When *Guanxi* Meets Structural Holes: Exploring the *Guanxi* Networks of Chinese Entrepreneurs on Digital Platforms

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ABSTRACT

In this exploratory study, we investigate how Chinese entrepreneurs on digital platforms interact and leverage guanxi (a system of relationships and social network) to buffer the negative impacts of structural holes on knowledge orchestration. We develop our research model and formulate ten hypotheses by drawing on the literature. We adopt a mixed-methods research approach in which we use quantitative surveys to test the hypotheses, and qualitative interviews to explain why certain relationships are stronger in one stage of entrepreneurial development than the other. The study contributes to the literature on digital entrepreneurship in two ways. First, this study offers an initial understanding of the dynamics of guanxi networks for knowledge mobilisation and knowledge coordination across start-up and growth stages of Chinese entrepreneurs on digital platforms. Second, by drawing on the relevant literature, our findings extend the current understanding of knowledge orchestration of digital entrepreneurs and contribute to the literatures of structural holes theory and guanxi.

Keywords: Chinese digital entrepreneurs on digital platforms; guanxi; structural holes; knowledge orchestration

1. INTRODUCTION

As leading Chinese digital entrepreneurs have made an increasing impact on the global landscape, significant attention has been paid to how they strategically overcome the barriers of China's volatile institutional environment and resource deficiencies in the entrepreneurial creation and growth process (Anderson & Lee, 2008; Leavy, 2016). A number of scholars, such as Guo and Miller (2010, p. 270) and Xin and Pearce (1996), have recognised the role of *guanxiwang* (*guanxi* network) that "refers to an aggregation of *guanxi* ties possessed by an individual" in overcoming such obstacles.

Such a social network perspective provides a useful lens for understanding entrepreneurship in the setting of digital platforms. As companies increasingly embed digital components into physical products, a digital product platform that encompasses loosely coupled layers has proliferated as an engine of innovation for other independent entrepreneurs to invent novel components, such as new applications, complementary software and peripheral hardware accessories, using company-controlled platform resources (Aanestad & Jensen, 2011; Ceccagnoli et al., 2012; Yoo et al., 2010).

Google's Android, Apple's iOS, and Microsoft's Windows are typical examples of digital platforms on which entrepreneurs can develop and integrate new devices, networks, services and content (Henfridsson & Lindgren, 2010). For example, Tencent offers its WeChat application for iPhone and is, therefore, a component provider at the service layer of the iPhone platform. Most attention has focused on the owners of successful digital platforms such as Apple and Google (Eaton et al., 2015; Song et al., 2017; Spagnoletti et al., 2015), while limited consideration has been given to those third-party developers or "external innovators" (Gawer & Cusumano, 2014), who launch and scale up their own complementary products, technologies, or services upon these platforms.

In this setting, where the advancement of technology is rapid and competition is fierce, entrepreneurial developers need to continually adapt their choices to "current and new

platforms under dynamic shifts of technical and business architectures" (Srinivasan & Venkatraman, 2018, p. 55), in order to differentiate their offerings from those of competitors. Thus, developers face a challenge of constant access to and effective orchestration of diverse knowledge resources to rapidly navigate technological innovations, while simultaneously supporting multiple platforms (Ghazawneh & Henfridsson, 2013; Tiwana, 2015).

Using a network perspective, a certain amount of orchestration, influence and direction is needed for entrepreneurs to appropriately mobilise and coordinate knowledge without sacrificing flexibility and independence in the processes of launching and scaling applications within and across digital platforms over time. Drawing on a network orchestration model (Dhanaraj & Parkhe, 2006), we adopt the view of "a hub in networks" (Heikkinen & Tähtinen, 2006, p. 273), suggesting that an individual who holds a nodal position in their network tends to use prominence and power to perform a 'prime mover' role in knowledge orchestration.

As structural holes theory attests, a hub actor who connects two or more otherwise disconnected individuals in a network, each with access to complementary information, has more advantages than an actor who does not occupy such a central position (Burt, 1992). Most studies highlighting the benefits that accrue to the 'brokers' occupying such structural holes have restricted their scope to Western contexts (e.g. Burt, 1997, 2000, 2002), but Xiao and Tsui (2007) highlighted that the collectivistic values of China can undermine the manner in which Chinese brokers gain such control and information benefits.

Being embedded in *Confucian* culture (Gelek & David, 2013), the Chinese perceive these brokers as unethical, selfish and opportunistic, as they manipulate "accurate, ambiguous, or distorted information" strategically between the two sides to have a "disproportionate say in whose interests are served" (Burt, 2000, p. 354). Thus, structural holes may expose the intermediary actors to conflicting allegiances (Podolny & Baron, 1997), increasing their risk of diminishing collective interest and tarnishing their personal reputation. Besides attenuated control benefits, Chinese brokers cannot fully realise their personal information benefit either, as the communal-sharing values oblige them to attribute a more significant 'share of the pie' to the group contribution and a smaller proportion to that of the broker (Xiao & Tsui, 2007).

Having said that, it is not clear whether such disadvantages can be mitigated given that '*guanxi*', a system of influential relationships and social network dynamics in Chinese culture, is certain to have a unique influence on structural holes. In China, every person is expected to observe *guanxi*, regardless of their age or profession, because it acts as the social standard when developing and maintaining a relationship among the Chinese (Wang, 2007). Scholars have studied the constraining effect of Chinese culture on structural holes (Batjargal, 2007, 2010; Xiao & Tsui, 2007), but, thus far, how *guanxi* moderates the negative impacts of structural holes on the orchestration of knowledge among Chinese entrepreneurs on digital platforms remains largely unexplored.

Because *guanxi* is a means by which people can accomplish their personal, family or business goals (Bell, 2000), an entrepreneur's *guanxi* network involves family-or-friend *guanxi* ties, where members are family or close friends, with a high degree of intimacy, obligation and expectation (Fan, 2002). In addition, business *guanxi* ties are also included in their *guanxi* network, which refer to social connection between digital entrepreneurs and their non-kin business associates, such as clients, users, platform designers, and other third-party developers, and which can often be unstable due to sparse interconnections (Yang, 2016).

The distinctive roles of these two kinds of *guanxi* have been ignored in terms of their effect on the relationship between structural holes and knowledge orchestration. These previous studies indicate that while the collectivist values of China can cause brokers to lose their control and information benefits, *guanxi* is likely to mitigate such disadvantages. However, neither *guanxi* nor entrepreneurship in digital platforms are "static, unchanging entities" (Guo & Miller, 2010, p. 268). The paucity of associated research leads to a lack of understanding of how *guanxi* ties together with network structures shape the orchestration of knowledge across entrepreneurial start-up and growth stages in Chinese culture. As such, we address the research question: how do Chinese digital entrepreneurs interact and leverage *guanxi* to orchestrate knowledge for launching and scaling their products and services on digital platforms through the stages of the entrepreneurial process?

This exploratory study employs a dynamic perspective to investigate how structural holes and

guanxi influence knowledge mobilisation and knowledge coordination in the *guanxi* networks of Chinese entrepreneurs on digital platforms during entrepreneurial start-up and growth stages. The rest of this paper is organised as follows: in the next section, we integrate diverse bodies of literature to build our research model and develop our hypotheses. Then, by adopting a mixed-methods research approach, we use questionnaire surveys to test the hypotheses, and qualitative analysis of our interviews to explain why certain relationships are stronger in one stage of entrepreneurial development than the other. Last, we report our results and articulate our contributions along with their associated theoretical and practical implications.

2. CHINESE ENTREPRENEURS ON DIGITAL PLATFORMS: KNOWLEDGE ORCHESTRATION AND *GUANXI* NETWORKS

Recent years have seen a world increasingly permeated by digital technology. This has led to the emergence of a layered modular architecture in which a new type of product architecture has evolved into a digital product platform encompassing a range of specific layers (devices, networks, services, and contents), and an ensemble of components that belong to multiple design hierarchies, enabling greater generativity, which produces "differences in kind" (Yoo et al., 2010, p. 729). For example, an iPad can act as a digital product platform on which a broad wave of entrepreneurial developers can innovate by designing and scaling up novel applications (Anderson et al., 2013; Tiwana et al., 2010).

In our study, we focus on Chinese digital entrepreneurs who occupy the role of third-party developers to launch and scale up their applications on digital platforms (i.e. Android, iOS, and Windows). Some examples of digital enterprises we focused on are *Xiaohongshu*, which is both an e-commerce and user-generated content (UGC)-based overseas shopping and sharing community, *Xiecheng*, which is an online travel services provider, *Meitu,* which is an online photo-editing application, *Eleme*, which is an online food order and delivery service, and *Didichuxing*, which is a ride-sharing platform providing transportation services for more than 450 million users in China.

As digital platform architectures are continuously evolving (Henfridsson & Bygstad, 2013), entrepreneurs need to keep developing and adapting their applications to these successive evolutions. To illustrate, Tencent has updated its WeChat application for the new version of iOS (11) on iPhone. Hence, developers face a challenge of constant access to knowledge resources to navigate the dynamism of platform settings, while ensuring that their applications remain differentiated from those of competitors (Ghazawneh & Henfridsson, 2013; Huang et al., 2018). To handle this challenge in China, where business rules are typically interpreted differently by different people (Fu et al., 2006), a *guanxi* network that is composed of family members, close friends, and key business associates is seen as particularly important. When entrepreneurs face a set of choices such as on which digital platforms to launch their new components, what components to launch and when to launch them, their *guanxi* networks can provide them with access to an abundance of knowledge resources, for which knowledge orchestration is critical if the right decisions are to be made (Srinivasan & Venkatraman, 2018). Drawing on the network orchestration model of Dhanaraj and Parkhe (2006), we identify knowledge mobilisation and knowledge coordination as the essential ingredients that constitute it.

Knowledge mobilisation concerns the ease with which knowledge is transferred, accepted and deployed within a network (Dhanaraj & Parkhe, 2006). Specifically, knowledge transfer is predominantly referred to in the network literature as an 'asset' that carries value for a network (Nahapiet & Ghoshal, 1998). Particular emphasis is placed on standardizing or establishing compatible methods of communication to facilitate the sharing of this form of intellectual capital across 'syntactic' boundaries (Carlile, 2002; Loebbecke et al., 2016). When the transferred knowledge is complex and there is not commonality or clarity of purpose, the challenge shifts to the receipt and application of the knowledge, where a 'semantic' approach (Carlile, 2002) is needed to recognize the different ways in which each actor interprets, accepts and uses the disseminated message in platform-based settings (Kaschig et al., 2016).

Knowledge coordination concerns the management of dependencies of member expertise in a network, involving "knowing where knowledge is located, where it is needed, and how to deliver it" (Schutz et al., 2009, p. 7). Thus, a 'pragmatic' approach (Carlile, 2002) is needed for

the network actors to fully explore their unique local context without losing their ability to interrelate and transform different types of 'hard-won', practice-based knowledge into a novel innovation that transcends its customary pragmatic boundaries (Yoo et al., 2012; Nandhakumar et al., 2013).

Moving to *guanxi* networks, we first focus on structural holes, which are defined as the gaps, or absence of connection, between two contacts who are both, nevertheless, linked to a common actor (Burt, 1992). Second, we place an emphasis on *guanxi*, defined as "the exchange of favours; the cultivation of personal relationships; and the manufacturing of obligation" (Yang, 2016, p. 6). According to Anderson and Lee (2008), the Chinese phrase "*guanxi*" is composed of two characters: the first character "*guan*" which represents a gate, and the second "*xi*", referring to a connection. Thus, literally, *guanxi* means "pass the gate and get connected". As a highly particularistic tie between two persons bonded by an implicit psychological contract (Yang, 1993), *guanxi* involves a mechanism that governs different types of relationships with different degrees of social norms and role obligations.

In this study, we divide *guanxi* into family-or-friend *guanxi* and business *guanxi*. As Tsui and Farh (1997) stated, the family is the fundamental social unit, and kinship is the most significant social relationship to an individual, involving unconditional loyalty and non-reciprocal obligations. According to the set of roles defined by *wulun* in ancient China (Yang, 2002), we can define entrepreneurs' family-or-friend *guanxi* in the form of five cardinal relationships: husband-wife, father-son, elder-younger brothers, emperor-subject, and friend-friend.

But *guanxi* is not merely an affection-based kinship relationship, but also involves a connection through which both parties exchange favours or valued materials. In platform settings, we view business *guanxi* as social connection between Chinese developers and their non-kin business associates, including partners, investors, clients, users, platform providers, and independent third-party developers, that is implicitly based on mutual benefits and interests (Yang, 2016).

Different types of *guanxi* can affect the extent to which the negative impacts of structural holes are mitigated, especially business *guanxi* that pursues resource mobilisation by exchanging favours, accumulating *renqing* (i.e. reciprocal favours in Chinese culture) and preserving

mianzi (face) (i.e. not showing disrespect in Chinese culture) (Chen et al., 2004; Hwang, 1987; Wang, 2007). The development of business *guanxi* is a dynamic process, in which a gradual transition occurs from being treated as an outsider to becoming part of the in-group. During this process, hub actors tend to fill their structural holes and pull previously disconnected individuals together into a buffer zone, a sphere of morality and human feeling (Gu et al., 2008), within a highly competitive and chaotic business environment, such that valuable personal connections help to smooth business transactions (Guthrie, 1998).

