Collective and Individual Social Capital and the Impact on Incubator Tenants' Graduation

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Abstract

Incubator tenants usually lack established business relationships and legitimacy. Incubators, therefore, aim to aid tenants in forming meaningful relationships that will contribute to their development. The literature on incubator tenants, including their development, naturally focuses naturally on when they are in an incubator. Valuable insights have been made on how network-based incubation influences the performance of tenants. However, the relationship between networks and performance is ambiguous, and the choice of measure plays an important role. Graduation is a clear indicator of venture development in an incubator. Nonetheless, few studies have focused on the impact of tenants' relationships on graduation. This study focuses on the impact of social capital on the graduation of incubator tenants. It explores how tenants' relationships impact their graduation by investigating the collective and individual social capital of tenants. A structural equation model was employed to study the impact of social capital on graduation based on data from incubators in the Wuhan Donghu High-Tech Zone. This study's contributions are as follows: first, it provides insights into the impact of bonding and bridging social capital on tenants' graduation. Second, it sheds light on the different roles of the collective social capital of incubators and individual social capital of tenants and their contributions to tenants' graduation. Third, it provides a description of the heterogeneous mechanisms of individual social capital of tenants and their association with graduation.

Keywords Incubators · Tenants · Graduation · Social capital · Relationships · Network

Classification code L26 · O25 · O31 · O32 · O38 · M13

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Introduction

The importance of start-up firms in business networks has been well studied (see Bøllingtoft, 2012; Aaboen et al., 2017). Many start-up firms use incubators to help form a network conducive to their business development. Incubators have thus been identified as central actors that can provide legitimacy and social capital to tenant firms (Tötterman & Sten, 2005). The relationships formed with the help of incubators include those with other tenants, incubator management, service providers, business coaches, and, to some extent, investors. In addition, incubator tenants develop their own idiosyncratic network relationships (Shih & Aaboen, 2019) with universities, research institutions, and potential customers, suppliers, or other market actors. Overall, these relationships play a role in aiding these firms to become viable businesses. While valuable insights have been made on how network-based incubation influences the performance of tenants, the relationship between networks and performance is ambiguous, and the choice of measure plays an important role (see Eveleens et al., 2017). A clear indicator of tenant development in an incubator is graduation. Nonetheless, few studies have focused on the impact of incubator tenants' relationships on graduation. Several studies have examined the performance of former incubator tenants after graduation (e.g., Lasrado et al., 2016; Schwartz, 2013); however, evidence on the effectiveness of incubator tenants' networks on their graduation remains scarce.

Bandera and Thomas (2017) state that the social capital infusion to tenants in incubators is considerable, which in turn can lead to better performance after graduation. This is an interesting avenue for further study. Nonetheless, this depends on how the relationships formed through incubation are used (see Lasrado et al., 2016; Bandera & Thomas, 2017). Here, it is important to understand the impact of different types of relationships that the incubator helps the tenants form to graduate. The strength and quality of the relationships that an incubator tenant forms naturally differ. Some relationships are deep, while others are more superficial. The former is often referred to as bonding social or strong ties capital, while the latter is referred to as bridging social or weak ties capital (Granovetter, 1973; Lee, 2009). Moreover, in incubators, there are relationships at the collective and individual levels (Redondo & Camarero, 2019). The latter is associated with the idiosyncratic relationships that an incubator tenant forms (Shih & Aaboen, 2019). Against this background, this study explores how tenants' relationships impact their successful graduation from an incubator, addressing the following research questions:

- Does collective social capital impact tenants' graduation?
- Why and how does bonding and bridging social capital influence tenants' successful graduation?

To fulfill this purpose and answer the research questions, this study investigates the collective social capital of incubators and individual social capital of tenant firms located in the Wuhan Donghu High-Tech Zone in China. The data

were based on tenants' perceptions of the individual and relational levels. This study provides insights into the impact of bonding and bridging social capital on tenants' graduation. Light is also shed on the different roles of the collective social capital of incubators and individual social capital of tenants and their facilitation of tenants' graduation. Moreover, the study provides a description of the heterogeneous mechanisms of individual social capital of tenants and their association with graduation. The study finds that the collective social capital of the incubator and individual social capital of the tenant both contribute to the successful graduation of tenants. However, they play different roles.

The remainder of this paper is organized as follows. The "Literature Review" section discusses the interaction between collective relationships and individual relationships in the context of an incubator based on the theories of collective and individual social capital. The "Hypotheses" section develops hypotheses and a theoretical model that depicts the incubator's collective social capital, tenants' individual social capital, and successful graduation. The methodology, including the background and samples, data collection procedures, and variable measures, is presented in the "Methodology" section. The "Data Analysis and Results" section presents the data analysis and results. The "Discussion" section provides the details of the study, and the "Conclusions" section discusses the conclusions, including theoretical and policy implications, and suggestions for future research.

Literature Review

Social Capital

Social capital refers to the collective value generated by relationships and networks through mutual and shared values (Putnam, 1995). The literature on social capital identifies specific notions associated with the term. First, social capital implies opportunities for social connections. The more connected someone is, the more likely it is that this person will benefit from their financial and human capital (Burt, 1995). Second, social capital originates from norms, shared values, and trust, which are features of social organization, and facilitates coordination and cooperation for mutual benefit (Putnam, 1995). Third, social capital is a kind of goodwill that results from the structure and content of an actor's social relations. Hence, it is the structure and content of the network of relationships that individuals and groups can derive goodwill from (Adler & Kwon, 2002). Fourth, social capital is the sum of actual and potential resources embedded within the network of relationships through which individuals or social units can be available and derived from (Nahapiet & Ghoshal, 1998). In summary, social capital represents the available resources that an individual or a collective can derive from a social structure or network of relationships (Lin, 2001).

