et al. 2017) or from the perspective of boundary spanner (Abrams et al. 2003; Huang et al. 2013). We simultaneously study the role of boundary spanning objects and boundary spanners and our results indicate that IOS use and interpersonal ties have different impacts on digital innovation, which highlights the distinctive role of boundary objects and spanners in shaping the firm's digital innovation.

Secondly, although firms can cross the institutional boundaries through boundary spanning objects and boundary spanners (Dong et al. 2017; Huang et al. 2013), the information shared through IOS and close interpersonal ties between boundary spanners is different. Specifically, knowledge and information through IOS sharing must be specific in order to be captured, encoded, and transformed (Pardo et al. 2006). However, for information sharing through close interpersonal ties between boundary spanners, in addition to sharing specific information, spanners can also share information that is not easily encoded and tacitness. We integrate the institutional theory and discuss the moderating effect of institutional distance on the use of IOS and close interpersonal ties on digital innovation. Our results find that institutional distance negatively moderates the relationship between IOS use but positively moderates the relationship between interpersonal ties and digital innovation, thus providing a better understanding of the institutional conditions under which the effects of boundary objects and spanners vary.

Thirdly, previous studies on institutional distance mainly have emphasized the impact of institutional distance between countries on firm performance and innovation (Chao and Kumar 2010; Mueller et al. 2013; Sartor and Beamish 2014; Wu 2013). We discuss the moderating effect of institutional distance within the country on different ways of knowledge and information sharing through IOS use and interpersonal ties, which will have different effects on digital innovation. Thus, our study contributes to the digital innovation literature by confirming the importance of sub-institutional distance.

### ***Managerial Implications***

Our research also gives managers some implications on how to collaborate with institutionally distant suppliers for better digital innovation. On the one hand, although the IOS can help sharing and transfer information and knowledge to help firms generate better digital innovation, the institutional distance between the firm and its suppliers in different regions will not conducive to the cooperation between the

firm and its suppliers. Therefore, managers should not only focus on developing a standardized IOS for communicate with suppliers but also investing in improving the adaptability of their IOS, because an adaptive IOS can mitigate the negative impact of institutional distance on information and knowledge sharing through IOS (Dong et al. 2017). On the other hand, our study validates the importance of interpersonal ties and further confirm that close interpersonal ties between boundary spanners will make the firms better use of the new knowledge and ideas brought about by the institutional distance and help the firms to carry out digital innovation better. Accordingly, managers need to encourage the formation of interpersonal ties and invest in interpersonal ties between boundary spanners in order to acquire effective channel of communication with exchange partners to crossing the institutional boundary.

### **Limitations and Future Research**

This study may have several limitations that point the way for future research. First, we only studied in China as a developing country, the regional scope, the population, the difference of each local customs and culture are relatively large, and thus the difference of institutional distance is even more pronounced. Meanwhile, our number of samples is limited and cannot represent all Chinese firms to a certain extent. Thus, future research can study the impact of IOS use and interpersonal ties and institutional distance in different developing countries on innovation and use more samples. Second, in addition to suppliers, the customers of the firm might also play an important role in the firm's digital innovation. Future research can include both suppliers and customers and further examine how they differentially influence a firm's digital innovation. Thirdly, since institutions are divided into three categories, normative distance, cognitive distance, and regulative distance, we did not test the specific moderating role of certain type of institutional distance. Future studies can study the effects of these three institutional distances on information and knowledge sharing separately. Fourth, there are some other factors, such as organizational culture and structure of the firms and the scale of the suppliers that might also influence the firm's digital innovation. We thus call for future research to include such factors in the model. Fifth, our research might also have an omitted issue and some firm-specific heterogeneities are not controlled. Therefore, we call for future research to conduct a longitudinal design to test the causality between IOS use, interpersonal ties, and digital innovation.

### **Conclusions**

Based on the theory of boundary spanning, we conclude that the use of IOS and interpersonal ties can help firms to achieve better digital innovation. Our results indicate that IOS use can significantly improve digital innovation, while interpersonal ties do not significantly improve digital innovation, providing a complete understanding of the impact of boundary objects and spanners on digital innovation. Further, based on the institutional theory, we argue that the institutional distance between the firm and its suppliers will affect the use of IOS and the interpersonal ties on digital innovation. Specifically, our results find that IOS use and interpersonal ties have different impacts on digital innovation under different institutional distance between the firm and its suppliers. Specifically, institutional distance weakens the effect of IOS use on digital innovation yet strengthens the effect of interpersonal ties on digital innovation. Our research not only enriches the research on how IOS use and interpersonal ties influence digital innovation but also calls for more research on exploration of the boundary conditions under which IOS use and interpersonal ties influence the firm's digital innovation.

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