Given an evolutionary shift in a platform architecture, we use a dynamic view to explore how developers orchestrate their *guanxi* networks and knowledge resources for their initial launch success, and how these combinations evolve over time for the continued success during scale-up (Yeow et al., 2018).

Following Srinivasan and Venkatraman (2018), we perceive Chinese entrepreneurs on digital platforms into two types: the first being the entrepreneurs at the start-up stage whose companies are less than three years old (according to Xiao (2011) who translated entrepreneurial stages into age-based development stages, and defined the start-up stage as the early period of two to three years), and who focus on making launch decisions about initial choice of digital platform to support and align with platform architectures; the second being the entrepreneurs at the growth stage with companies aged three years old or more, and who shift their focus toward expanding their offers beyond a single digital platform during scale-up.

At entrepreneurial start-up stages, survival is very challenging for new developers who seek to link their applications to dominant platforms. The liability of newness (Stinchcombe, 1965) leaves start-ups with insufficient resources to achieve launch success and compete with mature players (Street et al., 2018). As entrepreneurs attempt to achieve rapid scaling, constant launches of new platforms and the entry of new competitors pose fresh challenges for them in keeping pace with the ongoing technological innovation initiated by platform designers, while simultaneously ensuring that their offerings are not crowded out by those of competitors (Ghazawneh & Henfridsson, 2013; Srinivasan & Venkatraman, 2018).

Figure 1 presents our research model, which initially explores the impact of family-or-friend

guanxi, business *guanxi* and structural holes on knowledge mobilisation and knowledge coordination in the *guanxi* networks of Chinese entrepreneurs on digital platforms at start-up and growth stages. In addition, our model further explores the moderating effect of *guanxi* on the impact of structural holes on knowledge mobilisation and knowledge coordination.

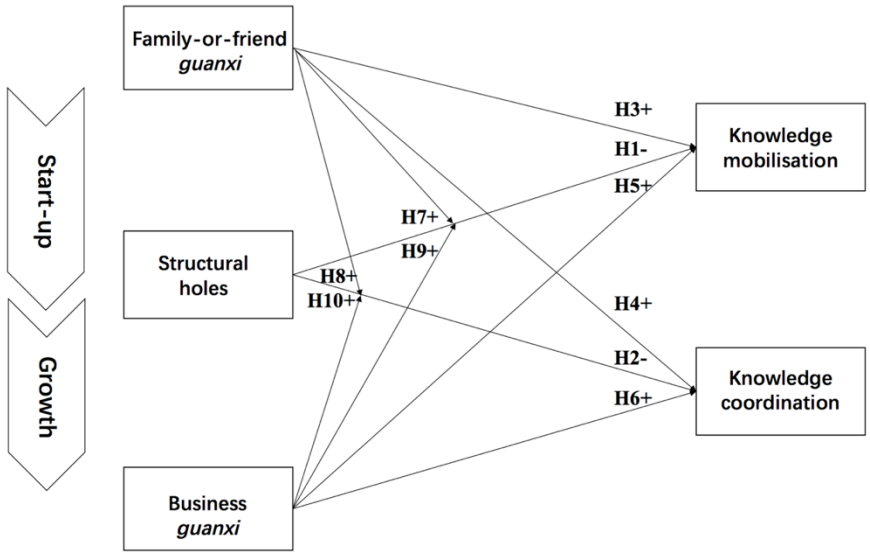

Figure 1. Research Model.

2.1 Structural Holes in Digital Platform Settings

Although structural holes theory has its roots in Western contexts (Burt, 1992, 1997, 2000, 2002), scholars have tested its validity in Chinese culture where institutional mechanisms and cultural norms are substantially different from those of Western culture (Xiao & Tsui, 2007; Batjargal, 2007, 2010). According to these scholars, although the bridging function of structural holes increases the broker's bargaining power, the severe sanction mechanism embedded in *Confucian* culture prevents such brokers from taking advantage of this power to achieve their fair share. It substantially decreases the material and intellectual gains from brokerage, thereby reducing their returns to brokers from structural holes (Xiao & Tsui, 2007). In reality, when brokers have to bear the high cost of maintaining structural holes while gaining a low return, they actually pay higher social costs. Hence, the Chinese generally do not benefit from spanning structural holes (Batjargal, 2007, 2010).

As new platforms with radically different technologies are frequently launched, structural holes

may induce three issues in the *guanxi* networks of Chinese entrepreneurs, which impede knowledge mobilisation, and exacerbate their difficulties in linking to dominant platforms and in balancing their links across multiple platforms (Srinivasan & Venkatraman, 2018).

First, structural holes in networks may slow down the communication process among distributed individuals who barely know each other (Batjargal, 2010). According to transactive memory theory (Wegner, 1986), the knowledge of "who knows what" is essential for the development of collective intellectual capital. However, dispersed communication may maximize the silo effect and minimize the collective learning, thereby making it difficult for third-party developers to mobilise knowledge resources to link their applications to dominant platforms with higher installed bases (Gulati, 1999).

Second, structural holes may trigger the creation of boundaries in the flow of information, leading to bottlenecks in knowledge diffusion (Batjargal, 2010). This decreases developers' efficiency, because the information quality deteriorates as it transfers from one actor to the next in a chain of intermediaries (Baker, 1984). Knowledge mobilisation is not just a matter of copy-and-paste from the sources to the recipients; but rather it is a newly generative process, where mutual trust is highly vital in removing barriers to the transfer of tacit knowledge. Thus, unsmoothed information mobilization may hinder trust-building, and exacerbate the sluggishness of knowledge flow around structural holes (Szulanski, 1995), preventing entrepreneurs from aligning their knowledge and routines across different platforms.

Third, a further mismatch of strategies may be created as a reflection of dispersed, vague and distorted information (Batjargal, 2007). As Obstfeld (2005) highlighted, an experienced entrepreneur is likely to maximize their own benefit from nascent entrepreneurs who are too vulnerable in themselves to protect their core techniques. Hence, unfocused strategies created by structural holes may aggravate the exposure of those vulnerable developers to unethical brokerage and potential malfeasance (Bizzi, 2013). All of these issues prevent Chinese entrepreneurs on digital platforms from sharing, acquiring and deploying knowledge to launch better quality products faster. Hence, we hypothesize that:

Hypothesis 1 (H1): Structural holes will be negatively related to knowledge mobilisation in

the guanxi networks of Chinese entrepreneurs on digital platforms.

In entrepreneurs' *guanxi* networks, structural holes may amplify incompatibilities in personal values and behaviours (Bizzi, 2013). Brokers embracing a cost-benefit calculus tend to manipulate information to exploit personal power, while those who value social obligation are inclined to pass on information in the collective interest (Marks et al., 2001). As members uncover conflicting beliefs and behaviours, they may induce unpleasant affections and negative attitudes. This is because that when brokers control information for personal gain, the remaining isolated individuals have to pay for it, creating resentment toward the brokers (Bizzi, 2013).

In the meantime, Costa and Bijlsma-Frankema (2007) indicated that brokers deriving personal benefits from structural holes decrease the benefits available to other brokers, so that all brokers may perceive each other as competitors and adopt mutually hostile attitudes. In addition, the shared perception of potentially opportunistic behaviours further deepens mutual monitoring and dependence, preventing brokers from relinquishing control and heightening their risk of becoming overloaded (Bizzi, 2013). All of these factors may reduce developers' motivation to integrate mutual knowledge to support multiple platform technologies at the same time.

Furthermore, Sandström (2004) highlighted that a greater number of structural holes may trigger a higher degree of heterogeneity of knowledge. Increased dissimilarity in developers' social and technical worlds exacerbated by structural holes, prevents them from building shared understanding for coordinating their product launches in compatible platform architectures. Thus, an action problem is posed (Obstfeld, 2005), which further exacerbates the knowledge heterogeneity, and hinders the coordination of knowledge for the effective navigation of the dynamism of platform settings (Ceccagnoli et al., 2012). Hence, we hypothesize that:

Hypothesis 2 (H2): Structural holes will be negatively related to knowledge coordination in the guanxi networks of Chinese entrepreneurs on digital platforms.

2.2 Family-or-Friend *Guanxi* in Digital Platform Settings

According to Hwang (1987, p. 949), family-or-friend *guanxi* implies sacrificing and giving that

engenders “an individual’s feeling of affection, warmth, safety, and attachment”. Thus, it can confer a commitment advantage (Anderson, 2008) on Chinese entrepreneurial developers who seek to link to dominant platforms, providing them with emotional support, access to otherwise unavailable resources, and shelter from the worst effects of opportunism (Hite & Hesterly, 2001). Hence, we assume that developers would rely on a *guanxi* network consisting of affection-based ties with their kinship members and friends to transfer, acquire and deploy knowledge resources critical for their launch and scale-up success.

First, individuals who are connected by “blood, extended family or some common background or experiences in the past” usually have a certain level of similar information, knowledge and insights (Fu et al., 2006, p. 14). Thus, family-or-friend *guanxi* can create high-capacity information links and motivate the sharing of knowledge, so that the focal entrepreneur can vicariously benefit from the perspectives of the others to launch higher quality applications faster (Kraatz, 1998).

Second, as Sequeira and Rasheed (2006) suggested, the family plays a significant role in giving convenient and low-cost sources of information support. Therefore, kinship members and close friends are willing to share inspiration, creative ideas on application development, unique insights into user requirement and valuable information regarding “permits, laws, management practices, reliable suppliers, and promising business lines” (Aldrich & Waldinger, 1990, p. 127) with Chinese entrepreneurs on digital platforms.

Last, strong ties that involve a high degree of trust can greatly aid the process of knowledge application (Yli-Renko et al., 2001). Fu et al. (2006) highlighted this as especially true in the Chinese business context where legal regulations for intellectual property protection are still missing. Under such circumstances, entrepreneurs developing third-party applications would find it easier to depend on family-or-friend *guanxi* to control and protect their proprietary knowledge due to a high level of relational capital, thereby facilitating the deployment of knowledge for linking to dominant platforms with the largest installed bases. On the basis of this discussion of the relevant theory and literature, we hypothesize that:

Hypothesis 3 (H3): Family-or-friend guanxi will be positively related to knowledge

mobilisation in the guanxi networks of Chinese entrepreneurs on digital platforms.

Although family members and intimate friends do not necessarily possess appropriate expertise nor always guarantee all necessary support, such *ganqing* (affection)-based *guanxi* ties ensure that all the information, advice, feedback and insights that entrepreneurs receive are sincere (Fu et al., 2006), increasing their affective trust in coordinating and aligning different knowledge and routines into a platform's architecture.

Many scholars have studied the role of relational proximity in knowledge integration in the entrepreneurial context. For example, Dhanaraj and Parkhe (2006) revealed that relational cohesiveness is critical for the reinforcement of a common identity and a logic of confidence and good faith, which can be seen as prerequisites to knowledge combination.

As a result, the high levels of relational capital embedded in family-or-friend *guanxi* can facilitate the flow of cognitive resources throughout the network, encouraging developers to coordinate knowledge to support current and emerging digital platforms (Nambisan, 2013; Yoo, 2013). Therefore, we hypothesize that:

Hypothesis 4 (H4): Family-or-friend guanxi will be positively related to knowledge coordination in the guanxi networks of Chinese entrepreneurs on digital platforms.

2.3 Business *Guanxi* in Digital Platform Settings

Business *guanxi* is grounded in the traditional *Confucian* values of *renqing* and *mianzi* (Chen et al., 2004). Specifically, the word '*renqing*' combines '*ren*', referring to human being, and '*qing*', which means affection and sentiment, and is a lubricant for the emotional and economic exchange of favours in the pursuit of relational longevity (Wang, 2007). Once *renqing* is developed, a person can ask a favour from someone, with the obligation to return this favour in the future (Yang, 2016). Such reciprocity allows developers to exploit social capital that offers leverage in interpersonal exchanges among their network connections (Luo, 2005), fostering the mobilisation of social and cognitive resources within and across digital platforms.

With frequent launches of new platforms, independent third-party developers need to

continually advance their knowledge in relation to the emerging technological trajectory. In this context, an arrangement of taking turns to give favours is significant for them in obtaining access to "a larger range, a greater diversity, and higher 'upper reachability'" (Bian, 2002, p. 277; Guo & Miller, 2010) of information, knowledge and social resources, enabling them to link and adapt their applications to newer platform technologies (Ghazawneh & Henfridsson, 2013). On the other hand, refusing to return a previously received favour will severely damage personal creditability, resulting in not just an exclusion from ongoing *guanxi* maintenance, but also a humiliating loss of *mianzi* (Zhang & Zhang, 2006).