As Portes (2000) notes, the analysis of social capital can be made at the individual or collective levels. The social relationships that are associated with an individual or a single organization level (Redondo & Camarero, 2019) are referred to as individual social capital. Collective social capital refers to "assets and resources

available to the collective through either relationships within the social structure of the collective (i.e., group or organization) or network relationships that span boundaries to other collectives, and through which the collective may benefit” (Payne et al., 2011: 497). Moreover, social capital can be categorized into two types: bonding and bridging. Bonding social capital refers to relationships within organizations or communities and is inward-looking. Such relationships facilitate resource pooling and knowledge transfer. Bridging social capital are relationships across groups and organizations. It has the potential for actors to occupy “structural holes,” which helps them to acquire novel information (Redondo & Camarero, 2019).

Incubator Tenants’ Social Capital

Incubator tenants use social capital to access resources and grow and advance their goals (Hughes et al., 2007). Extant literature describes the origin of incubator tenants’ social capital in various ways (see Table 1 for an overview of earlier descriptions). For example, social capital is acquired from the network of the incubator, as well as the idiosyncratic relationships that the tenant already has or gradually forms (Bøllingtoft & Ulhøi, 2005; Shih & Aaboen, 2019). The incubator network generally consists of relationships with other tenants, service providers, funding actors, various mentoring resources, and technology partners (Lyons, 2002). These relationships are at the disposal of all incubator tenants. Incubator tenants’ idiosyncratic relationships can relate to more specialized service providers within a specific technological field, market actors, funding actors, or research groups (Laage-Hellman et al., 2020; Lyons, 2002).

The value generated by incubator tenants can be understood by their bonding and bridging activities (Redondo & Camarero, 2019). Table 1 describes the characteristics and connections between collective and individual social capital. Scholars have identified the importance of both types of social capital in the development of incubator tenants (Junaid, 2014; Redondo & Camarero, 2019). Tenants’ relationships at the collective level can impact an individual’s resource pooling, information sharing, and market development (Bøllingtoft, 2012; Redondo & Camarero, 2019). The assets and resources available at the collective level depend on the degree of relational trust; identity as a group; and reciprocity, which is the relational dimension of social capital (Ebbens, 2014; Nahapiet & Ghoshal, 1998). Lyons (2002) describes how the access to external networks of an incubator facilitates the formation of their own network of relationships. The tenants’ individual relationships, which have idiosyncratic characteristics, are integral for further business development (Shih & Aaboen, 2019). Tenants’ relationships using the lens of multiple levels of individual-collective social capital are illustrated in Fig. 1.

Nevertheless, the cause-effect relationship of incubation is still discussed. While some studies have examined the performance of former incubator tenants after graduation (e.g., Lasrado et al., 2016; Schwartz, 2013), evidence on the effectiveness of incubator tenants’ networks on their graduation remains inconclusive. Social capital formed during the incubation period can lead to better post-graduation performance. Nonetheless, this depends on how the relationships formed through incubation are

Table 1 Origin, typology, and performance of tenants' social capital

Literature	Origin of social capital	Typology of social capital	Characteristics and connection between collective social capital and individual social capital	Performance of social capital	Methodology	Measurement
Lyons (2002)	<p>1. Relationships between tenant and other tenants, business partners, business development centers, universities, technical colleges, consulting companies, creative partners, other enterprises, banks, lending funds, cities, counties, federal agencies</p> <p>2. Relationships between incubator and other incubators, financial service institutions, funds, universities, professional institutions, professionals, management experts, consulting companies, training institutions, markets, brokers, distributors, various associations, cities, counties, and federal agencies</p> <p>3. Trust and norms of group members</p>	Collective social capital; individual social capital	<p>1. The access to external networks of the incubator facilitates tenants to form own network of relationships</p> <p>2. The collective trust and norms within incubator could impact relationships among tenants</p> <p>3. The collective relationship among tenants could impact individual's resource pooling, information sharing, and market development</p>	Successfully launch new ventures	Case study	Not mentioned

Table 1 (continued)

Literature	Origin of social capital	Typology of social capital	Characteristics and connection between collective social capital and individual social capital	Performance of social capital	Methodology	Measurement
Bøllingtoft and Ulhøi (2005)	<ol style="list-style-type: none"> 1. Relationships among tenants resulting from communication and cooperation 2. Trust among tenants 3. Incubator's space layout 4. Non-hierarchical, bottom-up nature of incubator 5. Values on which the incubator is based 	Collective social capital; individual social capital	Incubator's space layout could impact trust among tenants, while the non-hierarchical, bottom-up nature of incubator could impact the common values on which the incubator is based, and trust and common values should facilitate cooperation and communication among tenants	Not mentioned	Case study and network metaphor	Not mentioned
Tøtterman and Sten (2005)	<ol style="list-style-type: none"> 1. Occupying the central location of the network 2. The macro-level relationships of the incubator as a community 3. Trust of all members 	Collective social capital; individual social capital	Not mentioned	Credibility and support to develop viable businesses	Case study	Structural, relational, and cognitive dimension of social capital
Schwartz (2013)	Incubator induced relationship formation and support	Collective social capital; individual social capital	Not mentioned	Incubator provides network resources but can also inhibit development	Control group study	Survival of incubator tenants vs. non-incubated firms
Studdard (2006)	Relationships between tenants and incubator managers	Individual social capital	Not mentioned	Improve tenants' reputation	Multi-regression	Not mentioned

Table 1 (continued)

Literature	Origin of social capital	Typology of social capital	Characteristics and connection between collective social capital and individual social capital	Performance of social capital	Methodology	Measurement
Hughes et al. (2007)	1. Relationships among tenants resulting from resource pooling 2. Relationships among tenants resulting from strategic involvement	Collective social capital; individual social capital	Not necessary interrelated	Radical innovation; technical innovation; process innovation; competitive ability development; competitive performance	Case study and ANOVA analysis	Relational dimension of social capital
Scillioe and Chakrabarti (2010)	Relationships formed through counseling interaction and networking interaction between tenants and incubator managers	Not mentioned	Not mentioned	Business assistance; technical assistance	Hierarchical regression	Relational dimension of social capital; structural dimension of social capital
Junaid (2014)	1. Features of the architectural design and configuration of the incubator space 2. Incubator manager leadership style 3. Psychological compatibility and degree of vision commonality between IM and client 4. Trust 5. Relationships between incubator management, tenants, and relationships between tenants	Collective social capital; individual social capital	Collective social capital positively impacts individual social capital	Not mentioned	Case study	Not mentioned

