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Internal Social Network, Absorptive Capacity and Innovation: Evidence from New Ventures in China

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Received: 30 December 2017; Accepted: 3 April 2018; Published: 5 April 2018

Abstract: This research investigates the impact of the internal social network on new venture's innovation by building a comprehensive structural equation modeling (SEM) that integrates three streams of research: internal social network, innovation, and absorptive capacity. Based on a sample of 279 new ventures from China, the current study's results show that absorptive capacity plays a full mediating effect in the relationship of the internal social network and innovation. Particularly, among the skill set of absorptive capacity, a mere skill of knowledge acquisition does not guarantee an enhancement of new venture's innovation. For new ventures to better utilize the social capital generated by the internal network in the process of innovation, they must focus more on the skills of knowledge digestion and knowledge application. The authors further separate the new ventures into two different sub-samples: the new venture supported by mature enterprises (M-type) and the independent new venture (I-type). This study's findings indicate that the effect of the social network on innovation through knowledge digestion is greater in the M-type sample than in the I-type sample; internal social network heterogeneity in general plays a less important role in improving a new venture's innovation than internal social network density, for both M-type and I-type new ventures.

Keywords: new ventures; internal social networks; absorptive capacity; innovation

1. Introduction

During the last decades, innovation has become one of the most critical skills for businesses to enhance their competitiveness and achieve success [1–3]. According to Cefis and Marsili [4], innovation is a main determinant of not only a firm's prosperity, but also its survival. Innovation is closely related to the sustainability of a firm, an industry and even the whole business environment. As Peter Drucker has put it, if an established organization, which in this age necessitating innovation, is not able to innovate, it faces decline and extinction [5]. Innovation, as defined by Thompson [6], is the generation, acceptance, and implementation of new ideas, processes, products, or service. By implementing innovation, firms may be able to create new markets and increase their business values [7], thus maintaining a sustainable competitiveness.

This is especially important for new ventures. Usually, start-up companies do not have a lot of resources at their disposal, or access to big platforms. To survive in today's increasingly competitive environment, new ventures must continually evolve to grow and deliver whatever it is that customers need or want. Innovating could create great value for customers and give those new ventures an edge over their competition, thus helping them grab a market share and create a strong

brand identity in the long run. Therefore, how to build sustainable innovation capacity for new ventures has attracted considerable attention from industry, as well as management scholars.

Among the numerous studies and reports on innovation, a general belief was that innovation processes are interactive processes [8]. The "interactive" here actually suggests a "social network" concept. To have an innovation project work out, it requires an active involvement of personnel from different organizational bases [9], such as scientists, designers, marketers, end users, and even external partners. According to Felix et al. [10], network could provide a good cross-functional structure for firms to implement new initiatives that need joint work from all employees and departments, such as social media marketing, innovation and so on. Previous research has greatly emphasized the effect of inter-organizational or external networks on firms' innovation [3,11–15], as external partners might provide a variety of supports to the innovative firm [16]. However, the fact that firms innovate based on their internal structure [17] is somewhat neglected; the generation of new ideas often starts within the firm and the implementation is necessarily controlled by the firm itself. Google is a typical example of an organization that is committed to utilizing "internal social capital", encouraging its employees to innovate from within rather than looking outside for new ideas. Google has attracted and retained a lot of creative talents in doing so, and quickly grew into a monopoly in the online space. The success of Google evidences the fundamental role of an internal social network in boosting innovation.

Numerous studies have provided evidence on how internal resources, such as human resources [18], technological capability [19], and so on, would affect a firm's innovation. Liu, Gong, Zhou and Huang [18], for example, investigated whether, how and when different types of a firm's human resource system jointly influence the employee's creativity. Chen and Huang [20] also indicated that strategic human resource practices have a positive effect on innovation performances via a firm's knowledge management capacity. Srivastava and Gnyawali [21] examined the paradox of technological capabilities, they showed that the benefits of portfolio resources are greater for firms with low technological capability. Bakar and Ahmad [22] sought answers to the question about which of a firm's resources contributes most to product innovation performance (PIP), and concluded that intangible resources are the main drivers of PIP in a Malaysian context. Carnabuci and Diószegi [23] investigated the relationship between internal social network position and an individual's innovative performance in a firm, and they showed that individuals with an innovative cognitive style are most innovative when embedded within a closed network of densely interconnected contacts. Carnabuci and Diószegi's study is more on an individual level, while the current research emphasized the effect of the internal social network at the firm level. Plenty of literature has also contributed in examining internal factors that might affect innovation in an organization from a resource-based view [24,25]. However, as an important firm resource, the internal social network did not receive adequate attention in innovation literature. The authors of the current paper tried to address this research gap by focusing mainly on the relationship of a new venture's internal social network and its innovation.

Another related research stream is the firm's absorptive capacity. There is increasing evidence in the academic literature that merely entering into network relationships does not increase innovation definitely [16]. Literature has studied the mediating role of knowledge management [26], ego–network dynamics [27], dynamic capability [28] and so on in the relationship between social network and innovation. The knowledge-based view believes that innovation is closely related to organizational learning [29], as the transference of knowledge among organizations might provide opportunities for further cooperation, and stimulate the creation of new ideas [9,30]. Absorptive capacity fosters a firm's absorption of technological knowledge and enhances its search for new ways to achieve new competitive advantages, thus is highly related to innovation throughout organizations [31]. Previous research has examined the critical role of absorptive capacity in enhancing a business unit's innovation [32–35], and highlighted the need for strong absorptive capacity in leveraging the shared knowledge for innovation [36,37].

Given the importance of firms' absorptive capacities in innovation, the authors proposed that a new venture's innovation could be jointly affected by absorptive capacity and the internal social

network. Previous literature has investigated the joint effect of absorptive capacity with other factors. Nieto and Quevedo [38], for example, demonstrated that the absorptive capacity variable determines innovative effort to a greater extent than technological opportunity and knowledge spillovers. Kotabe, Jiang, and Murray [39] also investigated the effect of absorptive capacity and the social network on innovation, and their results showed that absorptive capacity complements the social network in enhancing both incremental and radical innovations. However, they focused on the external social network with government, while the current study's focus is the internal social network.

The present paper is an attempt to provide a comprehensive framework that integrates these three research streams: internal social network, absorptive capacity, and innovation. By establishing a SEM model, the authors examine the interaction effects between absorptive capacity, internal social network, and their impacts on a new venture's innovation. More specifically, the authors examine the mediating effect of absorptive capacity in the relationship between the internal social network and innovation in new ventures.