In China, *mianzi* as a social currency implies more than reputation. As Gelek and David (2013) pointed out, *mianzi* is just like the bark of a tree, without which the tree will die. Seen from the perspective of hierarchical ties, the underlying asymmetric social status of *mianzi* is a fundamental aspect of favour exchange. Thus, between two persons with dramatic differences in social power, saving the senior's *mianzi* represents a significant favour given, which may lead to a greater favour in return for the junior (Zhang & Zhang, 2006). As business *guanxi* involves an implicit rule of favour exchange among a network of non-kin business associates with different social status (Wang, 2007), it can promote the diffusion, acquisition and deployment of knowledge resources, thereby assisting the developers in navigating the dynamism of technological innovations. Based on the above, we can hypothesize that:

Hypothesis 5 (H5): Business guanxi will be positively related to knowledge mobilisation in the guanxi networks of Chinese entrepreneurs on digital platforms.

As a new platform launch potentially changes the current connections between third-party developers and digital platforms, those who are locked into (embedded in) a single platform need to spread their offerings across newer competing platforms and leverage greater knowledge diversity (Venkatraman & Lee, 2004). Such knowledge is mainly in the form of toolkits, including basic training skills, interfaces, layers and libraries of commonly used components that developers can incorporate into their applications (Srinivasan & Venkatraman, 2018). With *renqing*-based business ties promoting a high level of favour mobilisation,

heterogeneous cognitive and social resources can flow more freely through the *guanxi* network. Thus, entrepreneurs supporting particular platforms are more able to tinker flexibly to inspire critical reflection, question things taken for granted, promote perspective-taking, and enhance sense-making of the diversity of knowledge (Boland & Tenkasi, 1995; Yoo et al., 2010).

Such strong accommodation between one another's perspectives brings an 'optimal cognitive distance', at which the network members' knowledge bases demonstrate sufficient complementarity for them to learn from each other, while also maintaining fluent communication throughout reciprocal understanding (Cantner et al., 2010; Nooteboom et al., 2007). In this way, with extended business *guanxi* being connected to a breadth of experience in working with various platform technologies, developers are more capable of leveraging diverse domains of expertise to alleviate the liability of embeddedness and scale their business rapidly during periods of technological innovation (Schutz et al., 2009). Overall, within platform settings, business *guanxi* promotes the creation of a network of key business associates with better-matching cognitive modes, such that the developers can better integrate their knowledge and coordinate their product launches to navigate multiple technological regimes. Hence, we can hypothesize that:

Hypothesis 6 (H6): Business guanxi will be positively related to knowledge coordination in the guanxi networks of Chinese entrepreneurs on digital platforms.

2.4 The Moderating Effect of *Guanxi* on Structural Holes in Platform Settings

Through the influence of *guanxi*, Chinese digital entrepreneurs tend to fill structural holes and pull otherwise disconnected individuals together into an "in-group" to inhibit personal controlling behaviours and enhance collective intelligence benefits (Xiao & Tsui, 2007). In this way, they can effectively orchestrate knowledge resources to navigate technological innovation and simultaneously support multiple platforms (Tiwana, 2015).

Specifically, because the controlling behaviours are perceived as opportunistic and selfish (Frye, 2000), those entrepreneurs rarely choose to manipulate information and relations between their relatives or close friends at the expense of hurting them (Gu et al., 2008). This

view is supported by Yan (1996), who argued that acting toward one's family in a manner that is more suitable to dealing with strangers is seen as immoral, demonstrating a lack of *ganqing* (affection). In addition, Chinese entrepreneurs tend to steer away from the brokerage to avoid a humiliating loss of *mianzi* that would bring a high degree of shame. This is because unlike the West, which mainly operates on the basis of guilt, in *Confucian* culture the most primary deterrent to unethical behaviour is shame (Gelek & David, 2013).

In brokerage situations, rather than acting as controllers, those third-party developers who rely primarily on their family-or-friend *guanxi* tend to play the role of integrators (Guo & Miller, 2010; Xiao & Tsui, 2007). By pulling previously unconnected individuals together and turning indirect ties into direct ties, Chinese developers that act as integrators build a form of social capital in their cohesive *guanxi* networks, which makes them more attractive and receiving of preferential treatment from platform providers critical in linking to dominant platforms (Verona et al., 2006). This is because the collectivistic values of China oblige those who sit at the boundary between two in-groups to fill the structural hole and act as a 'real' bridge to facilitate information flow, so that the whole network can share the intelligence benefit that would otherwise have belonged primarily to the broker (Xiao & Tsui, 2007).

Hence, a 'buffer zone' appears, the concept of which was first proposed by Yang (2016), who indicated that the Chinese require a "private sphere" of kinship, friendship and *guanxi* networks around them to act as a form of buffer against dysfunctional legal systems as well as the increasing surveillance power of the communist state (Haveman et al., 2016). In digital platform settings, we focus on the affective side of *guanxi*, identifying the buffer zone as a space around entrepreneurial developers in which close-knit personal connections are built in order to mobilise and coordinate social-cognitive resources such as inspiration, creative ideas on App design, and prior experience in App development for launching and scaling applications aligned with dominant platforms (Song et al., 2017).

When a network is abundant in "filled" structural holes and coupled with affection-based kinship ties, it can not only provide developers with access to additive, otherwise unavailable information and knowledge, but also gives the benefit of timeliness (Guo & Miller, 2010).

Because China's entrepreneurial environment is characterized as highly volatile, any change in governmental policies, technology or the market can become a source of new innovation opportunities in digital platforms. In contrast to the extra time and money needed to navigate structural holes, a buffer zone made up of emotionally bridged structural holes enables third-party developers to share, accept and use knowledge in a faster and lower-cost way, fostering the launch and scale-up of products for dominant platforms. Hence, we hypothesize that:

Hypothesis 7 (H7): Family-or-friend guanxi will moderate the negative relationship between structural holes and knowledge mobilisation in the guanxi networks of Chinese entrepreneurs on digital platforms, such that structural holes will impede knowledge mobilisation less when family-or-friend guanxi is stronger.

Such a buffer zone, coupled with "filled" structural holes, can also assist entrepreneurs in their efforts to facilitate the coordination of product launches, which is a key feature of success in digital platform settings. When a variety of developers with heterogeneous knowledge create novel components based on a digital platform, the connection between them is most likely dialogical (Yoo et al., 2010). Each developer follows their own innovation trajectory, which is simultaneously interlaced with those of others (Yoo et al., 2008). As integrators at the focal nodes of the network build new links between previously disconnected individuals, it becomes easier for each member to integrate their diverse pieces of knowledge such as unique insights into more attractive products, which will not be crowded out by those of competitors (Broadbent et al., 1999). Hence, we hypothesize that:

Hypothesis 8 (H8): Family-or-friend guanxi will moderate the negative relationship between structural holes and knowledge coordination in the guanxi networks of Chinese entrepreneurs on digital platforms, such that structural holes will impede knowledge coordination less when family-or-friend guanxi is stronger.

The situation in which personal controlling behaviours are inhibited and collective intelligence benefit are enhanced also applies, when business *guanxi* plays a prominent role in digital

platform settings. Specifically, trust-building among Chinese businessmen is very challenging, because they do not make any assumptions about others' goodwill besides that of their family or intimate friends. Thus, most business dealings are highly dependent on personal and entrepreneurial trustworthiness. Within an interwoven business network, where prestige flows via word-of-mouth dissemination and where brokerage is seen as unethical, those who frequently leverage their business *guanxi* with a higher concern for *renqing* and *mianzi* are less inclined to profit from the brokerage, a behavior otherwise regarded as "standing on two boats" (a Chinese proverb) and socially distasteful (Batjargal, 2007).

Instead, independent third-party developers are more willing to cultivate a social exchange relationship with key platform designers to reap preferential advantages, so that they can launch and scale their products faster than competitors (Srinivasan & Venkatraman, 2018). By providing the favour of introducing unknown contacts to one another, integrators invest their *renqing*, which can extend through the network quickly, leading to a greater return because the Chinese tend to trust those who are introduced by their trustworthy sources (Batjargal, 2007). Likewise, those who receive a favour tend to pull more unknown, key business associates together in order to return this favour, as they follow the unwritten code of reciprocity.

We assume that a buffer zone again emerges, around which an abundance of cognitive and social resources flow in the form of favour exchange, *renqing* accumulation, and *mianzi* preservation, smoothly alleviating the negative issues that structural holes induce in platform settings. From the perspective of network structure (Burt, 1997), a network rich in 'filled' structural holes can reach a greater variety of persons with relevant expertise that developers cannot obtain from their own experiences or customary personal contacts. By filling structural holes, and creating connections with previously unknown members of other network clusters, rich flows of non-redundant and unique information can be facilitated, which allow entrepreneurs to adequately mobilise knowledge resources to adapt to changing platform technologies (Hitt et al., 2011; Spagnoletti et al., 2015).

In addition, Fu et al. (2006) indicated that "brokering" (bridging) unique information to appropriate parties can not only provide entrepreneurs with access to valuable resources, but

also promote the cultivation and accumulation of *renqing*. Thus, high levels of commitment, empathy and interdependence can be engendered to provide a control mechanism that prohibits opportunistic behaviour by brokers and limits the risk of being cheated (Guo & Miller, 2010), thereby securing the sharing, acquisition and deployment of knowledge for navigating technological change in platforms (Schilling & Phelps, 2007). Hence, we hypothesize that:

Hypothesis 9 (H9): Business guanxi will moderate the negative relationship between structural holes and knowledge mobilisation in the guanxi networks of Chinese entrepreneurs on digital platforms, such that structural holes will impede knowledge mobilisation less when business guanxi is stronger.

We further assume that knowledge coordination can be facilitated, when a third-party developer who occupies multiple structural holes performs as a transferable medium to establish *guanxi* on behalf of two entities (Ahuja, 2000), and smooth out potential issues that may arise from the entry of new competitors and the launch of new platforms. As connections between previously isolated individuals are created, existing ideas are linked across multiple boundaries, such that the widely distributed knowledge resources can be effectively combined and recombined for the developers to navigate across various platform technologies. Furthermore, when those otherwise disconnected business associates get access to buffer zones, by "taking in outside perspectives" (Schutz et al., 2009), they can cross pragmatic boundaries to reflexively negotiate their perspectives and transform their 'hard-won' knowledge into increased "waves of innovation" (Boland et al., 2007; Carlile, 2002; Kellogg et al., 2006), thereby rapidly scaling their products to support current and emerging platforms (Srinivasan & Venkatraman, 2018). Hence, we hypothesize that:

Hypothesis 10 (H10): Business guanxi will moderate the negative relationship between structural holes and knowledge coordination in the guanxi networks of Chinese entrepreneurs on digital platforms, such that structural holes will impede knowledge coordination less when business guanxi is stronger.

3. METHODS

In this study, we used a mixed-methods research approach, which is generally used to establish a more systematic account of a phenomenon (Zachariadis et al., 2013). Specifically, we used quantitative surveys to test the hypotheses and estimate their impacts, which were then discussed in conjunction with our qualitative results. In parallel, the qualitative analysis of our interviews allowed us not only to explain these hypothesized relationships but also to make better sense of the quantitative results by reviewing our interview data.

3.1 Quantitative Research

In the quantitative part of the research, we used a stratified random sampling approach to select 450 digital ventures listed in the yearbook published by the China Credit Information Service, Ltd. Our sampling frame included Chinese entrepreneurs who launch and scale up their applications on digital platforms. To collect the most reliable data available, we requested those key informants who were founders of digital ventures and had large *guanxi* networks to respond to the surveys; they frequently leveraged their personal connections to obtain valuable social and cognitive resources, and could be expected able to make informed comment on the survey variables. We distributed 450 questionnaires and deemed 325 of the responses usable for the quantitative analysis (the remaining 125 were deemed unusable for miscellaneous reasons, such as incompleteness), which represented a response rate of 72%. On the basis of Armstrong and Overton (1977), we used *t*-tests for evaluating non-responses bias in our quantitative surveys, and found no significant difference between early and late responses.

In addition, we classified these entrepreneurs on digital platforms into two types on the basis of Srinivasan and Venkatraman (2018), as we have described previously: the first being the entrepreneurs in the start-up stage whose company age was less than three years old; the second being the entrepreneurs in the growth stage with companies aged three years old or more. The demographic profile of the two types of respondent (depicted in Appendix A) allows us to make comparisons across several dimensions.