Table 1 (continued)

Literature	Origin of social capital	Typology of social capital	Characteristics and connection between collective social capital and individual social capital	Performance of social capital	Methodology	Measurement
Ebbers (2014)	1. Relationships of goodwill and reciprocity	Collective social capital; individual social capital	Not mentioned	Receiving business contracts; giving business contracts	Poisson regression	Not mentioned
	2. Network structure					
Lasrado et al. (2016)	3. Internal solidarity of network members					
	Incubator induced relationship formation and support	Individual social capital	Not mentioned	Incubator provides network resources and builds connectivity and legitimacy	Control group study	Survival of incubator tenants vs. non-incubated firms
Redondo and Camarero (2019)	1. Overall relationships among tenants	Collective social capital; individual social capital	Incubator's relationships impact the tenant's bonding and bridging relationships	Incubator tenants' management efficiency	Structural model	Relational dimension of social capital; bridging and bonding ties
	2. Relationships between tenants and incubator managers					
	3. Relationships between tenants and other actors					
	4. Relationships between tenants and external services providers					

Table 1 (continued)

Literature	Origin of social capital	Typology of social capital	Characteristics and connection between collective social capital and individual social capital	Performance of social capital	Methodology	Measurement
Shih and Aaboen (2019)	1. Relationships within the incubator 2. Relationships between tenants and generic service providers (the incubator's relationships) 3. Tenants' idiosyncratic external relationships	Incubator relationships; incubator tenants' idiosyncratic relationships	Incubator's relationships impact the incubatee's bonding and bridging relationships. The internal networking can inhibit development and individual external networking. Therefore, it becomes important for further value creation and understanding of business logic	Resource combination and business development	Case study	Not mentioned

Fig. 1 Tenants' relationships using the lens of multiple levels of social capital

being used (see Lasrado et al., 2016; Bandera & Thomas, 2017; Theodoraki et al., 2018). Here, it is important to understand the impact of different types of relationships that the incubator helps the tenants form to graduate. For instance, Scillitoe and Chakrabarti (2010) discuss the need for external networking for technological know-how skills, while learning buyer preferences was best enabled by counseling within the incubator. Redondo and Camarero (2019) offer a partial explanation of relationship dynamics, exploring how the incubator's social capital impacts individual tenants' bonding and bridging activities. The study finds that collective social capital fosters individual social capital, but bridging social capital improves tenants' management efficiency. As social capital at the individual and collective levels interact with each other (Payne et al., 2011), an avenue for further study is how they do so for incubator tenants. Table 1 summarizes some key aspects of the role and performance of social capital in the context of start-up incubation.

The following section proposes hypotheses and a model to investigate how the incubator's collective relationships impact tenants' individual relationships and how relationships at the collective and individual levels facilitate tenants' graduation.

Hypotheses

Collective Relationships, Individual Bonding Relationships, and Tenants' Successful Graduation

Tenants use internal and external relationships to access resources, reduce uncertainty, and obtain information (Soetanto & Jack, 2013). Bandera and Thomas (2017) note that incubators can play an important role in helping incubator tenants form these relationships. However, the evidence does not unilaterally support the idea that tenants receive these benefits. For example, Johannisson et al. (1994) describe how science parks and incubators are less relevant network arenas than industrial districts for entrepreneurial firms.

Gaining business intelligence and resources is a function of the degree of trust, identity as a group, and reciprocity between actors (Nahapiet & Ghoshal, 1998). As Hughes et al. (2007) note, incubator firms cannot generally gain more resources than they are willing to commit. In other words, the amount of their sharing underpins their return in the "resource pool." A higher degree of trust, identity, and reciprocity

among tenants allows for more resources to be shared, and the higher the value returns brought by resource pooling. This, in turn, further facilitates extensive strategic network involvement at the collective level. Under favorable interactive conditions, incubator tenants can enjoy exploratory learning, which results in information dissemination and knowledge transfer. Hence, trust, identity as a group, and reciprocity among incubator firms underpin resource pooling and strategic network involvement (Hughes et al., 2007). The solid collective relationships formed among incubator tenants facilitate resource pooling and information sharing, which enable tenants' growth and possibilities for graduation (Eveleens et al., 2017). Hence, the following hypothesis was tested:

H1: The relational dimension of the collective social capital of an incubator has a positive impact on the successful graduation of incubator tenants.

Meaningful relationships between actors are based on a certain level of trust, which takes time to form (Carson et al., 2003; Öberg et al., 2020). Trust among incubator tenants can strengthen their identity as a group and reciprocity (e.g., Cooper et al., 2012). When trust, identity as a group, and reciprocity are formed in relationships, weak ties can evolve into strong ties that entail closer cooperation (Soetanto, 2019). Trust also infers less opportunism when actors share resources, confidential information, and knowledge in cooperative activities. Trust results from ongoing exchanges and trustworthy behavior between partners (Brett & Mitchell, 2019). Reciprocity among incubator tenants can be viewed in terms of resources and knowledge reciprocity. Resource reciprocity is based on resource pooling (Hughes et al., 2007). The benefits of resource pooling are approximately equal to the willingness to contribute. Therefore, it is likely that resource pooling results in strong and close relationships. Knowledge reciprocity relates to benefits from knowledge transfer, for example, in the process of learning by doing. When incubator tenants engage in close cooperation, they become closely knit. Hence, the following hypothesis was tested:

H2: The relational dimension of the collective relationships of an incubator has a positive impact on the bonding social capital of incubator tenants.