In brief, the current research contributes to research in the following aspects. First, this paper focuses especially on the effect of the internal social network/resources on innovation for a new venture. Most previous studies have focused on the impact of the external social network in improving a firm's innovation [3,11–14]. Very little attention has been paid to the role of the internal social network on innovation. This paper examines two dimensions of the internal social network: internal social network density and internal social network heterogeneity. The results show that the internal social network density affects a new venture's innovation more than social network heterogeneity does. Second, scholars have considered different types of innovation [3], different aspects of social networks [14,40], or different types of knowledge [9] in examining the effect of the social network on innovation. However, to the authors' knowledge, no one has compared the results between different types of new ventures. This paper further separates the new ventures into two different types based on the business practices in China: the new venture supported by mature enterprises (M-type) and the independent new venture (I-type). The comparison of the two groups of new ventures shows that the impact of the internal social network on innovation is different across different types of new ventures. The total effects of network heterogeneity on innovation in M-type and I-type samples are 1.1% and 14.6% respectively. In contrast, the total effects of network density on innovation in M-type and I-type samples are 65.3% and 48% respectively. This could provide great insights to different new ventures as how to effectively improve their innovation based on limited resources. Third, the authors incorporate absorptive capacity in examining the relationship between the internal social network and innovation. Numerous studies have focused on the relationships between any two of these three streams [32,41,42], but few have taken all these three streams into consideration at same time. The authors closely investigate the mechanism as to how the internal social network affects a new venture's innovation by taking absorptive capacity into consideration, which provides great insights for new ventures to exploit their internal social capital to the full extent and to achieve sustainability by increasing their innovation. The authors highlight the full mediating effect of absorptive capacity in the relationship between social network and innovation.

The paper is organized as follows: Section 2 presents the theoretical background and establishes the framework for this study; Section 3 is concerned with the methodology; Section 4 describes the results and analyzes the findings; Finally, conclusions are given and further research concepts are identified in Section 5.

2. Theory and Hypotheses

2.1. Social Network and Innovation

Social network refers to a relational set of social actors. It could be the relationships between individuals in a group [43,44], or the relationships between individuals and groups [45], or even the relationships between organizations. The relations in the social network can be either formal or

informal. The formal networks usually refer to the relationship established by contract, consanguinity, and so on, whereas the informal networks are mostly set by emotion, friendship and so on. This paper examines the internal social network within an organization. Since formal and informal networks usually coexist within an organization, the authors focus on the interplay between group members in terms of both formal and informal relationships.

Social network is regarded as an important way to derive actual or potential resources [46]. Through the active participation of citizens or members in organizations, social capital as a collective resource can be created [47]. Previous literature has emphasized the positive effect of the social network, particularly the external network, on innovation. Scholars believe that most successful innovators invest in the breadth of accumulated knowledge and absorb information from all kinds of sources, not just external, but also internal [48]. The potential collaboration with external partners might facilitate the interactive learning process among firms [11] and help those firms get new skills [9]. Through social networks firms share knowledge that can improve their capacities for innovation [49,50], which leads to greater levels of both product and process innovations and creates a sustainable competitive advantage for firms [51]. Moreover, the implementation of new ideas greatly depends on coordination with external networks such as business partners, customers and suppliers [41,52–55]. Generally, researchers find that the external network has been positively correlated with innovation and performance of a firm [14,40].

The importance of the social network is especially highlighted when it comes to new ventures, as the social network may provide them with resources that are crucial to their growth, such as funding, information, and even opportunities [56]. Ostgaard and Birley [57] and Adler and Kwon [58] also empirically proved the important role the social network plays in new ventures.

While most of these researchers focus on the external linkages, this paper is trying address the effect of the internal social network on innovation. The resource-based view maintains that firm success is not only determined by external factors but also by its internal characteristics [59,60]. Previous studies have examined the effect of other internal resources on a firm's innovation. Bougrain and Haudeville [61] assess how internal research capacity helps a firm to exploit scientific and technical knowledge, and they find that internal research capacity might enhance the firm's ability to carry its project to success. The internal social network, also as a valuable internal resource, has been overlooked in the innovation research area.

Generally, the effectiveness of social network mechanisms is related to several dimensions, such as network diversity, network size and network density [62,63]. This paper focuses on the two main dimensions that have been extensively discussed in previous literature: the network density and the network heterogeneity. The first is used to illustrate the intensity of relations [64,65]. The second one describes the diversity of the relations.

Thus far, researchers have emphasized the importance of network density in improving a firm's performance. Mehra, Dixon, Brass, and Robertson [66] found that the density of friendship relations within an organizational group was positively related to group performance. Henttonen, Janhonen, and Johanson [67] echoed a similar conclusion. According to Luo [68], even a team structure with fully connected cliques can have a positive impact on performance. There are two main underlying reasons. First, members of highly dense networks are fully connected, which would foster the transference of information and cooperation between members [69,70]. A second reason, as pointed out by Coleman [70], is the high trust level between members that is facilitated by network density. It is easier for firms or groups to have better performances with more people sharing same belief and trusting each other, as proven by Reagans and Zuckerman [62], Zacharatos, Barling, and Iverson [71], and Snape and Redman [72]. To summarize, a high internal social network density would prompt knowledge sharing and improve the innovation of the firm. The authors believe that this general conclusion is also applicable to new ventures.

Hypothesis 1 (H1). Internal social network density has a positive effect on the innovation of a new venture.

There seems to be wide agreement that a diversified network will improve the innovation of a firm [14,42,73–75]. Regarding individuals, previous literature showed that heterogeneous networks

positively contribute to individual innovative performance [76,77]. Faced with the increasingly competitive world, firms also need both the width and depth of knowledge for successful innovation nowadays. A diversified network increases the variety of the information, resources, and knowledge accessed [3], which would in turn increase the innovation of a firm. Der Foo, Wong, and Ong state a new venture with higher heterogeneity is more dynamic [78]. Industrial economics supports the idea that heterogeneous structures affect the decision-making or behavior, which in turn affects innovation performance. According to organizational behavior theory, heterogeneity would also affect subsequent innovation activities and innovation processes. Moreover, researchers find that the more diversified the social networks, the higher the innovation level of a firm [14,40]. Therefore, this paper proposes the hypothesis as follows:

H2. Internal social network heterogeneity has a positive effect on the innovation of a new venture.