3.2 Quantitative Measures

Structural holes (SH). In order to measure structural holes (SH), we referred to Xiao and Tsui (2007)'s name-generator approach, which was originally developed by Burt (1992), and further adopted by Reagans and McEvily (2003). This approach involved two steps. First, we asked the respondent (ego) to give the names of the members (alters) within their *guanxi* network. In a second step, we asked the respondent to indicate the strength of all ego-alter ties and alter-alter ties in their network. Specifically, we asked eight questions, respectively, about property-based resource assistance (e.g., patents, financial & human capital) (1st), inspiration attainment on App design (2nd), idea test on user requirement (3rd), prior experience in application development (4th), business advice (5th), platform architecture technology (6th), technological change (7th), and technology-based resource sharing (8th). Thus, two sample questions were "Can you nominate several persons who you choose to contact when you need financial assistance with your application launch on digital platforms?" and "Can you nominate several persons who act as a significant source of technological change for your application scale-up?" For each question, we asked the respondent to list a maximum of three names. Then, we put together the names created by the eight name-generating questions to assemble the *guanxi* network of the respondent. Afterwards, we measured the strength of relationship on the basis of a 0-3 range, by reference to Xiao and Tsui (2007, p. 14): "3=Very close: strong personal bond; 2=Close: a person you get along with well; 1=Less close: the person is OK to get along with; 0=Distant: a person you don't know". Then we referred to the constraint, *c*, of Burt (1992) and Xiao and Tsui's (2007) to measure SH. The specific procedure is shown in Appendix C.

Family-or-friend *guanxi* (FG). In order to measure family-or-friend *guanxi* (FG), we referred to the measurement scale developed by Yen et al. (2011) for measuring *guanxi* based on three Chinese relational constructs – *ganqing* (affection), *renqing* (favour) and *xinren* (trust) (GRX). Specifically, we adopted two items to measure FG, which were congruent with those for

measuring the construct of *ganqing*. These two items measured to what extent respondents were confident that their family or friends would make every effort to help them out if their business was in trouble, and measured how much respondents believed that their kinship members or friends took account of their feelings before making any decisions. In addition, we adopted one item to measure FG that was used as an appropriate scale for the *xinren* construct. This item measured the general trust that respondents had toward their family or friends, and it was presented as "My family or friends have been frank in dealing with me". However, in terms of the GRX measurement scale of Yen et al. (2011), we did not adopt the items designed for measuring the construct of *renqing* to measure family-or-friend *guanxi*, because we believed that these items would be more appropriate for measuring business *guanxi*.

In addition to the GRX measurement scale, we further referred to the 15-item scale measure of *guanxi* created by Wong et al. (2003). This is a multidimensional measure that takes into account different behaviours associated with people having different levels of *guanxi* closeness. These behavioural categories include social activities, financial assistance, giving priority to a person, celebrating special events and emotional support. In our study, we focused on financial assistance and emotional support, and used two items to measure FG by asking respondents (1) to what extent they believed that their family or friends would lend them money if they were in need and would protect them from the opportunism of others, and (2) how much they believed that their family or friends would listen to their fears and worries.

Business *guanxi* (BG). As mentioned above, we adopted the items designed for measuring the construct of *renqing* in the GRX measurement scale of Yen et al. (2011) to measure business *guanxi* (BG). These measures of the *renqing* construct were strongly related to receiving and returning favours, and were also consistent with the items for measuring reciprocity developed by Mavondo and Rodrigo (2001). Specifically, we used four items to measure to what extent respondents in their *guanxi* networks: (1) are happy to provide a favour to business associates of their network with different social status who are in need; (2) feel obliged to return a favour to those business associates who have previously given them a favour; (3) believe that "calling in" a previous favour is part of doing business with their business associates; (4) believe that

giving and receiving favours is critical in maintaining the relationship between their business associates and themselves.

In addition, we adopted two items created by Hwang (1987) for measuring the construct of *mianzi* to measure BG, which were presented as "I will feel '*mei mianzi'* (embarrassed, loss of face) if I am unable to return a received favour to those favour providers", and "I will feel '*you mianzi'* (honoured) if I provide a requested favour to my business associates and introduce unknown, key contacts to one another".

Knowledge mobilisation (KM). According to Dhanaraj and Parkhe (2006), we measured knowledge mobilisation (KM) using the items for measuring the constructs of (1) ease of knowledge transfer, (2) ease of knowledge acceptance, and (3) ease of knowledge deployment. Specifically, referring to Reagans and McEvily (2003), we used two items for measuring the ease of knowledge transfer from a source to a recipient, which were represented as "It is easy for me to explain to my network members a key idea, concept, or theory as well as new developments in my area of expertise", and "It is easy for me to follow and disseminate other network members' ideas either orally or via information technologies".

In addition, we adopted the measurements of the construct of absorptive capacity to measure the ease with which knowledge is accepted and assimilated by network members, by reference to the four-item scale designed by Seo et al. (2015) for measuring individual absorptive capacity, and the ten-item scale designed by Gluch et al. (2009) for measuring the routines for acquiring knowledge. Specifically, we used two items to measure to what extent respondents recognise and accommodate the different ways in which each member interprets and accepts the disseminated message, and to measure the degree to which respondents receive the shared information and knowledge resources, increasing their existing knowledge base.

Finally, we referred to the Levels of Use (LoU) scale of Hall et al. (1975), designed for measuring eight levels of use of an innovation, and adapted it to measure the ease of knowledge deployment for launching and scaling up applications on digital platforms. Specifically, we used two items to measure to what extent respondents pay attention to day-to-day use of their expertise for addressing problems in launching new applications on digital platforms, and to

what extent respondents consolidate the application of their expertise to address problems in rapidly scaling up applications across digital platforms.

Knowledge coordination (KC). By referring to the study of Schutz et al. (2009), we used two items for measuring the KC construct: "I have established a full understanding of each member's expertise as well as how each member's knowledge should be coordinated"; "I have carefully interrelated practice-based expertise and actions to each other for strategic responses to technological changes in the platform architecture".

Furthermore, we draw from the knowledge integration instrument developed by Liu et al. (2008) for measuring KC. We adopted two items to measure to what extent respondents (1) understand how two or more ideas, concepts or theories from different specialties interact in a digital platform context, and (2) recognise potential connections between ideas, concepts or theories from different specialties, and elaborate the nature of these connections in ways specific to a platform-based setting.

Control variables. Each of the items in the preceding sections was measured with a seven-point Likert scale, ranging from Strongly Disagree to Strongly Agree. All of the variables were measured with the survey items listed in Appendix D.

We also controlled for three factors that might be associated with the performance of knowledge mobilisation and knowledge coordination. Thus, controls were included for entrepreneurial stage, education and industry experience. Specifically, we created two dummy variables to control for entrepreneurial stage by the age of the company (in years), as previously distinguished: 0 for the start-up stage (company age <3), and 1 for the growth stage (company age $\geq$ 3). In addition, to capture education we developed three dummy variables as follows: 0 for a Bachelor's degree, 1 for a Master's degree, 2 for a doctoral degree. Finally, we controlled for industry experience by the number of years the entrepreneur had worked in this industry.

In order to handle the potential common method bias, we referred to the study of Conway et al. (2015) and a series of follow-up studies (Podsakoff et al., 2003, 2012). Specifically, in the phase of research design, we ensured the anonymity of the survey and the confidentiality of the data. In addition, prior to survey distribution, a comprehensive pretest was conducted to increase the

understandability of the survey items. Last, exploratory and confirmatory factor analyses were performed to check the quality of the construct measurement and to establish the convergent and discriminant validity of the scales.

3.3 Qualitative Research

In the qualitative part of the research, we conducted semi-structured interviews to make sense of the quantitative results with supplementary evidence. Specifically, we conducted 48 interviews with developers who were directly involved in the processes of initial launch and rapid scaling and had an intimate knowledge of the *guanxi* networks involved. We asked the entrepreneurs to state the current stage of their firms, and to describe the types of *guanxi* that were established at different entrepreneurial stages. In addition, we asked them to evaluate the significance of both types of *guanxi* in relation to initial launch during company creation and continued scale-up during corporate growth. Finally, we asked them to indicate the specific *guanxi* ties used in fostering the mobilisation and coordination of knowledge in each entrepreneurial stage.

From all the survey respondents, we selected 48 entrepreneurs who established their digital ventures between 1996 and 2014 in Zhongguancun, a typical high-tech district in Beijing. After the assurance of confidentiality, we identified the interviewees whose demographic characteristics are shown in Appendix B.

Our qualitative analysis involved coding the interview transcripts to identify key themes and categories. Specifically, we used initial codes based on dimensions of network dynamics as a guide to categorize the transcripts, assisted by NVivo. For this, we referred to the study of Guo and Miller (2010) and coded the transcripts in terms of three crucial dimensions of network dynamics: social structure, content, and governance mechanisms (Hoang & Antoncic, 2003).

In terms of social structure, we coded (1) the nature of the compositional ties of a *guanxi* network as either family-or-friend-based or business-based, and (2) the configuration of a given *guanxi* network as possessing or not possessing a ‘filled’ sparse structure. As for content, we coded the qualitative data in relation to the importance of different types of *guanxi* for either

company creation or corporate growth or both. Regarding governance mechanisms, we coded the interview transcripts to identify the specific *guanxi* ties used in mobilising and coordinating cognitive resources for the entrepreneurial stages of initial launch and rapid scaling. During the process of moving back and forth between original interview recordings and transcripts, our appreciation of the links between *guanxi* and structural holes, knowledge mobilisation and knowledge coordination, initial launch and rapid scale-up, as well as entrepreneurial start-up and growth stages, progressively emerged (Nandhakumar & Jones, 1997).

4. RESULTS

In the following subsections, we describe the results of our surveys and interviews. First, we assessed the measurement model. Second, we tested our structural model. Third, we conducted a between-group analysis comparing two subsamples selected according to entrepreneurial stage. Finally, we reported our qualitative results to explain why some of the hypothesised relationships are stronger in one entrepreneurial stage than the other.

4.1 Measurement Model Assessment

This section had two parts. In the first part, we conducted exploratory and confirmatory factor analyses. Before evaluating the fit of the measurement model, we first performed an exploratory factor analysis of the four measures (FG, BG, KM and KC), using a principal axis factoring analysis with *Oblimin* oblique rotation with Kaiser normalization. The results are presented in Table 1. Specifically, the KMO measure of sample adequacy was 0.766, indicating that the data was suitable for factor analysis. In addition, the data showed support for the four factors, which had eigenvalues greater than 1 and explained 94.505% of the variance. Furthermore, the measures suitably represented the four factors, whereby all of the primary loadings of the sample exceeded 0.692. Finally, the Cronbach's alpha for the sample was 0.914, implying a high degree of reliability for the internal consistency of the measures for the four factors.

Variable	Item	Loading	SD	CR	Cronbach'α
Family-or-friend *guanxi*	**FG1**	.811	.129	.812	.877
	FG2	.717	.135		
	FG3	.767	.134		
	FG4	.739	.124		
	FG5	.692	.133		
Business *guanxi*	**BG1**	.693	.115	.745	.745
	BG2	.712	.102		
	BG3	.734	.124		
	BG4	.866	.126		
	BG5	.832	.109		
	BG6	.812	.117		
Knowledge mobilisation	**KM1**	.742	.119	.739	.931
	KM2	.766	.118		
	KM3	.788	.109		
	KM4	.742	.108		
	KM5	.695	.112		
	KM6	.802	.121		
Knowledge coordination	**KC1**	.694	.104	.767	.934
	KC2	.781	.109		
	KC3	.785	.111		
	KC4	.734	.126		

Table 1. Results of Factor Analysis of All of the Items.

Then, we carried out a confirmatory factor analysis to estimate the model and establish the construct validity of the scales using Amos software. This was done by following the two-stage approach proposed by Anderson and Gerbing (1988). First, all indexes displayed a good fit with the model: CMIN was 487.155 with 394 DF; NFI was 0.991; CFI was 0.990; RMSEA was 0.019, suggesting a good model fit.

In the second stage, we examined the convergent validity by testing the significance of the

factor loadings and their gap to the SE, based on the work of Koufteros (1999). As illustrated in Table 1, all item loadings were above the suggested cut-off of 0.6 (Hair et al., 1998), with a strong significance level. In addition, all the SE values were around 0.1, indicating that all the items had a significant and clear relationship with their own latent variables. Finally, all the CR values of the latent variables were above the criterion of 0.7 (Hair et al., 1998), displaying good convergent validity.

Furthermore, we examined the discriminant validity using the AVE. According to the criterion established by Koufteros (1999), when the AVE between items and their underlying latent variable is greater than that between this latent variable and other latent variables, the measurement model has good discriminant validity. Table 2 shows the inter-factor correlation matrix for all of the variables in the study. It can be seen that all the square roots of the AVE shown (in bold) on the diagonal of the correlation matrix were greater than the off-diagonal construct correlations, implying distinctness in its discriminant validity (Koufteros, 1999).

Last, as shown in Table 2, we found that an entrepreneur's education and industry experience have little impact on family-or-friend *guanxi*, business *guanxi*, structural holes, knowledge mobilisation or knowledge coordination. These independent and dependent variables were only significantly associated with the entrepreneurial stage (.301, $p<.001$), which means that the entrepreneurial stage may have an important influence on the hypothesised relationships.