The stronger the relationships, the easier it is to engage in resource pooling and knowledge transfer and subsequently to gain benefits from networking activities (Soetanto & Jack, 2013). Strong relationships make the "collective action dilemma" and free riding phenomenon less accentuated, and actors are more willing to share information and access to other actors. Moreover, strong relationships help maintain stability in the network and decrease the number of opportunistic actors. Deepened knowledge and idiosyncratic information can be easily embedded in a stable network (Tötterman & Sten, 2005). For example, prior knowledge of what strategies have worked out well is shared more efficiently in networks with stronger relationships between actors (Nahapiet & Ghoshal, 1998). Hence, the following hypothesis was tested:

H3: Incubator tenants' bonding social capital has a positive impact on tenants' successful graduation.

Fig. 2 Process of triadic closure

Bonding Relationships, Bridging Relationships, and Incubator Tenants' Graduation

Close relationships between incubator tenants mean that they are more likely to introduce new external partners into the existing network (Peng et al., 2016). According to the notion of triadic closure, two people with a common friend will tend to have a triadic friendship in the future (Neumeyer et al., 2019). Hence, strong and close relationships between tenants will increase the likelihood that they act as “brokers” between other tenants and external actors (see Fig. 2).

As Peng et al. (2016) note, by studying entrepreneurial companies, personal networks often strengthen business networks at the firm and market levels, setting conditions for bridging relationships. Hence, the following hypothesis was tested:

H4: Incubator tenants' bonding social capital has a positive impact on tenants' bridging social capital.

Incubators can help tenants with possible access to external networks such as customers, investors, research partners, and other external actors (Soetanto & Jack, 2013). Such connections act as sources of new resources and novel knowledge for incubator tenants and are considered tenants' bridging social capital (Hughes et al., 2007). Hence, tenants' bridging social capital functions as an opportunity to gain access to a broader external resource base. Tenants' bridging social capital facilitates explorative learning across boundaries, which rarely occurs internally. As bridging social capital means a higher likelihood of acquiring novel knowledge, access to financing opportunities, or new market opportunities, it can possibly result in tenants' successful graduation by eliminating resource bottlenecks and knowledge constraints. The benefit of bridging capital has also been well described in the sociological literature, that is, the strength of weak ties (see Granovetter, 1973). Hence, the following hypothesis was tested:

H5: Incubator tenants' bridging social capital has a positive impact on their successful graduation.

To sum up the hypotheses, we formulate the following theoretical model, as illustrated in Fig. 3.

Fig. 3 Theoretic model

Methodology

Background and Sample

Data were collected from incubators located in the Wuhan Donghu High-Tech Zone. The Wuhan Donghu New Technology Entrepreneurship Center was established in 1987 and is China's first incubator. Today, there are 45 incubators in the Wuhan Donghu High-tech Zone. Fifteen incubators are governed at the state level and 30 at the provincial level. Additionally, there are 15 accelerators in the Wuhan Donghu High-Tech Zone. Altogether, there are more than 5000 tenants located in the incubators, which cover an area of approximately 4.5 million square meters. Of the tenants, more than 3800 have successfully graduated from incubators (<http://www.wehdz.gov.cn/doc/2018/12/13/13465.shtml>).

In Hubei province, where Wuhan is the provincial capital (see Fig. 4), there were 192 incubators, including 45 at the state level. These had a total of 10,344 incumbent firms at the end of 2018.¹ Hence, a quarter of incubators and half of the incubator firms in the Hubei province are located in the Wuhan Donghu High-tech Zone (Fig. 5). Therefore, the Wuhan Donghu High-tech Zone is an appropriate context for studying entrepreneurial behaviors as well as networks resulting from incubator interactions.

¹ <http://www.chinatorch.org.cn/kjfw/tjsj/201912/821a6e5045a942c9a378d5ae3fbffc27.shtml>

Fig. 4 Hubei province and Wuhan (source: www.wnyc.org)

Data Collection

Business incubator regulations issued by the Ministry of Science and Technology of the People's Republic of China stipulate that the local science and technology departments oversee the macro-level management and guidance of incubators located in their administrative districts. Access to incubators in the Wuhan Donghu High-Tech Zone was granted by an executive in charge of the macro management of the incubators at the local Science and Technology Department.

We started data collection using a basic online questionnaire as a pre-test. The questionnaire was accessed by respondents through a QR code generated by the website “Wenjuan start.” The questionnaire, which took about 5 min to complete, included 10 scoring items and a series of questions related to demographics (the first 17 responses were part of the pre-test and were not included in the final study). Based on the pre-test, we adjusted the sample and identified 45 incubator managers within the administrative district. With the help of the executive at the local Science and Technology Department, the QR code was distributed to incubator managers via the application “WeChat,” which in turn was distributed to incubator tenants. The distribution by the executive enabled high response rates, and almost all entrepreneurs responded. There were 153 responses at the end of March 2017. After managers reminded incubator tenants to respond in April of the same year, another 93 responses were received. In total, there were 246 valid responses.

Fig. 5 Incubators and tenants in Hubei province and Wuhan Donghu High-Tech Zone (Tenants located in the incubators are about 10,344 and 5000, respectively. Their values are reduced by a factor of 1000 to facilitate the display of the relative ratio of the two)

After receiving the questionnaires, we cross-checked the incubator logs and archives to trace the status of tenants since 2017. At the end of July 2020, we obtained the final status of all tenants that included 63 successful graduations, 148 failures, and 35 censored (information missing or dropped out).

Building trust (Cooper et al., 2012), developing networking skills (Tello et al., 2012), and identifying joint benefits and interests (Sá & Lee, 2012) is a time-consuming process. We excluded seven successful tenants from the final sample as they spent less than 12 months in the incubator. Through discussions with incubator managers, a commonly accepted view was that networks usually stabilize after 12 months. Hence, the samples whose network had come into being after 12 months could provide more robust theoretical insights.