2.2. Absorptive Capacity and Innovation

The concept of absorptive capacity was first raised by Cohen and Levinthal [33,79]. It refers to the capacity that a firm recognizes the value of new information, assimilates it, and applies it to commercial ends. Absorptive capacity then has been explored in more areas, which led to a review of its definition in academia. Zahra and George [34] expanded the concept and further defined it as "a set of organizational routines and processes by which firms acquire, assimilate, transform and exploit knowledge to produce a dynamic organizational capability." According to Zahra and George [34], absorptive capacity includes two elements: (a) potential absorptive capacity, meaning the capacity that makes the firm receptive to acquiring and assimilating knowledge/information; and (b) realized absorptive capacity, which refers to a firm's function of transforming and exploiting the knowledge.

Based on the definition from both Cohen and Levinthal [33,79], Zahra and George [34], this paper summarizes three dimensions of the absorptive capacity: knowledge acquisition, knowledge digestion, and knowledge application. Among the three dimensions, knowledge acquisition and knowledge digestion are consistent with the definition of potential absorptive capacity in Zahra and George's model. Knowledge application is a generalization of a firm's capacity in transforming and exploiting knowledge. The current authors believe that these three dimensions are sufficient to characterize a firm's absorptive capacity.

Absorptive capacity is important in the process of innovation [80]. Many researchers stress that absorptive capacity contributes both directly [81,82] and indirectly [83,84] to innovation performance. Innovation is originated through enterprises' knowledge circulation (that is a process on inflows and outflows of knowledge) which facilitates the development, and even the commercialization, of internal innovation [85,86]. Innovation practices concern the inter-organizational exchange of knowledge and the inflow of external knowledge into an organization which requires absorptive capability [87,88]. Therefore, the process of creating a new technological knowledge cannot be efficient without a solid absorptive capacity [89]. The innovation process involves the acquisition, dissemination, and use of new knowledge [90–92]. Since absorptive capacity demonstrates a firm's ability in dealing with knowledge, the chances are high that the absorptive capacity is correlated with a firm's innovation.

An enterprise with higher absorptive capacity tends to adjust its internal organization to changes in its environment, to explore opportunities, even solutions, and to exploit innovation to meet its needs as well. According to Cohen and Levinthal [33], organizations with a higher level of absorptive capacity are more likely to harness new knowledge to help their innovation. Those firms have a higher ability to create new knowledge from the obtained knowledge. Moreover, Kim [93] notes that the absorptive capacity might help firms acquire information from their external partners and create new ideas from the transferences of knowledge. Evidence from high tech firms of the Pearl River Delta in China also has shown that absorptive capacity has a positive effect on a firm's innovation [94]. Therefore, a higher absorptive capacity might not only generate more profits from the knowledge it absorbed, but also enhance the firm's innovation [32].

H3. Absorptive capacity has a positive effect on the innovation of a new venture.

Absorptive capacity includes a firm's capacity for acquiring, digesting and applying knowledge. These elements of absorptive capacity play different but complementary roles in enhancing organizational performances [80]. The knowledge acquisition refers to a firm's capability to identify and acquire knowledge that is critical to its operations [34]. Even though knowledge acquisition capability does not generate a direct benefit to firms, it is a prerequisite for a firm to further utilize the knowledge. Knowledge digestion capability enables a firm to analyze, process, interpret and understand the knowledge obtained, which lays a foundation to transform the knowledge into innovation. Therefore, the authors propose the hypotheses below:

H3a. Knowledge acquisition has a positive effect on innovation.

H3b. Knowledge digestion has a positive effect on innovation.

Among the three elements of absorptive capacity, the knowledge application capability is more likely to have a direct effect on a firm's innovation. Knowledge application capability requires knowledge transforming and exploiting skills. The knowledge transforming skill helps firms to develop new blueprints of products with new information or technology, while the exploiting skill can help convert knowledge into new products [95]. Kazanjian, Drazin, and Glynn [96] also observe that firms need the skills of leveraging and recombining knowledge for product line extensions or new product development. Gao et al. [80] proved that firm's innovative activities are more likely to be enhanced when the firm has a higher level of knowledge transformation and exploitation capability. Therefore, the current authors believe that knowledge application skill is beneficial to firms in enhancing their innovation.

H3c. Knowledge application has a positive effect on innovation.

2.3. Social Network and Absorptive Capacity

Previous literature supports the theory that both the social network and absorptive capacity might improve the innovation of a firm. An interesting question naturally arises as to how the social network would interact with absorptive capacity in this system. The authors therefore propose the hypotheses on the relationships of social network and absorptive capacity in this section.

Absorptive capacity depends on the level of knowledge in the corporation [33]. As an endowment for firms, the internal social network could provide direct information, knowledge, and complementary resources for firms. Hence, previous studies focused on how the network would help a firm improve its absorptive capacity. The firm's centrality in a network of relationships naturally reflects the resources it can get from the network, for example. Powell et al. [52] find that the greater the firm's centrality, the easier for the firm to acquire information from the network, thus the higher the absorptive capacity. Burt [41] states that the structural holes in the social network will improve the firm's knowledge acquisition. Uzzi [97] believes that the weak ties in the network might incentivize firms to actively extend their networks, from which the firms might have more exposures to heterogeneous information and, thus, a higher ability to get new knowledge. Hein and Rauschnabel [98] propose a conceptual model to illustrate how enterprise social network can help increase knowledge sharing efficiency by adopting new technology. Furthermore, Dyer and Singh [99] and Jung-Erceg, Pandza, Armbruster, and Dreher [100] have emphasized the influences of social capital and inter-firm relationships on a firm's absorptive capacity (knowledge digestion and application) respectively.

This paper focuses on the density and heterogeneity aspects of the network. Network density refers to "the proportion of direct ties in a network relative to the total number possible" (Wikipedia.com). Network density could facilitate the build-up of trust and cooperation while constraining opportunism among members [101–103]. Thus, a dense network is advantageous for knowledge exchange and acquisition [104,105]. Additionally, network ties could also act as a device for screening and interpreting novel information, resulting in an enhanced absorptive capacity of the firm, especially the knowledge acquisition and digestion skills [106]. Even though some researchers

claim that a dense network would increase the redundancy of information [42], this redundancy plays a limited role as the key focus here is on finding and absorbing novelty, making considerations of efficiency less of an issue [103,107]. Therefore, network density, no matter internal or external, can help a firm with knowledge absorption and digestion.

Regarding the effect of network density on realized absorptive capacity (knowledge application), previous studies have provided some insights as well. According to Zahra and George [34], network density, or connectedness, might allow units to better transform and exploit new knowledge. By developing the trust and cooperation between members, network density could foster commonality of knowledge and encourage communication in organizations [105,108]. This might improve the efficiency of knowledge exchange and application throughout organizations. Moreover, members of a dense network usually have common goals; therefore, it is less likely to cause conflicts in utilizing knowledge and implementing innovation programs [109]. Thus, the authors propose that:

H4. Internal social network density has a positive effect on the absorptive capacity of a new venture.