Variable	Mean	SD	1	2	3	4	5	6	7	8
1.Structural holes	3.715	.113	**.816**							
2.Family-or-friend *guanxi*	4.124	.130	.306	**.806**						
3.Business *guanxi*	3.912	.116	.201	.305	**.755**					
4.Knowledge mobilisation	3.988	.117	.261	-.355	-.342	**.815**				
5.Knowledge coordination	4.092	.119	.391	.289	.362	.392	**.816**			
6.Entrepreneurial stage	3.010	.155	.211	.234	.253	.321	.259			
7.Education	.087	.043	.011	-.024	-.023	.021	.037	.083		
8.Industry experience	.104	.051	.013	.007	-.013	.103	.046	.101	.087	

Table 2. Descriptive Statistics and Bivariate Correlations.

In the second part of our measurement model assessment, to measure interaction terms, we referred to the research of Conway et al. (2015) and adopted the approach of Ping (1995) to moderated structural equation modelling (MSEM). This was done by using the three-step procedure outlined by Cortina et al. (2001). Specifically, in the first step, we standardized all indicators for the independent variable (SH), and moderator (FG or BG). Second, we created interaction terms: FG×SH and BG×SH. Thirdly, we fixed the measurement properties for interaction terms. Overall, the data shows a good fit with the model: CMIN was 380.475 with

475 DF; NFI was 0.973; CFI was 0.951; RMSEA was 0.021.

In order to control for multicollinearity, we referred to the approach of Xiao and Tsui (2007) by mean-centering each paired component measure (FG&SH; BG&SH) before entering the interaction terms (FG×SH; BG×SH) (Aiken & West, 1991). Then we calculated the variance inflation factors (VIFs) for all the variables in the model. All the VIFs were less than 5.0, an accepted cut-off value (Neter et al., 1990), suggesting a well-controlled multicollinearity.

Besides this approach, in order to better capture interaction terms, we further used the residual centering approach of Little et al. (2006), which adopts residuals as product indicators, and possesses "the positive aspects of structural equation modeling (i.e., controlling for measurement error and providing a model fit)" (Steinmetz et al., 2011, p. 96). Specifically, the approach involved two steps, and the specific procedures are shown in Appendix E. The descriptive statistics of the indicators resulting from the residual centering approach are presented in Appendix F. The result presents a good model fit: SB $\chi 2$ (Satorra-Bentler corrected chi-square) was 3.19 with 27 DF; CFI was 1.000; RMSEA was 0.001.

4.2 Structural Model Testing

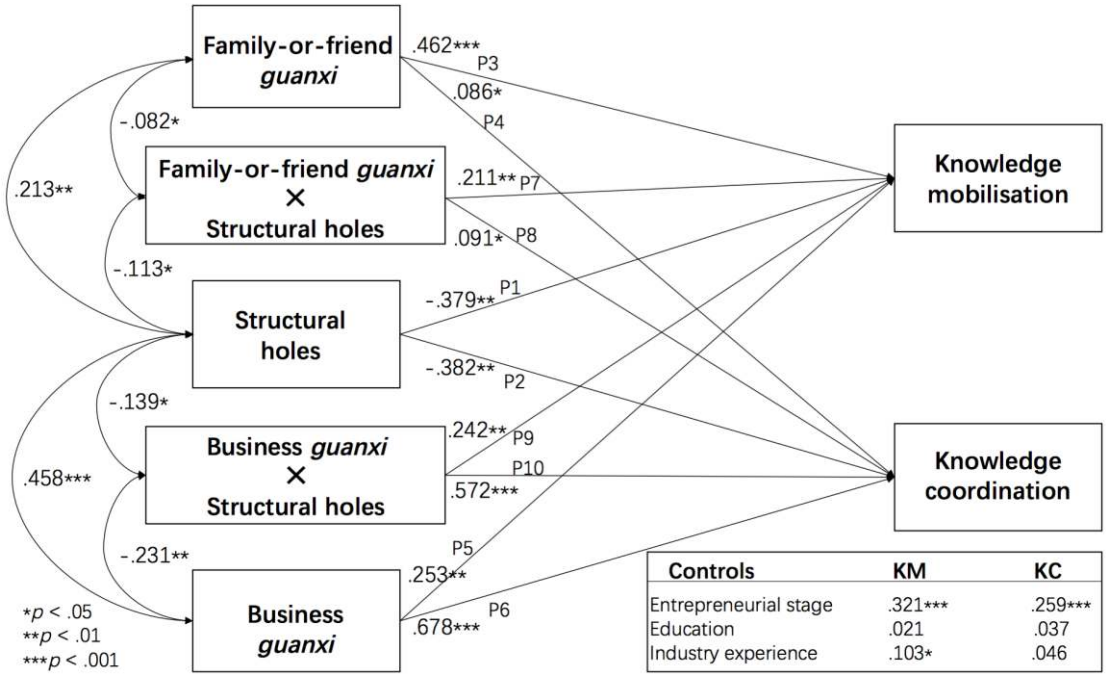

Figure 2. The Results of the Hypothesis Testing

In terms of the structural model, testing involved two parts. In the first part, we again referred to Conway et al. (2015), and adopted Ping's (1995) approach to MSEM by using the three-step procedure outlined by Cortina et al. (2001). Figure 2 shows the results of the hypothesis testing based on the whole sample using Amos. It can be seen that all ten of the potential connections were significant, supporting all of the hypothesised relationships. Specifically, the coefficient of structural holes was negative and moderately significant in knowledge mobilisation (P1=–.379, p<.01), which supports Hypothesis 1. In addition, the coefficient of structural holes was also negative and moderately significant in knowledge coordination (P2=–.382, p<.01), supporting H2. Furthermore, the results in Figure 2 indicate that family-or-friend *guanxi* was positively related to both knowledge mobilisation (P3=.462, p<.001) and knowledge coordination (P4=.086, p<.05). This provides support for both H3 and H4. Similarly, Figure 2 demonstrates that the coefficients of business *guanxi* were positive and significant in knowledge mobilisation (P5=.253, p<.01), and positive and highly significant in knowledge coordination (P6=.678, p<.001), supporting both H5 and H6.

In terms of the moderated relationships, the findings illustrated in Figure 2 show that the interaction coefficients for family-or-friend *guanxi* and structural holes were positive and moderately significant in knowledge mobilisation (P7=.211, p<.01), and positive and slightly significant in knowledge coordination (P8=.091, p<.05), providing support for H7 and H8. In addition, a simple slopes test based on one SD above and below the moderator offers further support for these moderated relationships. Figure 3 plots the interactions, demonstrating that the original negative relationship between structural holes and knowledge mobilisation (B=–.25, t=–3.81, p<.001) was weakened (B=–.05, t=–.63, p<.001), when family-or-friend *guanxi* was strong. This test further suggests that the original negative relationship between structural holes and knowledge coordination (B=–.14, t=–2.10, p<.05) was positive (alleviated) (B=.04, t=.41, p<.05), when family-or-friend *guanxi* became strong.

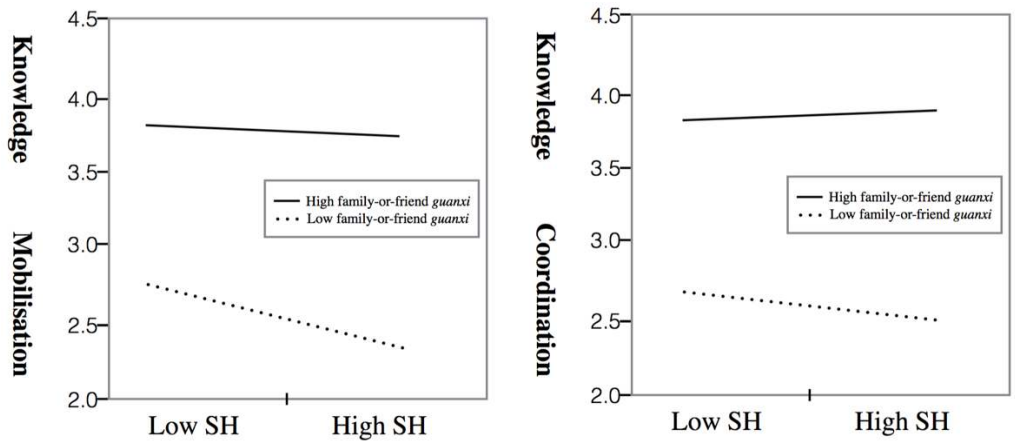

Figure 3. Interactions between FG and SH in KM and KC.

Finally, Figure 2 indicates that the interaction coefficients for business *guanxi* and structural holes were positive and significant in knowledge mobilisation (P9=.242, p<.01), and positive and highly significant in knowledge coordination (P10=.572, p<.001), supporting H9 and H10. In addition, plotting the interactions, as illustrated in Figure 4, shows that the relationship between structural holes and knowledge mobilisation was negative at low levels of business *guanxi* (B=–.21, t=–3.21, p<.001), and was positive at high levels of business *guanxi* (B=.12, t=.51, p<.001). Likewise, the relationship between structural holes and knowledge coordination was negative at low levels of business *guanxi* (B=–.29, t=–3.82, p<.001), but was positive (mitigated) when business *guanxi* was strong (B=.23, t=.62, p<.001).

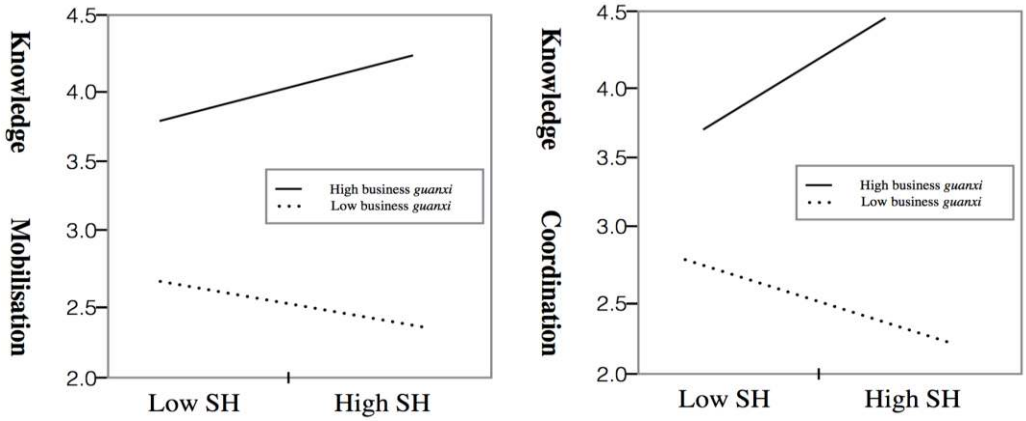

Figure 4. Interactions between BG and SH in KM and KC.

In the second part of our structural model testing, in order to better detect interaction effects, we used the residual centering approach of Little et al. (2006) using SPSS. The resulting effects of FG, BG, SH and the respective product variables (FG×SH; BG×SH) on KM and KC are shown in Appendix G. Specifically, the interaction effect of FG and SH in KM was positive and significant (P7=.051, p<.01); the interaction effect of FG and SH in KC was positive and significant (P8=.023, p<.01); the interaction effect of BG and SH in KM was positive and significant (P9=.021, p<.01); the interaction effect of BG and SH in KC was positive and highly significant (P10=.078, p<.01). These results show further support for the moderated relationships hypothesised in H7, H8, H9 and H10.

4.3 Between-group Analysis of Knowledge Orchestration Performance in Entrepreneurial Start-up and Growth Stages

While acknowledging the significant influence of the entrepreneurial stage, the next step was to conduct a between-group analysis comparing two subsamples that were selected according to the company age, to detect between-group path differences and gain a further insight into whether certain relationships are stronger in one stage than the other (start-up and growth).

On the basis of Qureshi and Compeau (2009), we adopted a covariance-based SEM approach to conduct a between-group analysis by using Amos with maximum likelihood estimation. In general, this approach involves an initial test of measurement invariance, which allows us to constrain the measurement models of the two subsamples to be equal, thereby isolating any differences in structural paths. As Cheung and Rensvold (2002, p. 233) stated, "Measurement invariance is critically important when comparing groups. If measurement invariance cannot be established, then the finding of a between-group difference cannot be unambiguously interpreted". Following this initial test, the approach involves a test of structural model invariance to see whether the path coefficients across the two subgroups differ significantly.

In terms of the measurement invariance test across the two subsamples, we made use of the approach of Qureshi and Compeau (2009), employing chi-squared ($\chi 2$) differences and CFI

differences to test a set of nested models, and set the intercepts (measurement means), factor loadings (measurement weights), residual variances of the factor indicators (measurement residuals), as well as the means of the factors as the measurement parameters of interest. Technically, the default model, which has no parameters constrained to equality across the samples and allows the parameters to vary, is compared to the more restrictive models with imposed equality constraints for each of the four parameters (Cheung & Rensvold, 2002). Then the chi-squared differences ($\Delta\chi2$) are calculated when the $\chi2$ value and degrees of freedom of the default model are subtracted from those of the nested, more restrictive model.