The final sample consisted of 56 firms that successfully graduated from the incubator. We also calculated the duration spent in incubators of valid firms through incubator logs and archives. There were nine successful tenants whose duration ranged between 13 and 24 months, while the remaining 47 tenants graduated after 24 months. There were 51 tenants that failed between 13 and 24 months, while the remaining 97 tenants failed after 24 months (no tenants announced failure within 12 months). Among the 35 censored tenants, seven were censored between 13 and 24 months, while the other 28 were censored after 24 months, and no tenants were censored within 12 months (Fig. 6).

Fig. 6 Demographic statistic of status and duration

Variables Measures

Tenants' successful graduation is a binomial variable (Schwartz, 2013; Vanderstraeten et al., 2016): 1=successful graduation; 0=failure or data censorship. Inspired by Redondo and Camarero (2019), tenants' bonding social capital was measured by the question "how many other tenants have kept close contacts with you?" Tenants' bridging social capital was measured using two items on a seven-point Likert scale: (1) I acquired the necessary social skills to engage with commercial communities while I was in the incubator and (2) My external commercial relationships multiplied while I was in the incubator. The relational dimension of the collective social capital of the incubator was measured with three dimensions of trust, identity with a group, and reciprocity (Nahapiet & Ghoshal, 1998). The measurement of trust and identity as a group were adapted from those in the study of societies (Chiu et al., 2006), and the measurement of reciprocity was adapted from those in the literature of Wasko and Faraj (2005). These are second-order constructs. These items are listed in Table 2.

When a second-order factor is used instead of a first-order factor to explain causality, the chi-square is bound to be larger, and the degree of freedom increases. We assume that a second-order factor is valid as long as the increment of χ^2 between M2-order and M1-order is not significant (Byrne, 1998: 287). When trust, identity as a group, and reciprocity are considered as first-order factors, the coefficient of each factor is between 0.44 and 0.52, and the goodness-of-fit (GFI) of M1-order is $\chi^2=71.93$, $df=17$, $\chi^2/df=4.232$, RMSEA=0.101, NNFI=0.91, and CFI=0.95. In contrast, if trust, identity as a group, and reciprocity are considered as second-order factors, the GFI of the M2-order is $\chi^2=28.12$, $df=17$, $\chi^2/df \leq 2$, RMSEA=0.024, NNFI=0.99, and CFI=0.99. The tests indicate that the two models are significant at the 95% level ($\alpha=0.05$, χ^2

Table 2 Constructs and measures

Constructs	Second-order constructs	First-order constructs	Author(s)
Collective relationships of incubator	Trust (x_{11})	I would not make use of my peers located on the incubator even when the opportunity arises (x_{111})	Chiu et al. (2006)
		We always abide by our commitment to our peers located on the incubator (x_{112})	
		We are consistent and honest to our peers located on the incubator (x_{113})	
		We are honest to other pees located on the incubator (x_{114})	
		As a member of tenants, I have a sense of belonging to them (x_{121})	
Individual relationships of tenants	Identity as a group (x_{12})	Our tenants contact with each other closely and intimately (x_{122})	Wasko and Faraj (2005)
		Our peers located on the incubator would help me as long as I ask for it (x_{131})	
		I could seek help from other peers located on the incubator even if the tenant I have helped could not help me in the future (x_{132})	
		I acquired the necessary social skills in order to involve in commercial communities when I have been a member of incubator (x_{21})	
		The external commercial relationships of mine have been multiplied when I have been a member of incubator (x_{22})	
			Redondo and Camarero (2019)

Chi-Square=20.12, df=17, P-value=0.026, RMSEA=0.024

Fig. 7 Second-order model. Note: C.R., collective relationship; tru, truth; ide, identity as a group; rec, reciprocity

(17)=27.59). Meanwhile, the values of GA are 0.83, 0.62, and 0.71, respectively (Fig. 7), which indicates that the correlation between the second-order factors and first-order factors is strong. The three dimensions of trust, identity as a group, and reciprocity could act as first-order factors to measure the collective relationships of tenants. According to the principle of simplicity, it is plausible to use the second-order model (Byrne, 1998: 287).

Common Method Variance

Due to the small number of variables in the study, common method bias is possible as the same person answers the questionnaires. Therefore, we conducted Harman's single factor to test for common method bias. If a single factor accounts for most of the variation, a common method bias might exist (Podsakoff et al., 2003). A factor analysis included all multi-item measurements, and the unrotated first principle factor explained only 39.7% of the total variation. Hence, a single factor could not account for most of the variation, which excluded the common method bias.

Data Analysis and Results

Validity of Measurement Model

Table 3 summarizes the descriptive statistics and internal consistencies (Cronbach's α). The Cronbach's α values of the constructs are all greater than 0.70, indicating acceptable levels of reliability (Nunnally, 1978: 124).

As noted in the "Variables Measures" section, the relationship dimension of collective social capital can be measured by second-order constructs: trust, identity, and reciprocity. Thus, the relationship dimension of collective social capital is a three-item measurement. Bridging social capital is a two-item measurement, while the other measurements are one item. Therefore, it is necessary to conduct a confirmatory factor analysis for multi-item measurements. The covariance matrix for the five items that measure collective and bridging social capital was analyzed using the maximum-likelihood method. The factor loadings in the measurement model are all greater than 0.70 (Table 4), which indicate that the reliability of each item is within acceptable levels (Nunnally, 1978).

Additionally, the constructs have high internal reliability, as the composite reliability coefficients of the constructs in the theoretical model are all greater than 0.70 (see Fornell & Larcker, 1981). The average variance extracted (AVE) coefficients are all greater than 0.50 (Table 5). The tests suggest that the items can explain the variance in the constructs (Fornell & Larcker, 1981).