H4a. Internal social network density has a positive effect on knowledge acquisition.

H4b. Internal social network density has a positive effect on knowledge digestion.

H4c. Internal social network density has a positive effect on knowledge application.

Network heterogeneity, or network diversity, is another aspect of social relations. It is generally believed that entrepreneurs with more diverse networks will get more support and thus are easier to success [13,110,111]. A similar conclusion is reached regarding the effect of network heterogeneity on absorptive capacity. First and foremost, a diverse network is favorable for firms in acquiring different types of knowledge. Burt [41] has stressed that accesses to these non-redundant contacts is of great benefit to obtain novel information (novelty value). Thus, it is reasonable to propose that network heterogeneity would secure the diversification of the organizational knowledge and facilitate potential absorptive capacity (knowledge acquisition).

Second, diverse knowledge structures support explorative learning and increase the prospect that new external knowledge is related to existing knowledge [112]. The more diverse an individual's external network, the easier it is to find the required knowledge and the more likely an individual will engage in transformation and exploitation activities, and the more likely they are to be exposed to potential new knowledge, which positively affects the recognition of new knowledge [33,113]. People with different backgrounds might have different understandings toward the new information. By sharing their perspectives and views with each other, it is easier for group with higher diversity to assimilate the new knowledge. Meanwhile, the interplay between members with diverse background would augment a firm's capacity for making novel linkages and associations [33]. Overall, the heterogeneity facilitates the digestion of new knowledge that constitutes potential absorptive capacity.

There are different views regarding the impact of heterogeneity on knowledge application in the process of innovation. On the one hand, a diverse internal social network suggests a variety of experiences, expertise and cultures. In most cases, employees with only certain expertise are not sufficiently competent to succeed with a whole project. Therefore, a diverse internal network with different expertise could play complementary roles in transforming the knowledge and applying the knowledge in innovation. Some research, on the other hand, has raised doubts on network heterogeneity. They argue that participation in decision making might have a negative effect on new product development speed due to the difficulty in gaining consensus [114]. A participation of diversified employees might hamper information-processing efficiency and negatively affect knowledge utilization [115]. The authors of this current paper think that there usually is an inspiring and determined leader in a new venture, thus making it less possible to have a consensus problem in decision making. Hence, the authors believe that a diversified internal social network, overall, would be beneficial to knowledge application in the innovation process.

H5. Internal social network heterogeneity has a positive effect on the absorptive capacity of a new venture.

H5a. Internal social network heterogeneity has a positive effect on knowledge acquisition.

H5b. Internal social network heterogeneity has a positive effect on knowledge digestion.

H5c. Internal social network heterogeneity has a positive effect on knowledge application.

Based on the hypotheses above, the authors proposed the following conceptual model (Figure 1).

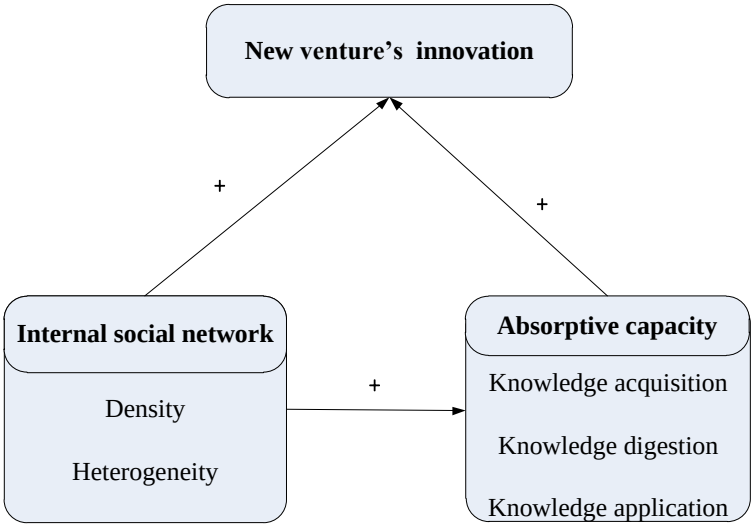

Figure 1. The conceptual model.

3. Methodology

To examine these proposed hypotheses, the authors conducted a survey among people working in new ventures in mainland China. A multi-item questionnaire was developed based on prior literature and the pilot survey. Following the validation of reliability and validity of the scales, data analysis was carried out with Amos.

3.1. Measurement

The survey measurements were composed of three major sections: (a) internal social network; (b) absorptive capacity; and (c) innovation. Altogether, the authors developed six constructs. The scales and items that were adopted for the present survey have been validated in prior empirical studies. Responses were measured on a well-established 5-point Likert scale ranging from "strongly disagree" (1) to "strongly agree" (5). The questionnaire was written in Chinese.

3.1.1. Internal Social Network

Two constructs regarding internal social network were included: internal social network density and internal social network heterogeneity.

The items for network density were adapted from Ke et al. and Peng et al., which included formal and informal contacts between group members [116,117]. Regarding formal contacts, the authors refer to the discussion meetings and coordination in work. Apropos of the informal contacts, the authors mean by informal discussions and personal relationships between the members.

Concerning items of network heterogeneity, the authors adapted the measurements from Zhang, Sun and Wang's research to suit the context of this research [118]. Respondents were asked if members (in their group/company) had large differences in the level of education, if members had different working experience; if members had different ways of thinking; if members had different years of working in this group; if members had differences in working styles, knowledge

sets, and experiences. The network heterogeneity was also measured by five 5-point Likert scales anchored by 1 = "Strongly disagree" and 5 = "Strongly agree." The measurement methodology was consistent with Jehn, Northcraft, and Neale [119].

3.1.2. Absorptive Capacity

Absorptive capacity refers to the ability of an enterprise to acquire external knowledge, combine, and assimilate it within the organizational setting [34]. This process enables enterprises to develop less in-house research and development activities [120]. Cohen and Levinthal [33] highlighted three main dimensions of the absorptive capacity. Consistent with Cohen and Levinthal, the authors developed three constructs: knowledge acquisition, knowledge digestion, and knowledge application. The items for these three constructs were adapted from Jansen, Van Den Bosch, and Volberda [121].