As Homburg and Giering (2001) found, the $\chi2$ value will always be lower for the general (less restrictive) model, because the models that are nested with the general model have one degree of freedom more than the general model. As a result, for each successive model (depicted in Appendix H), the $\Delta\chi2$ was not significant ($p<.05$), and the ΔCFI was less than 0.01. According to the research of Qureshi and Compeau (2009), and Marcoulides et al. (2008), a nonsignificant $\Delta\chi2$ and ΔCFI below 0.05 suggests model invariance, indicating that imposing these constraints did not worsen the model fit significantly.

After we established measurement invariance, we tested the between-group structural equation model. Specifically, we compared the default model, all the path coefficients of which are able to vary freely across the two subgroups, to the model with equality constraints imposed on the path coefficients. According to Byrne (2001), the path coefficients across the groups will not differ significantly, if imposition of equality constraints does not deteriorate the model fit significantly. In this test, we referred to the study of Floh and Treiblmaier (2006), and imposed a null hypothesis that the particular entrepreneurial stage does not have any effect on the ten parameters. As shown in Table 3, the ten hypotheses were rejected for this control variable ($\Delta\chi2\geq19.11$, ΔDF=10). As a result, significant differences (CR=3.84 at the 5% level) imply that the particular entrepreneurial stage (start-up or growth) does have a critical influence on the hypothesised relationships.

	The overall sample (N=325)		Subsample 1 (N=150)		Subsample 2 (N=175)		Chi-Squared Difference (ΔDF = 1)	
Predictor	**KM**	**KC**	**KM**	**KC**	**KM**	**KC**	**KM**	**KC**
SH	P1=-.379 (10.745)	P2=-.382 (12.328)	P1=-.592 (14.962)	P2=-.311 (9.507)	P1=-.455 (7.752)	P2=-.414 (19.915)	Δχ2= 4.402*	Δχ2= 7.760*
FG	P3=.462 (13.212)	P4=.086 (4.713)	P3=.468 (13.584)	P4=.387 (11.341)	P3=.299 (8.425)	P4=.390 (10.288)	Δχ2= 11.645*	Δχ2= .045
BG	P5=.253 (9.478)	P6=.678 (17.719)	P5=.470 (10.477)	P6=.315 (13.511)	P5=.494 (9.659)	P6=.464 (15.170)	Δχ2= .008	Δχ2= 16.503*
FG×SH	P7=.211 (7.922)	P8=.091 (1.242)	P7=.309 (8.281)	P8=.416 (14.128)	P7=.265 (8.449)	P8=.367 (14.345)	Δχ2= .753	Δχ2= 1.396
BG×SH	P9=.432 (10.373)	P10=.572 (14.218)	P9=.424 (10.218)	P10=.475 (10.438)	P9=.435 (10.410)	P10=.586 (15.563)	Δχ2= 1.641	Δχ2= 17.577*

Δχ2= for all path set equal across subgroups (DF = 10): 15,161*. Subsample 1: Start-up stages; Subsample 2: Growth stages.

* Chi-squared difference is significant at the 5% level, and calculated between subsamples of start-up and growth stage.

Table 3. Between-group Analysis in Entrepreneurial Start-up and Growth Stages.

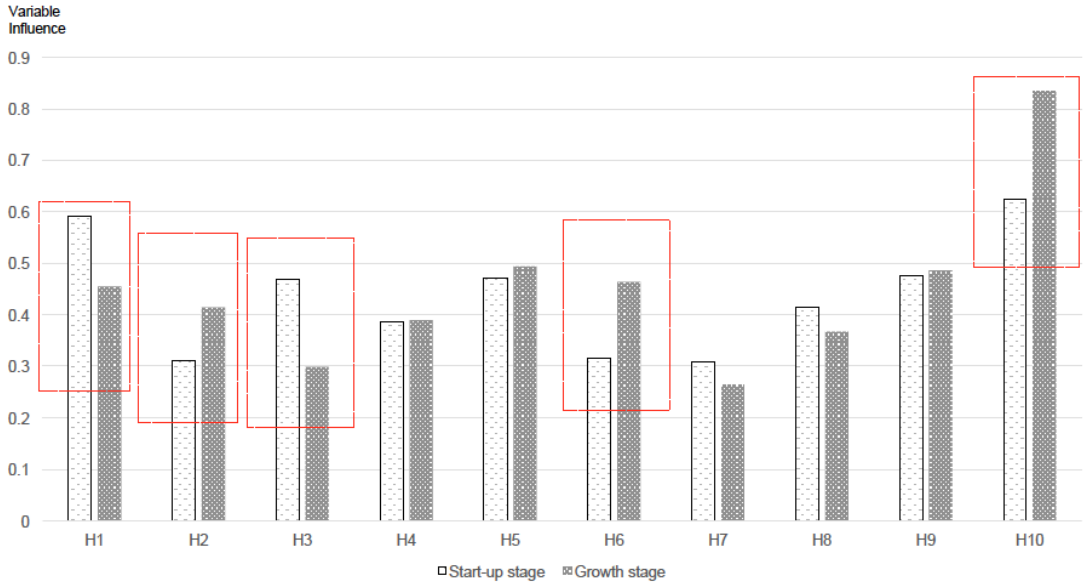

Figure 5. Between-group Comparison of Hypothesis Test across Two Subsamples.

The results of between-group comparison of hypothesis testing across the two subsamples are

presented in Figure 5, and indicate a significantly different effect of the entrepreneurial stage on five of the path coefficients of the ten hypotheses (outlined in red).

In terms of H1 ($\Delta\chi2=4.402*$), the results indicate that the adverse influence of structural holes on knowledge mobilisation is more severe for start-up entrepreneurs (p1=-.592) than for entrepreneurs whose companies are at the growth stage (p1=-.455). As for H2 ($\Delta\chi2=7.760*$), the findings suggest that the negative relationship between structural holes and knowledge coordination intensifies for entrepreneurs at the corporate growth stage (p2=-.414). For H3 ($\Delta\chi2=11.645*$), we found that start-up entrepreneurs (p3=.468) rely more on their family-or-friend *guanxi* to facilitate knowledge mobilisation than do entrepreneurs in their growth phase (p3=.299). With regard to H6 ($\Delta\chi2=16.503*$), the results reveal that entrepreneurs at the growth stage (p6=.464) rate the significance of business *guanxi* in promoting knowledge coordination markedly higher than nascent entrepreneurs do during the start-up phase (p6=.315).

Finally, moving to H10 ($\Delta\chi2=17.577*$), the analysis demonstrates that the entrepreneurial stage does affect the interaction between business *guanxi* and structural holes in knowledge coordination. More specifically, business *guanxi* better moderates the negative relationship between structural holes and knowledge coordination in the entrepreneurial growth stage (p10=.586) than in the start-up stage (p10=.475). To put it another way, the moderating power of business *guanxi* in mitigating the disadvantages imposed by structural holes on knowledge coordination is stronger for mature entrepreneurs than for start-up entrepreneurs.

The overall result table for hypothesis testing is presented in Appendix I. To summarise, we first adopted the MSEM approach of Ping (1995) to test the hypotheses based on the whole sample using Amos, which showed that all of the ten hypotheses were supported. We then used a covariance-based SEM approach (Qureshi & Compeau, 2009) to conduct a between-group analysis comparing two subsamples, and found a significantly different effect in terms of entrepreneurial stage for five of the hypotheses: H1, H2, H3, H6, and H10.

4.4 Qualitative Results: When *Guanxi* Meets Structural Holes

The quantitative results of the between-group analysis demonstrate that five particular relationships are stronger in one entrepreneurial stage than the other. The qualitative evidence gathered from our interview data helps to explain such differences.

Why family-or-friend *guanxi* is not as effective in the growth stage

Quantitative results indicate that entrepreneurs in the growth phase rate the significance of business *guanxi* in promoting knowledge coordination much more highly than that of family-or-friend *guanxi*. Our analysis of interviews provides further explanation of why family-or-friend *guanxi* is less useful for developers than business *guanxi* in the coordination of knowledge to support more rapid scaling and growth.

Qualitative results suggest that entrepreneurs, when they first started to establish their firms, were uninformed and vulnerable with limited resources. At this time, it was their instinct to return to their family and close friends to mobilise knowledge resources for initial launch success. Such knowledge was primarily reflected in the form of inspiration, creative ideas on App design, unique insights into user requirement, suggestion on the product 'pain points' and prior experience in App development. This seems to suggest that the stronger the relationships, the better, such that developers might also rely more on their family-or-friend *guanxi* to coordinate knowledge for continued scale-up success even at the growth stage, yet this was not the case in our interviews.

Because the entrepreneurial growth phase in digital platform settings is usually accompanied by the frequent launch of emerging platforms (Srinivasan & Venkatraman, 2018), our interviewees demonstrated a conscious effort to expand their business *guanxi* networks in support of rapid adaption to new technologies. This is because that they believed that although family-or friend *guanxi* could help them gain access to resources at emergence, it was less flexible in providing the more diverse knowledge base required during periods of technological change, thereby restricting the number of available platforms, and the breadth of integrated knowledge needed for rapidly scaling the user base and navigating the platform dynamism.

This finding is consistent with the work of several scholars, such as Hite and Hesterly (2001), and Yli-Renko et al. (2001), who highlighted that calculative networks composed of more market-like weak ties are better at coordinating a variety of resources for growth, whereas strong ties usually lead to a vicious cycle of relationship constraint and a slower response to external contingencies.

In the interviews, our entrepreneurs stated that in their growth stages, they consciously developed a diverse business *"guanxiwang"* to carry out their scaling goals. They preferred establishing business *guanxi* with persons who could compensate for their own weaknesses and would bring in fresh, creative ideas to advance their routines along new technological trajectories, rather than working with someone who just had a deep personal relationship with them. They further stressed that a network primarily populated with family and friends does not have sufficient structural holes to access and integrate diverse knowledge resources for rapid scale-up in simultaneous support of multiple platforms.

For example, one entrepreneur who had operated a software firm for more than ten years said: "*When I started my firm, it was tough to scale the user base rapidly, making me very stressed. At that time, my friends provided me with selfless help, including all kinds of information and valuable social resources. With the passage of time I realised that colluding only with close friends was far from enough to grow and reach a large scale. What matters most was to build a larger guanxi network with platform owners, other third-party developers, and independent users. I believed that mixing friendship and business together was not a good idea, because emotions usually get in the way. I needed to hear different voices and get access to novel sources of information. Putting a substantial amount of efforts into building guanxi, I approached the CEO of a mobile operator firm. He allowed me to share his platform, and provided me with exclusive information about the platform affordability, so that I was more able to design attractive apps upon his platform and adapt to changing platform technology*".

In addition, as platforms became increasingly crowded, our entrepreneurs encountered a challenge in making their applications stand out among those of their competitors (de Reuver et al., 2017), requiring effective leverage of heterogeneous knowledge. They emphasized the

inability of family-or-friend *guanxi* to handle this challenge, because unlike *renqing*-based business *guanxi*, it is primarily *ganqing*-based and lacks the reciprocity that values economically oriented favour exchange among persons with asymmetric social status. Without being such a lubricant, family-or-friend *guanxi* posed a challenge for third-party developers in coordinating different cognitive resources to ensure the consistent popularity of their applications over time.

As the developer of Xiaokaxiu said, *"Before launching Xiaokaxiu, I developed video software on Android that faced fierce competition from many other similar apps. As I expanded my guanxi networks, and built renqing with some platform designers, I got access to unique information. I was recommended to develop a video app with 'kuso' function; that's the origin of Xiaokaxiu. When we officially launched it in May 2015, it ranked first in the app store after two months. I believed the person who gave me this idea should take credit for this success. In China renqing is extremely significant. It is very special, and only occurs in business guanxi".*

Why business *guanxi* is not as effective at the start-up stage

Our quantitative results reveal that start-up entrepreneurs rely more on their family and friends than their business associates to facilitate knowledge mobilisation. Our analysis of interviews provides further explanation of why business *guanxi* is not as useful as family-or-friend *guanxi* in mobilising knowledge for early launch success in the start-up phase.

Specifically, our entrepreneurs on digital platforms described how, when their firms were new and small, they attempted to link to dominant platforms with the largest installed bases for survival (Srinivasan & Venkatraman, 2018). At this stage, controlling and protecting their proprietary knowledge and highly specialized intellectual property amid current and new competitors was very significant. Thus, they tended to place more trust in their family and close friends than business associates when it came to protecting their most important competitive advantages due to the high levels of obligation and intimacy implicit in such relationships.

As one new developer stated: *"The core technology behind our product is very important to the survival of our firm. It is our most valuable property. So, I won't share it with any other*

persons besides my family. To me, they are the most trustworthy, although they may not always guarantee all necessary support. I won't expose my proprietary technology to my business partners, especially those potential competitors in similar fields, because I am still in a vulnerable position now". As Sequeira and Rasheed (2006) argued, due to its tacit nature, knowledge is hard to protect from unauthorized overspill beyond company walls. Thus, the strong ties that evolve from family-or-friend *guanxi* can help new businesses build given levels of social capital, helping them out of such a potentially disadvantageous position.