Discriminant validity indicates the extent to which the measures of a specific construct are distinct from others in the same model. Discriminant validity is sufficient if the AVE of the latent variable is greater than the square of the correlation coefficients of the constructs (Fornell & Larcker, 1981). The AVE of the latent variables are 0.921 and 0.824, respectively (Table 5), while the square of the correlation coefficients (0.520) of the constructs is 0.721. This demonstrates adequate discriminant validity of the measurement model, which implies that the various constructs used in the model are distinct and separate. Moreover, the measurement model indicates that the fit values for RMSEA, CFI, GFI, AGFI, NFI, and NNFI are acceptable (see Table 4). The tests reveal that the model is appropriate for explaining the relationships between the latent variables and observed variables. The constructs were used to study the causal model. A conceptual diagram of the basic causal model clarifying the hypothesized relationships is shown in Fig. 8.

Table 3 Means, standard deviations (S.D.), and internal consistencies of scale constructs

Latent variables	Observed variables	Means	S.D	Cronbach's α
Collective relationships of tenants (x_1)	Trust (x_{11})	1.865	1.209	0.977
	Do not make use of each other (x_{111})	1.862	1.162	
	Abide by commitment (x_{112})	1.840	1.264	
	Be consistent (x_{113})	1.862	1.258	
Identity as a group (x_{12})	Be honest (x_{114})	3.467	1.409	0.957
	Have a sense of belonging to team (x_{121})	3.482	1.472	
	Contact with each other closely and intimately (x_{122})			
Reciprocity (x_{13})	Help me as long as I ask for it (x_{131})	3.006	1.429	0.982
	Seek help from peers except those I have helped before (x_{132})	2.927	1.506	
Bridging relationships of an individual tenant (y_2)	Acquired the social skills that are necessary to involve in commercial communities (y_{21})	2.614	1.370	0.967
	Multiply my external commercial relationships (y_{22})			
Bonding relationships of an individual tenant (y_1)	How many other tenants have kept close contacts with you?	2.717	1.346	
		5.078	4.299	N.A

N.A. is not applicable

Table 4 Result of measurement model and goodness-of-fit (GFI)

Latent variables	Measurement items	Standardized loading	<i>t</i> statistic	Average variance extracted (AVE)	Composite reliability	GFI
Collective relationships of tenants (ξ_1)	x_{11}	0.961	18.421***	0.921	0.972	$\chi^2 = 11.990$ df = 4 $\chi^2/df = 2.997$ RMSEA = 0.099 GFI = 0.980 NFI = 0.990 IFI = 0.990 CFI = 0.990 RFI = 0.972
	x_{12}	0.960	18.633***			
	x_{13}	0.959	18.435***			
Bridging relationships (η_2)	y_{21}	0.862	13.124***	0.824	0.903	

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$.

Causal Model Results and Hypotheses Testing

The coefficients and error terms of the causal model are shown in Fig. 9.

The fit indices of the causal model are as follows: $\chi^2/df = 3.419$, RMSEA = 0.079, NFI = 0.973, NNFI = 0.961, GFI = 0.949, AGFI = 0.872, CFI = 0.980 (see Table 6). The fit is considered acceptable when the χ^2/df ratio is 2–5 (Kelloway, 1998: 363), the RMSEA value is less than or equal to 0.08 (Browne & Cudeck, 1993: 185), and the values of NFI, NNFI, GFI, AGFI, and CFI are greater than 0.90 (Bentler & Bonett, 1980). Although the value of AGFI is slightly lower than the recommended value of 0.90 (Jöreskog & Sörbom, 1996: 136), the fit indices show that the causal model demonstrates the cause-effect among the constructs in the theoretical model. Overall, the fit indices show that the causal model fits the data well enough to account for the relationships among the latent variables.

The hypotheses can be empirically examined using structural coefficients in the causal model (Fig. 8). Table 7 provides the paths, respective standardized parameter estimates, and *t* values.

H1 predicts the paths of the relationship dimension of collective social capital to the tenant's successful graduation. As the standardized path coefficient is negative ($\beta_{y3x1} = -0.010$) and insignificant, H1 is not supported. This suggests that the incubator's collective relationships do not directly impact the tenant's successful graduation.

Table 5 Correlation coefficient of latent variables and average variance extracted (AVE)

Latent variables	AVE	ξ_1	η_2
ξ_1	0.921	0.959	
η_2	0.824	0.520	0.907

The values on the diagonal are the square root of AVE of constructs; other values are correlation coefficients of constructs

Fig. 8 Conceptual diagram of basic casual model

H2 accounts for the path from the relationship dimension of collective social capital to the bonding social capital of individual tenants. This hypothesis is supported because the path coefficient is positive ($\beta_{1x1}=0.581$) and significant ($p<0.001$). As predicted, the results show a significant positive correlation between the collective relationships of the incubator and the bonding relationships of individual tenants. Therefore, the collective relationship of the incubator can facilitate the tenants to develop their own bonding relationships. These findings reveal that collective relationships underpin tenants' close external connections.

H3 predicts the path from bonding social capital to tenants' graduation. As the path coefficient is positive ($\beta_{3y1}=0.751$) and significant ($p<0.001$), the hypothesis is supported. The results show that, as suggested by H3, there is a significant positive correlation between the bonding relationships of individual tenants and their successful graduation. The findings reveal that the close external connections of individual tenants within the incubator positively impact the path to successful graduation.

Fig. 9 Path diagrams for casual model

Table 6 Fit statistics for the causal model

Statistics		RMSEA	GFI	NFI	CFI	NNFI	AGFI
Causal model	1.907	0.079	0.949	0.973	0.980	0.961	0.872
Threshold	≤ 2	≤ 0.080	> 0.90	> 0.90	> 0.90	≥ 0.90	> 0.90

H4 tests the path of bonding social capital to bridging social capital. This hypothesis is supported because the path coefficient is positive ($\beta_{y_2y_1} = 0.440$) and significant ($p < 0.001$). The result indicates, as predicted by H4, that there is a significant positive relationship between individual bonding connections and bridging connections when it comes to individual tenants within the incubator. This reveals that close links with other tenants help the tenant to act in a bridging role, that is, as a broker.