3.1.3. Innovation

Innovation has never failed to catch people's attention ever since the 1940s when Schumpeter deemed creative destruction at the heart of economic growth. Innovation has a broad definition. It could be both an outcome and a process. Zaltman, Duncan, and Holbek [122] and Rogers [123] believe innovation is more like a "result". According to their definition, innovation is an idea, practice, or material artifact perceived as new by the relevant unit of adoption. Amabile, Conti, Coon, Lazenby, and Herron [124] also define innovation as the successful implementation of creative ideas within an organization. Since the purpose of this paper is to help new ventures recognize the possible ways to enhance its performance, it must focus not only on the successful result but also the process of innovation. Therefore, the authors borrowed a more general definition of innovation from Thompson [6], that is, the generation, acceptance, and implementation of new ideas, processes, products, or services.

Measures of innovation were adopted from Chen [125] and then adapted to suit the context of the current research. The six items for innovation include: the frequency of new product (or service) development, the responsive feedback to customers' requirements, the improvement in a firm's performance, and the adoption of a new service, new technology, and new methods.

3.2. Procedure and Method

A combination of SPSS 24 and Amos software package 20.0 was used to carry out all the data analyses. A pilot survey was carried out first to assess the clarity of the questionnaire and its suitability to the participants. The questions that might cause ambiguity and confusion based on the feedbacks were rephrased. Furthermore, the authors conducted exploratory factor analysis (EFA) to identify the underlying factor structure with data from the pilot survey. Two items were deleted for innovation construct that caused low measurement quality, resulting in a questionnaire with 6 constructs (Appendix A1). Subsequently, the data was re-collected using the updated questionnaire. The confirmatory factor analysis (CFA) was conducted to assess the reliability and convergence validity of the measurement model based on the re-collected data. Following the confirmatory factor analysis, SEM analysis was carried out to test the hypothetical model. Last, a sub-group comparison analysis was conducted between M-type and I-type ventures in the extension.

3.3. Sample and Data Collection

The pilot survey was conducted based on a sample of 90 respondents in August 2015 of which 82.222% responded, and 75.556% were valid. Based on the pilot survey, the authors distributed the questionnaires in November 2015 to a sample of 279 respondents. The questionnaires were distributed both online and offline. The online questionnaire was created on wjx.cn, the most popular online survey service provider in China. The authors then sent out the online questionnaire to potential respondents who were working in new ventures via emails, chats, social media, and so on. Offline questionnaires were distributed mainly to part-time MBA students at Beihang

University (China). One item was added as the screening question regarding how many years the company the respondent working at has been founded. Responses from companies that existed for more than 5 years were not adopted. The authors also asked the respondents to specify the name of their company. The authors fully erased the respondents' details, dealing with their concern on privacy in distributing the questionnaire. In total, 230 questionnaires were retrieved. The authors excluded responses that: (a) reported same scale for every item; (b) were answered in a certain pattern; (c) had missing data, yielding a usable sample of 202. The survey covered new ventures from five provinces in China: Beijing, Shanghai, Tianjin, Shandong, and Hebei, providing a strong basis to conduct the next step of the analysis.

Table 1 demonstrates the demographic information of the respondents in detail. Among the 202 valid samples, 58.416% were male and 41.584% were female. Most of the respondents were 25–35 years old (75.743%) and were working in new ventures of a knowledge-intensive industry (63.366%); 92.574% of respondents received a higher education in universities (45.049%) or postgraduate schools (47.525%). Two types of new ventures in collecting data were identified: the new ventures supported by mature enterprises (M-type) and the independent new ventures (I-type). 54.555% of respondents were from M-type new ventures and 45.545% were from I-type new ventures. Regarding the size of their working teams, 38.119% of respondents reported a team number of 6–11 and 44.059% reported a team number that was larger than 11.

Table 1. Basic information of the sample (n = 202).

Variable	Category	Numbers	Ratio (%)
Gender	Male	118	58.416
	Female	84	41.584
Age	<25	32	15.842
	25–35	153	75.743
	>35	17	8.416
Education level	College or below	2	0.990
	Bachelor	91	45.049
	Postgraduate	96	47.525
	Ph.D. or above	13	6.436
Industry type	knowledge-intensive	128	63.366
	labor intensive	42	20.792
	capital-intensive	32	15.842
Venture type	M-type	110	54.455
	I-type	92	45.545
Number of team members	2–5	36	17.822
	6–11	77	38.119
	>11	89	44.059

4. Results

4.1.. Exploratory Factor Analysis

Exploratory factor analysis (EFA) is to identify the underlying factor structure of a set of observed data. To perform EFA, the authors first conducted validity analysis through KMO (Kaiser-Mayer-Olkin) and Bartlett sphere test. KMO indicates the amount of variance shared among the items designed to measure a latent variable when compared to that shared with the error. Kaiser (1974) recommends accepting values greater than 0.5 as acceptable [126]. Table 2 shows the KMO index >0.5 and the Bartlett test is statistically significant ($p < 0.01$), which indicates that the data have sufficient inherent correlations to perform exploratory factor analysis (EFA).

Table 2. KMO and Bartlett sphere test of the sample.

	KMO	Bartlett
Result	0.654	790.081 ***
Df		300

*** $p < 0.01$.

To understand the factor structure and the measurement quality, a principal component analysis was conducted with varimax rotation, and an evaluation of the eigen values was used to identify the number of factors to retain. Hair et al. (2006) suggests that an item should be removed if (1) the factor loading is lower than 0.5; (2) the item loads in two different factors at same time with both loadings higher than 0.4; and (3) the item does not load in a group to which it belongs [127]. Following this suggestion, two items of innovation construct were dropped. The final results show that all items were included on the correct factor with a load above 0.5. The identified factors correspond to the six constructs presented in the conceptual model. Detailed results of the EFA can be found in Appendix A2.

The reliability of measurement was also tested through the Cronbach alpha coefficient, which was assessed for each construct (Table 3). As all alpha values are above the recommended threshold of 0.70, the reliability of the data is established.

Table 3. Assessment of reliability.

Construct	Item	Cronbach α
Social network density	4	0.825
Social network heterogeneity	5	0.738
Knowledge acquisition	4	0.718
Knowledge digestion	4	0.803
Knowledge application	4	0.841
Group innovation	4	0.860

0.749

4.2. Measurement Assessment

To verify the factor structure, the measurement model for the constructs was tested using confirmatory factor analysis (CFA) with AMOS 20.0. To ensure that the model was a good fit, several indices were calculated, including Chi-square/degrees of freedom, Goodness of Fit Index (GFI), Comparative Fit Index (CFI), Tucker–Lewis Index (TLI), Incremental Fit Index (IFI) and Root Mean Square of Approximation (RMSEA). The results are summarized in Table 4, which indicates a reasonably good fit [127,128].