In addition, according to McDermott and O' Dell (2001), we see that cultural resistance is a critical obstacle in knowledge sharing, knowledge acquisition and knowledge application, because no matter how strong the approach to knowledge management, the prevailing culture is bound to be stronger. This notion was reflected in our interviews. Our interviewees mentioned that Chinese entrepreneurs tend to hoard knowledge assets until they become familiar with each other, and this is especially true when they are new to the industry and need to build initial launch success.

As one interviewee pointed out: "*In China, awareness of protection of intellectual property rights is very weak due to unsound legal systems, and dysfunctional institutional orders. This is particularly obvious in the digital industry, because the cost of innovation is very high but that of imitation is very low. That is why for a long time China was called the land of copycats. So, it is not surprising that new entrepreneurial developers always treat proprietary knowledge protection as the most important thing*".

Thus, the strong ties that evolve from family-or-friend *guanxi* are better able to help new developers transfer, acquire and deploy knowledge for linking to dominant platforms, while business *guanxi*, which is based on personal gain and loss, is not as good at aiding the process of knowledge mobilisation in the initial launch stage, because its unstable nature enables nascent entrepreneurs to treat each other as outsiders in any single business deal.

Why the moderating power of business *guanxi* on structural holes is stronger

The results of the between-group analysis demonstrate that business *guanxi* is more able to moderate the negative relationship between structural holes and knowledge coordination at entrepreneurial growth stages than family-or-friend *guanxi*. In parallel, our qualitative results explain why the moderating power of business *guanxi* is stronger in these platform settings.

On the basis of our interviews, we found that most digital entrepreneurs who operated at the network boundaries with non-connected individuals chose to act as integrators and fill structural holes the first time they saw them. They gave up their advantage of "having a hand in distribution" (Xiao & Tsui, 2007) to maximize the interest of the whole network. Although family or friends also tend to fill structural holes and lead to a more robust network, third-party developers who start with a large number of such strong ties may face a growth barrier to rapid adaptation and scaling, due to restricted relational capability and network structure.

In order to overcome such growth problems, our interviewees reported that they chose to sever strong ties deemed redundant (Elfring & Hulsink, 2007) and substitute them with wider business ties with reputational partners, platform providers and other third-party developers, establishing access to a greater diversity of resources and the potential for a better response to dynamic shifts in platform technologies (Anderson et al., 2013). Compared with family-or-friend *guanxi*, business *guanxi* not only involves affection, but also economic instrumentality (Hwang, 1987), which assists entrepreneurs more in leveraging a variety of knowledge in response to competitor moves and the promotion of value exploitation.

This was reflected in an interview with an entrepreneur expanding his business: "*In this society, highlighting time is money, building a good relationship with your business partners can help you gain a deep understanding of their ways of thinking, their products, their strategic moves and their 'mine field'. All this information is a huge plus for you in responding to external environment changes and growing your business".*

As entrepreneurs filled structural holes through wider access to non-redundant resources, they highlighted the creation of a buffer zone, where they could engage in certain levels of controlled networking, reducing the risk of being cheated (Guo & Miller, 2010) and increasing their

confidence in leveraging diverse knowledge to scale their businesses rapidly. Although a sparse network configuration led to a variety of relations, the high level of trust, commitment and empathy embedded in *renqing* ensured that these extended ties are also strong ties, secured the exchange of favours in business transactions, and provided a control mechanism, by which opportunistic behaviour on the part of a broker could be inhibited (Chell & Baines, 2000).

In addition, in *Confucian* culture where *renqing*, reciprocity and *mianzi* plays prominent roles, when entrepreneurs acted as integrators to create value for the whole network, other network members recognised their contribution and rewarded their structural hole-filling behaviour, so as to reduce the risk of opportunism and promote the coordination of mutual knowledge.

Our interviewees corroborated this view. For example, one developer stated that in China it is commonplace for digital entrepreneurs to connect different business-related stakeholders with each other to create a healthy "digital entrepreneurship ecosystem" (Li et al., 2017) and realise win-win outcomes, because the Chinese are inclined to trust new contacts who are introduced by sources they regard as trustworthy (Reve & Lu, 2011): "*Zhu introduced Li to me and asked me to bring Li into the in-group of a digital innovation summit. This in-group is very exclusive. Li would not be accepted unless a member of this group offers him a reference. Zhu had always helped me when I was in trouble. When I verified Li with Zhu, I trusted Li as well and provided him the favour. I have no doubt that Zhu and Li will return this favour to me. In our society, renqing is like money that can be banked and retrieved later".*

5. DISCUSSION AND IMPLICATIONS

In the above analysis, we draw on structural holes theory and *guanxi* literature to explain the dynamics of *guanxi* networks for knowledge orchestration performance across the stages of start-up and growth in the context of Chinese entrepreneurs on digital platforms. The findings of our study contribute to the literature on digital entrepreneurship, as well as the literature on structural holes theory and *guanxi*.

Implications for studies on digital entrepreneurship

The findings demonstrate that Chinese digital entrepreneurs strategically leverage their *guanxi* networks to orchestrate knowledge for achieving initial launch and rapid scaling success with platforms evolving along multiple technological trajectories. This complements the existing studies (e.g., Srinivasan & Venkatraman, 2018) on the association between third-party developers' strategic moves in their resource and module networks and entrepreneurial success. By revealing the co-evolution (Hite & Hesterly, 2001) of Chinese digital entrepreneurs' *guanxi* networks and knowledge orchestration performance across the stages of start-up and growth, our study has provided new insights into the dynamics of *guanxi* ties coupled with network structures for knowledge mobilisation and knowledge coordination in digital platform settings. Our results indicate that, in the start-up stage, Chinese entrepreneurs on digital platforms primarily rely on their family members and close friends to transfer, obtain and use knowledge (e.g., inspiration, creative ideas, and prior experience) for the success of their initial launch, including launching better quality applications and linking to dominant platforms with the largest installed base, without being overly burdened by payback obligations.

As digital entrepreneurs reach their growth phase where newer platforms emerge or current platforms evolve, a network, that is built on a diversity of *renqing*-based business *guanxi* with rich, 'filled' structural holes, enables developers to leverage and integrate diverse knowledge for their continued scale-up success. Simultaneously, the mutual commitment, trust and expectation embedded in business *guanxi* provides a control mechanism that limits the risk of the opportunistic behaviour that is highly possible in a sparse network.

Thus, we describe a dynamic network configuration that meshes *guanxi* and structural holes in a complementary way to promote the mobilisation and coordination of knowledge in the context of Chinese entrepreneurs on digital platforms. As *guanxi* is identified to "fit the new structural needs of capitalism and even to provide Chinese capitalism with a competitive advantage" (Yang, 2002, p. 475), increasing Western business practices are moving in the direction of *guanxi*-type systems. Hence, we believe that our findings might not only be unique

to China, but also relevant to wider world by contributing a dynamic view of *guanxi* networks and knowledge orchestration performance in digital platform settings.

In addition, this study reveals how purposeful, interrelated knowledge mobilisation and knowledge coordination may help digital entrepreneurs navigate the complex landscape of linking and adapting to different digital platforms across their launch and scaling processes. Specifically, drawing on the network orchestration model of Dhanaraj and Parkhe (2006), we highlight the significant role that knowledge orchestration plays in entrepreneurial launch and scale-up success in digital platforms. In terms of knowledge mobilisation, we demonstrate how the appropriate transfer, acquisition and application of knowledge in the social networks of third-party developers allows them to preferentially link their products to the given platforms, and adapt their strategies when their applications are coordinated within and across digital platforms. With regard to knowledge coordination, we demonstrate how the effective mediation and management of the variety of knowledge in the *guanxi* networks of entrepreneurs on digital platforms facilitates the integration and transformation of diverse knowledge into novel, attractive applications during periods of technological change and rapid scaling. In this way, our findings extend the current understanding of knowledge orchestration of digital entrepreneurs.

Implications for research on structural holes theory

Xiao and Tsui (2007) and Batjargal (2010) pointed out that the collectivistic values of China undermine the ways in which brokers gain their information and control benefits that accrue to structural holes as originally described in the Western literature (Burt, 1992, 1997, 2000, 2002). Drawing on their work, we have further demonstrated how *guanxi* and structural holes coexist in a manner beneficial to the orchestration of knowledge in support of Chinese entrepreneurs on digital platforms. Thus, our second contribution is to complement the extant literature around structural holes theory by identifying this moderating effect of *guanxi*.

Although our results suggest that structural holes are indeed detrimental to the mobilisation and coordination of knowledge, we do not deny the significance of those associated hub

entrepreneurs who occupy a prestigious and advantageous position in their *guanxi* networks. Rather, we highlight that the value of a buffer zone, if and when it is created, can only be realised by a collection of integrators who are sitting at the center of diverse structural holes and are willing to fill these holes. Unlike those brokers who act as 'gatekeepers', controlling information inflow and outflow, we emphasise that Chinese integrators tend to serve as 'honest' brokers (Obstfeld, 2005) and 'pathfinders' (Xiao & Tsui, 2007). By opening the gate and bringing outsiders into a buffer zone, the otherwise isolated individuals around structural holes can be pulled together, and these dispersed, heterogeneous social and cognitive resources can be connected to benefit the *guanxi* network as a whole.

By teasing out the unique value that integrators bring to their *guanxi* networks, our study systematically presents how 'structural holes owners' become 'structural hole fillers' under the moderating influence of *guanxi*. Hence, we contradict the view of many Western scholars who have perceived such middlemen as typical brokers who take advantage of their position to reap personal benefit, who exercise control over "whose interests are served" (Burt, 2000, p. 354), and who manipulate the relationships to expand their own power by strategically playing off isolated individuals against one another (Frye, 2000).

Implications for research on *guanxi*

By revealing why business *guanxi* is so significant for the mobilisation and coordination of cognitive resources in digital platform settings, our study has indicated a fundamental difference between the "market coldness" of the Western mindset of human relations (Yang, 2002, p. 472) and "*Confucian* affection-oriented ethics" (Guo & Miller, 2010, p. 288).

Specifically, as part of the traditional *Confucian* culture emphasizing human affection, our findings highlight the role of business *guanxi* in offering a buffer zone for Chinese entrepreneurs on digital platforms. In such a buffer zone, around which resources flow in the form of favour exchange, *renqing* accumulation and *mianzi* preservation, these entrepreneurs tend to prioritise the ability to exhibit human affection, while considering those who depend merely on legal procedures as socially incompetent (Guo & Miller, 2010; Guthrie, 1998).

When entrepreneurs show respect for and comply with a tacit, subtle and everybody-does-it rule of reciprocal favour exchange to oil the wheels of resource mobilisation, they have more opportunities to obtain otherwise unavailable knowledge to evolve their products through technological innovation, better navigating the dynamism of platform settings.

Suggestions for digital entrepreneurs regarding relationship control

Uncovering the comparative advantages of family-or-friend *guanxi* and business *guanxi* in entrepreneurial start-up and growth stages provides a business implication for Chinese digital entrepreneurs in the control of relationships. According to Yoo et al. (2010), with a layered modular architecture, a digitised product can be both a product (component) and a platform at the same time, but not all digital entrepreneurs can simultaneously pursue both of these. Hence, the distinctiveness of the entrepreneurs depends on their capacity to build a digital product platform encompassing loosely coupled layers, which will attract different developers to remix digital components in support of digital innovation (Yoo, 2013).

Specifically, we suggest that those established entrepreneurs who are able to build a digital product platform should leverage their business *guanxi* to facilitate favour exchange, *renqing* accumulation, and *mianzi* preservation in order to develop sufficient incentives to attract heterogeneous developers to join their platforms and create third-party applications, while continuing to control the core components (Henfridsson & Yoo, 2014)

However, those smaller entrepreneurial firms who cannot afford a digital product platform should focus on creating novel components for an existing one until they have accumulated a sufficiently stable user base. Under such conditions, we suggest those start-ups utilise their family-or-friend *guanxi* to share, acquire and deploy useful knowledge resources in order to make themselves less vulnerable. Through the provision of emotional support and access to resources, kinship members and close friends can help nascent entrepreneurs decrease the cost of mobilising external knowledge across structural holes and lower the entry barrier for entrepreneurial start-ups in digital platform settings.

Implication for future research

The fact that we have not taken into account the issue of reverse causality represents an implication for future research in terms of the testing of the reverse hypotheses. The behaviour drives the outcome, but what about vice versa? We have corroborated that business *guanxi* creates more structural hole fillers, leading to enhanced knowledge coordination, but does this outcome of improved knowledge coordination promote stronger business *guanxi* and the creation of even more structural hole fillers in digital platform settings?

Theoretically speaking, business *guanxi* practice is embedded in entrepreneurs' social activities, and thus, traditional practices highlighting reciprocal exchange, such as gifting or banquets, are identified as major *guanxi* maintenance means in Chinese business environments. In traditional *guanxi* (Anderson & Lee, 2008), gift-giving is not bribery in the Western sense, but more about a reflection of the value placed on a relationship.