H5 accounts for the path from bridging social capital to tenants' graduation. This hypothesis is supported because the path coefficient is positive ($\beta_{y_3y_2} = 0.210$) and significant ($p < 0.001$). The results show that there is, as predicted, a significant positive correlation between bridging relationships and tenants' graduation. This finding illustrates that more bridging connections help tenants' graduation.

The Mediation Effects of Individual Social Capital

As the impact of the relationship dimension of collective social capital on tenants' successful graduation is not statistically significant in the full model, we further explore whether individual social capital (bonding and bridging social capital) has played a mediating role. To assess the mediation effect of individual social capital, the procedure shown in Fig. 10 was followed. First, we test whether X has a significant impact on Y. Second, we test whether the path coefficients of a and b are significant. If they

Table 7 Path, standardized coefficient, and hypothesis confirmation

Hypothesis	Path	Standardized path coefficient	t statistic	Results
H1	Relationship dimension of collective social capital $\rightarrow$ successful graduation ($\beta_{y_3x_1}$)	-0.010	-0.271	Not statistically significant
H2	Relationship dimension of collective social capital $\rightarrow$ Bonding social capital ($\beta_{y_1x_1}$)	0.581	9.789***	Supported
H3	Bonding social capital $\rightarrow$ successful graduation ($\beta_{y_3y_1}$)	0.751	15.508***	Supported
H4	Bonding social capital $\rightarrow$ Bridging social capital ($\beta_{y_2y_1}$)	0.440	6.189***	Supported
H5	Bridging social capital $\rightarrow$ successful graduation ($\beta_{y_3y_2}$)	0.210	4.862***	Supported

*** $p < 0.001$ level; ** $p < 0.01$ level; * $p < 0.05$ level

Fig. 10 Mediation effect

are both significant, it means that the impact of “X” on “Y” is partly fulfilled through mediator “M.” Third, we further speculate that if the co-efficient for path “C” is significant, then it is a fully mediated process. Otherwise, it is a partially mediated process. Fourth, we refer to Sobel test (Sobel, 1982) if the path coefficient of either “a” or “b” is not significant.

1. The mediation effect of bonding social capital

Regarding the impact of the relationship dimension of collective social capital of the incubator on tenants’ successful graduation, the findings show that the impact is positive and significant. This is supported by the results of the binary logistic regression analysis (Table 8).

Concerning the mediation effect of bonding social capital in the process, we have positive effects. In the full causal model (Fig. 8), the coefficients of path “a” and “b” are significant at 0.001 level, and the coefficient of path c is not significant at the 0.05 level. The results confirm that bonding social capital fully mediates the impact of the relationship dimension of collective social capital on tenants’ successful graduation.

2. The mediation effect of bridging social capital on tenants’ successful graduation, the results of the binary logistic regression show that the impact is positive and significant (Table 9).

With regard to the impact of bridging social capital on tenants’ successful graduation, the results of the binary logistic regression show that the impact is positive and significant (Table 9).

We further tested the mediation effect of bridging social capital in this process. In the full causal model (Fig. 9), the coefficients of paths “a” and “b” are significant at

Table 8 Binary logistic regression: the impact of RDCSC on tenants’ successful graduation

		B	S.E	Wald	df	Sig	Exp(B)	95.0% C.I. for EXP(B)	
								Lower	Upper
Step 1	RDCSC	0.876	0.135	41.768	1	0.000	2.401	1.841	3.131
	Constant	−3.976	0.534	55.424	1	0.000	0.019		

Variable(s) entered in step 1: RDCSC; RDCSC relationship dimension of collective social capital

Table 9 Binary logistic regression: the impact of BSC on tenants' successful graduation

		B	S.E	Wald	df	Sig	Exp(B)	95.0% C.I. for EXP(B)	
								Lower	Upper
Step 1	BSC	0.652	0.092	50.048	1	0.000	1.920	1.603	2.300
	Constant	-4.679	0.537	75.988	1	0.000	0.009		

Variable(s) entered on step 1: BSC; *BSC* bonding social capital

the 0.001 level, and the coefficient of path *c* is also significant. The findings suggest that bridging social capital partially mediates the impact of bonding social capital on tenants' successful graduation.

Discussion

Bandera and Thomas (2017) note that social capital plays an important role in the survival of new firms. Networked incubation has been widely studied, and the extant literature identifies incubators as dense sites of social capital (Eveleens et al., 2017; Redondo & Camarero, 2019; Tötterman & Sten, 2005). While valuable insights have been made on how network-based incubation influences and plays a role in the performance of tenants (Shih & Aaboen, 2019), the relationship between incubator networks and performance is ambiguous, and the choice of measure plays an important role (see Eveleens et al., 2017).

A clear indicator of tenant development in an incubator is graduation, which suggests that the firm is ready for the business world. Focusing on the impact of the incubator tenant's social capital on graduation is relevant as the firm's network will influence how it continues to develop. It is of particular interest to further the understanding of the impact of different types of relationships that the incubator helps the tenants form to develop and graduate (Redondo & Camarero, 2019). The strength and quality of the relationships that an incubator tenant forms naturally differ. Some relationships are deep, while others are more superficial (Aaboen et al., 2017). This study has analyzed the role of social capital for incubator tenants from two levels, the collective and individual, by asking two questions:

- Does collective social capital impact tenants' graduation?
- Why and how does bonding and bridging social capital influence tenants' successful graduation?

The findings provide insights into the impact of bonding and bridging social capital on tenants' graduation. They also shed light on the different roles of the collective social capital of incubators and individual social capital of tenants and their facilitation of tenants' graduation. Moreover, the study provides a description of the heterogeneous mechanisms of individual social capital of tenants and their association with graduation. It is demonstrated that the collective social

capital of the incubator and the individual social capital of the tenant both contribute to the successful graduation of tenants. However, they play different roles. This can be helpful in explaining the inconsistent results of studies (e.g., Lasrado et al., 2016; Schwartz, 2013) that seek to verify whether firm survival is improved by gaining social capital from incubators.