Table 4. Summary of the overall fit indices for confirmatory factor analysis (CFA) model. CFI: Comparative Fit Index; IFI: Incremental Fit Index; GFI: Goodness of Fit Index; RMSEA: Root Mean Square of Approximation; TLI: Tucker–Lewis Index.

Fitting Estimation	χ^2/df	CFI	IFI	GFI	RMSEA	TLI
CFA	1.218	0.974	0.974	0.903	0.033	0.967
Recommended value	<3	>0.9	>0.9	>0.9	<0.08	>0.9

Additionally, composite reliability (CR) was also calculated based on the standardized regression weights (factor loadings) by the CFA (Table 5). When the CR exceeds 0.60, it suggests that the measures could consistently represent the latent construct [129]. The results demonstrate the CR values of all the constructs in CFA range from 0.737 to 0.865, which indicates a good internal consistency [127].

Convergent validity refers to the correspondence or convergence between similar constructs, which can be examined in terms of the factor loadings and average variance extracted (AVE) score (Table 5). The analysis is usually regarded as acceptable if factor loading estimates and average

variance extracted (AVE) values are higher than 0.5 [127,130]. The AVE scores for constructs social network density, knowledge digestion, knowledge application, and innovation were 0.528, 0.503, 0.550, and 0.617 respectively, all of which met the threshold condition. The AVE scores of knowledge acquisition and social network heterogeneity did not reach 0.5. Deleting these two constructs might have made the statistical results look better; however, the authors still decided to keep the two constructs due to the following reasons: (a) even though the AVE values for social heterogeneity and knowledge acquisition were a little bit lower than 0.5, the results showed that all the indicators of knowledge acquisition and social network heterogeneity loaded significantly ($p <$ 0.001) and substantially (all factor loadings >0.5) onto their constructs in this model. Moreover, the AVE score of knowledge acquisition was quite close to the threshold (0.433). Previous literature has documented similar treatment to this by keeping the constructs [131]; (b) the authors might have missed out on some insightful conclusions about the social network and absorptive capacity if the authors deleted the two constructs. The authors were then able to show the different roles heterogeneity and density play in affecting a venture's innovation by considering the heterogeneity in the current model. Additionally, by considering the knowledge acquisition dimension, this study can provide full insights to new ventures as to how absorptive capacity plays a role in the relationship of an internal social network and innovation. Furthermore, given the two constructs were strongly supported in the literature (see Section 2), the authors decided to keep the constructs.

To recapitulate, the confirmatory factor analysis indicated a satisfactory level of reliability and validity overall, as well as an adequate model fit, meaning that the model was valid. Therefore, it was appropriate to conduct the next step, structural model analysis.

Table 5. Reliability and validity of the measurements.

Construct	Item	Factor Loading	1-R2	CR	AVE
Social network density	SND1	0.682	0.534	0.813	0.528
	SND2	0.819	0.329		
	SND3	0.838	0.298		
	SND4	0.524	0.726		
Social network heterogeneity	SNH1	0.563	0.683	0.737	0.362
	SNH2	0.608	0.630		
	SNH3	0.718	0.485		
	SNH4	0.528	0.721		
	SNH5	0.575	0.669		
Knowledge acquisition	KAC1	0.620	0.615	0.751	0.433
	KAC2	0.781	0.390		
	KAC3	0.631	0.601		
	KAC4	0.581	0.663		
Knowledge digestion	KAS1	0.657	0.569	0.800	0.503
	KAS2	0.619	0.617		
	KAS3	0.735	0.460		
	KAS4	0.811	0.342		
Knowledge application	KAP1	0.683	0.533	0.829	0.550
	KAP2	0.834	0.304		
	KAP3	0.801	0.358		
	KAP4	0.630	0.603		
Group innovation	GIP1	0.791	0.374	0.865	0.617
	GIP2	0.837	0.299		
	GIP3	0.758	0.426		
	GIP4	0.753	0.433		

4.3. Structural Model Assessment

The authors used structural equation modeling (SEM) with software AMOS 20.0 in this paper to test all the hypotheses. Introduced in the 1960s and 1970s, SEM has been extensively used in sociology, psychology, and other social sciences [132]. SEM includes a diverse set of mathematical models, computer algorithms, and statistical methods that fit networks of constructs to data (Wikipedia.com). There are two main reasons why the authors adopted SEM in this paper. One of the reasons is that SEM is able specify relationships between unobserved constructs (or latent variables) from observable variables [133]. There are latent variables, like network density, in this paper that could not be measured directly. SEM could help deal with those latent variables and test the hypotheses using the observed data. Next, SEM is considered as one of the most significant techniques in understanding multiple relationships [134]. In the proposed hypothetical model, there are both direct relationships and indirect relationships. SEM allows the authors to test the overall theory as well as specific relationships between observed relationships.

4.3.1. Conceptual Model Analysis

The conceptual model and hypotheses were evaluated by structural model analysis with maximum likelihood estimation. The overall model fit was assessed in terms of same fit indices as above. According to the results, the Chi-square/degrees of freedom had a value of 1.305, which is below the recommended criteria of 3. The statistics for CFI, IFI and TLI are 0.962, 0.963, and 0.954 respectively. The value of RSMEA is 0.039. These indices demonstrate that the model is a good fit with the observed data.

The statistical significances of path coefficients were also examined. Figure 2 depicts the standardized regression coefficient of each path together with its significance. According to the squared multiple correlation coefficients (R^2), 58% of the variance in innovation can be explained by the hypothetical model.