Buckley et al. (2006) proposed a new form of *guanxi* cultivation and maintenance that involves knowledge and information sharing. Specifically, frequent information exchange with business partners allows Chinese entrepreneurs to remain informed about their business associates' needs so as to better adapt to their business routines and practices. At the same time, the commitment to learn and adapt via knowledge sharing with business associates is a way of creating mutual trust, critical in maintaining *renqing*-based business *guanxi*. However, whether enhanced knowledge coordination leads to a stronger degree of business *guanxi* and a higher number of structural hole fillers in platform settings is still in debate and worth exploring.

In addition, we have corroborated that a large number of structural holes impede the mobilisation and coordination of knowledge, but does this outcome of attenuated knowledge mobilisation and knowledge coordination lead to the creation of a greater number of structural holes in the *guanxi* networks of Chinese entrepreneurs on digital platforms? Thus, we believe that a promising direction for future researchers is to examine the reverse hypotheses to deepen understanding of the interactions between *guanxi* network structures and knowledge orchestration, as well as to enhance the development of theory in relation to digital platforms.

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Appendix A. Demographic Profile of the Two Types of Survey Respondents

Characteristic	**Entrepreneurs at start-up stage (N=150)**	**Entrepreneurs at growth stage (N=175)**
Average company age (from 2016)	2.2 (min=0.7; max=3)	11 (min=4.5; max=27)
Average company size (no. employees)	16 (min=2; max=36)	151 (min=32; max=950)
Entrepreneurs with a PhD	90	110
Entrepreneurs with prior industrial experience	30	117
Entrepreneurs with R&D activities	50	125

Appendix B. Demographic Characteristics of the Participating Interviewees

Characteristic		**Number**
Company age	Less than three years old	23
	Three years or more	25
Company size	Less than ten employees	4
	Between ten and 500 employees	41
	More than 500 employees	3
Company	Digital games	14
function	Video software	15
	Mobile apps	19
Education	Doctor	32
background	Master	10
	Bachelor	6

Appendix C. Constraint (*c*) to Measure Structural Holes

Referring to the constraint (*c*) of Burt (1992) and Xiao and Tsui (2007, p. 14) for measuring structural holes, specific procedures were used. For an ego-centered network, we measured to what extent an alter (*j*) constrains the ego (*i*) through a multiplication of (1) "*i*'s investment in *j*", and (2) "the lack of structural holes around *j*", i.e., $Cij = (Pij + \Sigma q Piq Pqj)^2$ for $q \neq i, j$ "where *P*ij is the proportion of *i*'s relations invested in contact *j* and Σq*P*iq*P*qj is the proportion of *i*'s relations invested in contact *q* who are in turn invested in contact *j*". In addition, we used ΣjCij as a measure of network constraint that is summed over all the alters to measure to what extent the focal actor's network lacks structural holes. Finally, we adopted "(1-*c*)" to measure the number of structural holes. As a result, the eight name-generators yielded an average of 14 contacts in a respondent's *guanxi* network with a range of 8 to 24.

Appendix D. Survey Items.

Variable		Item	Source
Family-or-friend *guanxi*	**FG1**	My family or friends will try their best to help me out if my business is in trouble	Yen et al. (2011)
	FG2	My family or friends will take account of my feeling before making any decisions	Wong et al. (2003)
	FG3	My family or friends have been frank in dealing with me	
	FG4	My family or friends will lend me money if I am in need and will protect me from the opportunism of others	
	FG5	My family or friends will listen to my fears and worries	
Business *guanxi*	**BG1**	I am happy to provide a favour to business associates of my network with different social status who are in need	Yen et al. (2011)
	BG2	I feel obliged to return a favour to those business associates who have previously given me a favour	Mavondo & Rodrigo (2001) Hwang (1987)
	BG3	"Calling in" a previous favour is part of doing business with my business associates	
	BG4	Giving and receiving favours is critical in maintaining the relationship between my business associates and myself	
	BG5	I will feel '*mei mianzi*' (embarrassed) if I am unable to return a received favour to those favour providers	
	BG6	I will feel '*you mianzi*' (honoured) if I provide a requested favour to my business associates and introduce unknown, key contacts to one another	
Knowledge mobilisation	**KM1**	It is easy for me to explain to my network members a key idea, concept, or theory as well as new developments in my area of expertise	Dhanaraj & Parkhe (2006) Reagans & McEvily (2003)
	KM2	It is easy for me to follow and disseminate other network members' ideas either orally or via information technologies	
	KM3	It is easy for me to recognize and accommodate the different ways in which each other interprets and accepts the disseminated message	
	KM4	It is easy for me to receive and assimilate the shared information and knowledge resources, increasing my existing knowledge base	Seo et al. (2015)
	KM5	It is easy for me to pay attention to day-to-day use of my expertise for addressing problems in launching new applications on digital	Gluch et al. (2009)

		platforms	Hall et al. (1975)
	KM6	It is easy for me to consolidate the application of my expertise to address problems in rapidly scaling up applications on digital platforms	
Knowledge coordination	**KC1**	I have established a full understanding of each member's expertise as well as how each member's knowledge should be coordinated	Schutz et al. (2009)
	KC2	I have carefully interrelated practice-based expertise and actions to each other for strategic responses to technological changes in the platform architecture	Ou et al. (2008)
	KC3	I have understood how two or more ideas, concepts or theories from different specialties interact in a digital platform context	
	KC4	I have recognized potential connections between ideas, concepts or theories from different specialties, and elaborated the nature of these connections in ways specific to a platform-based setting	

Appendix E. Residual Centering Approach

A two-step procedure was outlined by Little et al. (2006) to carry out a residual centering approach that adopts residuals as product indicators to capture interaction terms. In the first step, we respectively multiplied an uncentered indicator of family-or-friend *guanxi* with that of structural holes, and an uncentered indicator of business *guanxi* with that of structural holes. This resulted in 11 product terms (FGSH: 5 and BGSH: 6). We regressed each of the 11 products on all indicators, saved the residuals of this regression in the data file and then named them 'res 1 1', 'res 2 1', etc. Overall, there were five residuals for the measurement of the latent product term variable – FGSH ('resf 1 1', 'resf 2 1', 'resf 3 1', 'resf 4 1', 'resf 5 1'), and six residuals for the measurement of the latent product term variable – BGSH ('resb 1 1', 'resb 2 1', 'resb 3 1', 'resb 4 1', 'resb 5 1', 'resb 6 1').

Second, we specified each latent interaction model. In each model, the five FG (or six BG) items were used as indicators of a latent FG (or BG) variable, one SH item as an indicator of a latent SH variable, and the five (or six) residuals as indicators of a latent product FGSH (or BGSH) variable. For each latent variable (FG, BG, SH, the latent product FGSH and the latent product BGSH), one factor loading was fixed to one to provide a scale for the respective latent variable. Furthermore, for the two latent interaction models, we respectively specified four (or five) error covariances between five (or six) pairs of residual product indicators. The covariances between the error of 'resf 1 1' (or 'resb 1 1') was fixed to zero. That is, an error correlation covariance was freed for the residual product indicators resulting from the multiplication of the same first-order effect items.

By referring to Finney and Distefano (2006), we conducted all the analyses with robust maximum likelihood (RML) and Satorra-Bentler corrected standard errors, with an attempt to correct the standard errors underestimated in non-normally distributed data (Hoogland & Boomsma, 1998; Satorra & Bentler, 1994). In this study, we involved the covariance matrix of the indicators and the asymptotic covariance matrix as input for the model.

Appendix F. Descriptive Statistics and Correlation Matrix of the Indicators

	Mean	SD	Skew	Kurtosis	1	2	3	4	5	6	7	8	9	10	11	12
1SH	3.469	1.290	1.782	-1.592												
2FG1	2.512	1.013	.921	1.182	.621											
3FG2	2.331	1.213	.934	1.432	.575	.543										
4FG3	2.413	1.123	.812	1.339	.475	.412	.501									
5FG4	2.679	1.117	.597	1.252	.629	.578	.439	.411								
6FG5	2.161	1.108	.919	1.311	.541	.632	.491	.511	.619							
7Res11	.000	1.381	-1.981	7.823	.000	.000	.000	.000	.000	.000						
8Res21	.000	1.301	-1.875	6.956	.000	.000	.000	.000	.000	.000	.871					
9Res31	.000	1.408	-1.923	9.121	.000	.000	.000	.000	.000	.000	.672	.594				
10Res41	.000	1.114	-1.295	10.116	.000	.000	.000	.000	.000	.000	.478	.513	.528			
11Res51	.000	1.467	-1.911	12.349	.000	.000	.000	.000	.000	.000	.691	.594	.491	.511		
12KM	1.302	1.231	1.934	3.712	.519	.692	.615	.719	.493	.522	.391	.412	.382	.441	.512	
13KC	1.201	1.119	0.612	2.811	.523	.402	.393	.321	.401	.509	.417	.392	.423	.501	.592	.231

	Mean	SD	Skew	Kurtosis	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1SH	3.258	1.183	1.619	-1.642														
2BG1	2.342	1.112	.981	1.981	.549													
3BG2	2.871	1.392	.921	1.310	.491	.485												
4BG3	2.912	1.019	.981	1.561	.501	.491	.582											
5BG4	3.129	1.31	.819	1.412	.712	.671	.601	.591										
6BG5	3.362	1.291	1.134	1.108	.812	.791	.788	.902	.793									
7BG6	2.132	1.451	1.145	1.109	.602	.681	.692	.777	.703	.781								
8Res11	.000	1.493	-1.992	6.793	.000	.000	.000	.000	.000	.000	.000							
9Res21	.000	1.211	-1.783	7.893	.000	.000	.000	.000	.000	.000	.000	.612						
10Res31	.000	1.023	-2.023	11.544	.000	.000	.000	.000	.000	.000	.000	.732	.592					
11Res41	.000	1.191	-1.182	9.399	.000	.000	.000	.000	.000	.000	.000	.692	.612	.721				
12Res51	.000	1.381	-1.612	9.213	.000	.000	.000	.000	.000	.000	.000	.594	.581	.651	.672			
13Res61	.000	1.251	-1.232	14.238	.000	.000	.000	.000	.000	.000	.000	.693	.681	.712	.782	.699		
14KM	2.201	1.389	1.872	6.121	.582	.343	.401	.492	.381	.372	.561	.449	.502	.492	.391	.501	.271	
15KC	2.692	1.119	1.792	5.192	.672	.612	.693	.413	.419	.423	.517	.492	.523	.408	.398	.495	.401	.211

It can be seen that all of the correlations between the indicators of the first-order effect variables family-or-friend *guanxi* and structural holes (or business *guanxi* & structural holes), and those of the product term FGSH (or BGSH) were zero, because the residuals, which were designed for the interactions terms, included no common variance with those first-order effect indicators.

Appendix G. Effects of FG, BG, SH, and the Respective Product Variables on KM & KC

Residual centering approach	Unstandardized		Standard error		z-value	
	KM	**KC**	**KM**	**KC**	**KM**	**KC**
FG	P3=.013	P4=.009	.018	.022	.698	.733
SH	P1=.021***	P2=.019	.009	.011	3.318	.865
FG×SH	P7=.051***	P8=.023***	.003	.006	1.784	4.268
BG	P5=.010	P6=.028***	.007	.010	1.675	1.302
SH	P1=.021***	P2=.019	.005	.011	1.201	7.191
BG×SH	P9=.021***	P10=.078***	.007	.004	4.129	13.143

Appendix H. Fit Statistics from Baseline Measurement Model Comparisons

Models	χ^2	DF	CFI	NFI	$\Delta\chi^2$	ΔCFI
Default model	311.688	98	.963	.948		
Model 1	333.627	106	.961	.944	21.939	-.002
Model 2	341.453	110	.960	.943	29.765	-.003
Model 3	353.982	113	.959	.941	42.294	-.004
Model 4	360.472	115	.958	.940	48.784	-.005

χ2 = chi-square discrepancy; DF = degrees of freedom; CFI = comparative fit index; NFI = normed fit index; $\Delta\chi^2$ = difference in chi-square, ΔCFI = difference in CFI.

In all measurement models, error terms were free to covary to improve fit and help reduce bias in the estimated parameter values. All models are compared to the default model.

Model 1: measurement means

Model 2: measurement weights

Model 3: measurement residuals

Model 4: factor means

Appendix I. The Overall Results Table for Hypothesis Testing

Independent variable	**Dependent variable**	**Hypothesis**	**Whole sample N=325**	**Start-up stage N=150**	**Growth stage N=175**
SH	KM	H1	Supported	**Highly supported**	Supported
SH	KC	H2	Supported	Supported	**Highly supported**
FG	KM	H3	Supported	**Highly supported**	Supported
FG	KC	H4	Supported	Supported	Supported
BG	KM	H5	Supported	Supported	Supported
BG	KC	H6	Supported	Supported	**Highly supported**
FG×SH	KM	H7	Supported	Supported	Supported
FG×SH	KC	H8	Supported	Supported	Supported
BG×SH	KM	H9	Supported	Supported	Supported
BG×SH	KC	H10	Supported	Supported	**Highly supported**