Our study suggests that the mechanisms of social capital need to be understood at a more granular level. For example, an incubator's collective relationships do not directly impact the tenant's successful graduation. Nevertheless, the collective relationships of the incubator can facilitate the tenants to develop their individual bonding relationships. This finding has been described by other scholars that describe the important role of incubators in helping tenants form networks (Öberg et al., 2020; Soetanto & Klofsten, 2021). Strong collective social capital, characterized by collective trust, identity as a group, and reciprocity in an incubator, enables exchange and learning, which aligns with the description of Bøllingtoft and Ullhøi (2005).

Bonding social capital at the collective level also means a higher likelihood of forming individual bonding capital that is positively correlated with successful graduation. The results reveal that strong collective relationships in the incubator will facilitate tenants forming individual external relationships, which in turn increases business viability. As Shih and Aaboen (2019) note, idiosyncratic relationships are particularly important for business survival. On this note, the empirical study suggests that the ability to form individual external relationships is positively correlated with successful graduation during the time in the incubator. This confirms the results of extant research (see Payne et al., 2011; Redondo & Camarero, 2019).

In addition, our study demonstrated a significant positive correlation between individual bonding and bridging relationships for individual tenants. This suggests that close links with other tenants will help the tenant act in a bridging role. This mechanism has also been suggested by Lyons (2002). Moreover, there was a significant positive correlation between bridging relationships and tenant graduation. This finding coincides with the important role of bridging relationships, that is, weak ties, as described in social network analysis (Granovetter, 1973; Liu, 2015; Liu et al., 2015). An explanation for the important role of weak ties is that strong network relationships might lead to inertia and difficulties in changing (see Abosag et al., 2016). It is, therefore, necessary for incubator tenants to develop outward looking activities, especially for firms in formative stages.

Conclusions

Implications

This study has demonstrated that the collective relationship base is a source for incubator tenants to develop their own relationships. Stimulating interaction and cooperation among tenants should be prioritized in incubators by incubator management and policymakers. Incubator management can be accomplished by organizing various formal or informal social activities that enable tenants to access heterogeneous social groups within the incubator. The shorter average distance and reachability

between actors enable interaction and cooperation among network actors (Neumeyer et al., 2019). Hence, frequent interaction and cooperation are effective measures for cultivating empathy and mutual benefits, which can build trust, group identity, and reciprocity (Redondo-Carretero & Camarero-Izquierdo, 2017). Incubators should promote strong collective relationships in the incubator (see Öberg et al., 2020). At the same time, it is also imperative, as shown in our study, that tenants form individual external relationships, which can in turn be facilitated by strong bonding relationships. This will, in turn, increase chances for graduation, but primarily, as Shih and Aaboén (2019) note, promote business viability.

Policymakers play an important role in establishing favorable conditions at the system level, such as reducing opportunism and intellectual property theft. Incubator management could also lay more emphasis on their role of “network broker” (Van Rijnsoever et al., 2017) and act as “gate-keepers” to resolve freeriding behaviors. Another important aspect that incubator management should focus on is cultivating a culture conducive for interaction and cooperation. Here, the entrepreneur’s willingness to cooperate and complementarity play an integral role. The willingness to cooperate would push the tenants to engage in spontaneous interaction and cooperation, while their complementarity would pull tenants to share knowledge, ability, and equipment for mutual gain. Complementarity is always the driving force of tenants’ cooperation, whether the business incubator is a specialized (Schwartz & Hornych, 2012) or diversified one (Schwartz & Hornych, 2010). Moreover, as bonding social capital can lead to bridging relationships, incubator management should undertake measures to maintain and nurture existing strong relationships between tenants. This is associated with a “proactive continual model of co-production” as suggested by Rice (2002).

Limitations and Further Research

This study examined the connection between social capital and tenants’ successful graduation. Social capital has at least an indirect impact on tenants’ successful graduation (see also Bøllingtoft & Ulhøi, 2005; Bøllingtoft, 2012; Bruneel et al., 2012). These findings provide avenues for further research.

First, future research could seek to answer why and how collective and individual social capital have impacted incubator tenants’ innovation capability, market share, and human capital. It would be interesting to study how social capital has an impact on tenants’ core competitiveness, for example, by enhancing innovation capability (Eggers & Kaul, 2018), marketing of products, and human capital (Soetanto & Jack, 2018), which in turn influences tenants’ graduation. This demonstrates that social capital promotes the core competence of tenants. In particular, additional aspects of bridging are of particular interest. In our study, we were only able to test whether bridging positively correlates with the successful graduation of incubator tenants. Nonetheless, the question of how remains unanswered.

Second, the collective and individual relationship portfolios are dynamic (Soetanto, 2019). This study empirically verified the impact of these relationships on tenants’ successful graduation based on cross-sectional data. However, the study

does not consider the dynamics of the networks. Future research could employ longitudinal studies to exploit how the dynamic relationships and networks inside the incubator could impact the outcome of tenants' development.

Third, this study discusses the network of relationships using data collected at the individual and relational levels based on tenants' perceptions. It does not collect network-level data, which can limit some of the findings. Future studies could examine social capital and graduation by using direct data on networking activities.

Fourth, the study was based on data collected in Wuhan (Hubei region) and one of the oldest incubators in China. This may have impacted the broader generalizability of the results. The history and well-developed science and technology infrastructure in Wuhan provide opportunities for externalities that are generally only found in Tier 1 cities in China (e.g., Beijing, Shenzhen, Hangzhou, and Shanghai). In addition, the contextual conditions in China for entrepreneurship, technology development, intellectual property protection, and incentive structures differ from other developed countries in North America and Europe, which infer the challenges of directly transferring findings to other contexts. Hence, comparative studies of different regions (in China) as well as between countries could be of interest.

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Availability of Data and Material The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Code Availability Custom code

Declarations

Consent to Participate Informed consent

Consent for Publication Informed consent

Conflict of Interest The authors declare no competing interests.

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