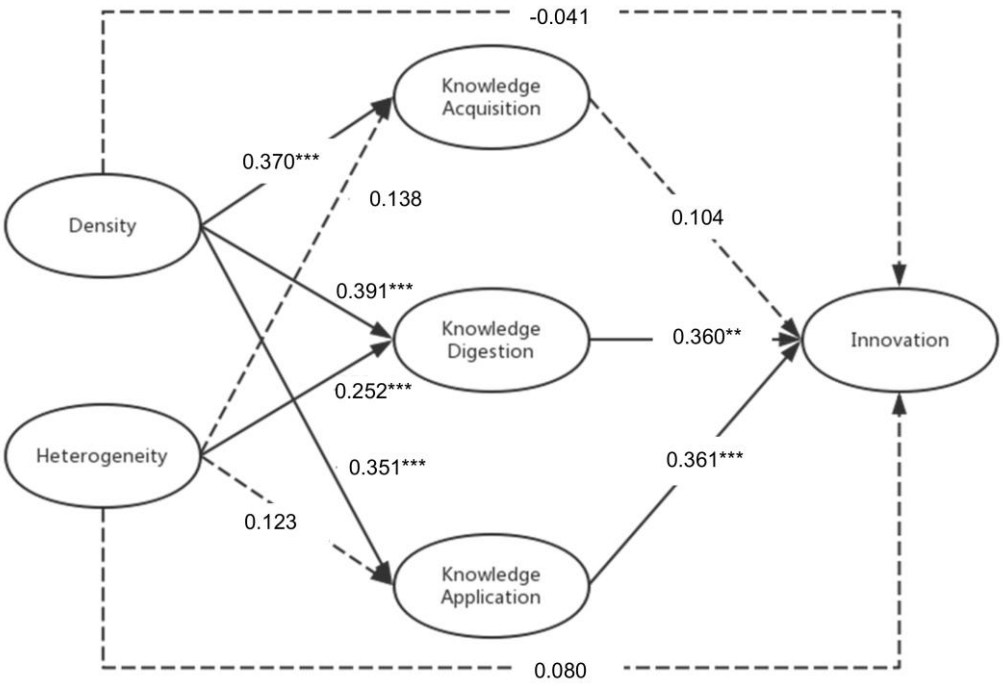

Figure 2. Standardized regression results of the structural model. (Dotted lines indicate non-supported paths, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$).

Continuing from the result, it was found that internal social network density had a significantly positive effect on the three constructs of absorptive capacity (knowledge acquisition, knowledge digestion, and knowledge application), but no significant effect on innovation directly. Thus, **H1** is

not supported, and **H4** (**H4a**–**H4c**) is supported. Regarding internal social network heterogeneity, there was no evidence showing that internal social network heterogeneity had a significantly direct effect on innovation either. Therefore, **H2** is not supported. Concerning the three constructs of absorptive capacity, only the relationship between internal social network heterogeneity and knowledge acquisition was confirmed to be significant. Thus, **H5b** is supported, but **H5a** and **H5c** failed to be supported. Moreover, knowledge digestion and knowledge application positively predicted the innovation. Accordingly, **H3b** and **H3c** are supported, while H3a is not supported.

4.3.2. Modified Model

Based on the result of the conceptual model (Figure 2), the authors reevaluated the hypotheses. The model was modified and reexamined by deleting the insignificant paths one by one. The fit indices indicated an overall good fit for the modified model, as summarized in Table 6. The specific standardized weight estimates are illustrated in Figure 3, all of which are significantly positive. Furthermore, 58% of the variances in innovation are explained by the modified model.

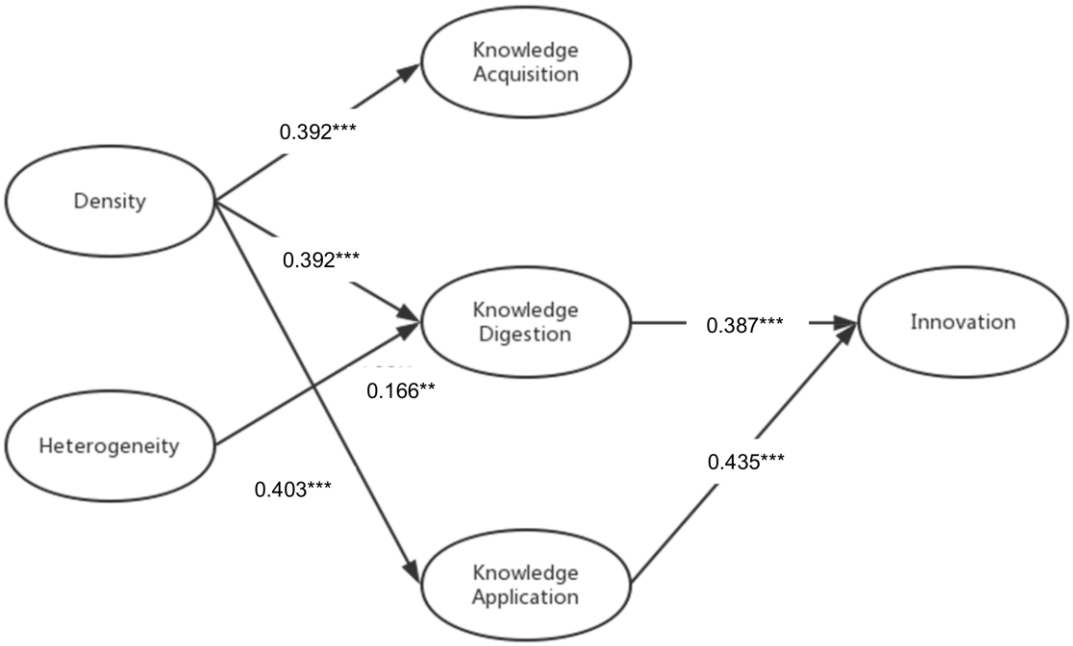

Figure 3. Standardized regression result of the modified model (* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$).

Table 6. Summary of the overall fit indices for hypothetical model and modified model.

Fitting estimation	χ^2/df	CFI	IFI	GFI	RMSEA	TLI
Conceptual model	1.305	0.962	0.963	0.892	0.039	0.954
Modified model	1.336	0.957	0.958	0.889	0.041	0.949
Recommended value	<3	>0.9	>0.9	>0.9	<0.08	>0.9

Absorptive capacity played an important role as a mediator in the relationship between internal social network and innovation. That is to say, internal social network did not have a direct impact on innovation but did indirectly affect innovation via absorptive capacity. The authors highlighted three dimensions of absorptive capacity in this paper. Figure 3 demonstrates that the results of the modified model are consistent with the conclusions stated above: (1) the heterogeneity of the internal network would positively affect a new venture's skills in knowledge digestion ($\beta = 0.259$ **), while the density of the internal network is crucial in enhancing a new venture's skill in knowledge acquisition ($\beta = 0.392$ ***), knowledge digestion ($\beta = 0.392$ ***) and knowledge application ($\beta = 0.403$ ***); (2) regarding the absorptive capacity, what really matters in its relationship with innovation are knowledge digestion dimension ($\beta = 0.387$ ***) and knowledge application dimension ($\beta = 0.435$ ***).

Overall, the standardized (indirect) effect of social network density and heterogeneity on innovation are 0.538 (density) and 0.081 (heterogeneity) respectively, which means that the internal social network will significantly improve a new venture's innovation.

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4.3.3. Discussion and Managerial Insights

Both internal network heterogeneity and density would have a positive effect on a firm's performance in innovation. This result is consistent with Reagans and Zuckerman [62], and Pelled [135]. However, the current results further indicate that the direct effect of the social network on innovation is considerably weaker and statistically insignificant (Figure 2). According to Salazer et al. [16], merely entering into network relationships does not guarantee the organization an increase in its innovation. Social network, in essence, is a type of resource for the organization. Only by utilizing this "resource" through a certain mechanism, can firms achieve better performance in innovation. Results in the current study show that the only way for the internal social network to influence innovation is through a firm's absorptive capacity. Thus, the direct effect in hypotheses **H1–H2** is not supported. Kotabe, Jiang, and Murray's study confirmed absorptive capacity complements the external network in enhancing innovation [39]. The current study further emphasizes the importance of absorptive capacity as a mediator in the interaction between the internal social network and innovation.

Second, among the three dimensions of absorptive capacity, the knowledge digestion and knowledge application skills of a new venture would have significantly positive effects on its innovation (**H3b** and **H3c** are supported). Even though knowledge acquisition skill might lay a foundation for further utilization of knowledge, it does not necessarily increase a new venture's innovation. The key characteristic of innovation is to "create" new ideas from the transferences of knowledge and information. Knowledge acquisition skill does not help firms "generate" new ideas, it only helps firms get the necessary knowledge/information to be further transformed. Therefore, it might not be too surprising to see that **H3a** is not significantly supported. However, the conclusion adds importance to the knowledge digestion and application skills for innovation: new ventures should not just be a "receptor" of new knowledge, but also be an active "user" of the knowledge in the process of innovation.

Last, as expected in the hypotheses, internal social network density would significantly improve the new venture's absorptive capacity ($p < 0.01$). The result of this study confirmed the previous research on network density and absorptive capacity [34,106]. Regarding the impact of heterogeneity on absorptive capacity, network heterogeneity might be able to secure the diversification of the organizational knowledge, which is of help (but not guaranteed) in increasing a firm's knowledge acquisition skill. Meanwhile, a diverse internal network with different expertise could play complementary roles in transforming and applying the knowledge. However, previous literature has debated whether heterogeneity would increase or hamper information-processing efficiency and knowledge utilization. Atuahene-Gima and Cardinal believe that heterogeneity might make it difficult to reach a consensus, thus a participation of diversified employees might hamper information-processing efficiency and negatively affect knowledge utilization [114,115]. The current authors' results show that the heterogeneity of the internal social network could positively increase a new venture's knowledge acquisition and knowledge application skills. However, the result is not statistically significant. The cause for the result could be the interaction between the positive effect and negative effect of the heterogeneity. Regardless, the current paper's result suggests that it does not require new ventures to maintain a diversity of employee backgrounds in order to have better knowledge application skill. Rather than putting unnecessary investment to maintaining network

diversity, it is better for new ventures to build a dense team in which members work closely with each other.

4.4. Extension: Different Types of New Ventures

New ventures differ from each other in many aspects, such as initial funding, business resources and so on. The external linkages are sometimes important as well, since the support or resources from outside might greatly improve their efficiency in innovation. In the context of China, the authors separated the new venture companies into two different types: new ventures supported by mature enterprises (M-type new venture) and independent new venture (I-type new venture). The M-type new venture is common in China, as there are many venture capital (VC) funds by those large and mature companies. One prime example is the Innovation Foundation Project established by Tencent (qq.com). Not only can those new ventures get financial support, but they are also provided with vast technical or managerial resources, which are unavailable to those I-type new ventures.

The authors identified 102 responses from M-type ventures and 90 from I-type ventures of all the 202 responses. To test the generality of the current framework and check the effect of the social network on innovation for those two different types of companies, the authors conducted a group comparison study by estimating the modified structural model with data from two sub-samples. The values of RSMEA for the pooled sample and both sub-samples were 0.046, 0.062 (M-type), and 0.071 (I-type) respectively. It shows that the structural model in this paper fit well with the pooled sample and both sub-samples. Regarding the venture type difference, the model accounted 71.6% of variance in innovation for the M-type venture, and 43.9% for the I-type ventures, respectively.

Table 7 presents the result of M-type and I-type ventures, respectively. It was found that most of the path coefficients were significant for both sub-samples. The only exception in the M-type sample was the path from network heterogeneity to knowledge digestion. In contrast, the network heterogeneity would positively affect knowledge digestion in the I-type sample (β = 0.294 **). Noteworthy is the path from knowledge application to innovation, which was significant in the M-type sample (β = 0.622 ***) but insignificant in the I-type sample.

To test the effect of venture type, the authors followed the process proposed by Keil et al. [136]. Table 7 also gives the subgroup analysis result. T value was used to detect the differences in specific paths between M-type and I-type ventures.

Table 7. Standardized path coefficients of the two types of new ventures.

Assumption	M-Type	I-Type	t-Value
Knowledge digestion → Innovation (H3b)	0.303 ***	0.577 ***	1.449
Knowledge Application → Innovation (H3c)	0.622 ***	0.105	2.523 **
Network density → Knowledge acquisition (H4a)	0.450 ***	0.348 **	0.262
Network density → Knowledge digestion (H4b)	0.374 **	0.430 **	0.184
Network density → Knowledge application (H4c)	0.464 ***	0.279 **	0.666
Network heterogeneity → Knowledge digestion (H5b)	0.015	0.294 **	0.677

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 7 details that the effect of the social network on innovation through knowledge digestion was greater in those I-type new ventures (**H3b**, **H4b**, and **H5b**). One possible reason is that I-type companies did not have to deal with the big supporter company, thus the I-type ventures might have less bureaucracy and their employees were usually more active. Their quickness in assimilating knowledge and spotting new opportunities was especially amplified by the density and heterogeneity of their networks.

The M-type startups, on the contrary, had more advantages in resources. With the help of large companies, M-types were more efficient in implementing the new ideas, which would in turn accelerate their innovation. Providing they were good at transforming and exploiting the current knowledge set into generating new ideas (knowledge application), the innovation performance

would be improved. Therefore, the effect of knowledge application skill on innovation was much larger and more significant among M-type ventures (**H3c**).

This finding is interesting, as it is generally believed that the more support for those new ventures, the better performances in innovation they might have. However, the current study shows that the effects of their knowledge digestion skills on innovation were actually weaker. To have greater success, those ventures have to keep reflecting and avoid slowness in spotting new market trends. For those independent ventures, the lacking of resources might limit them from implementing innovative projects. Therefore, those ventures should be actively involved in seeking external supports once they have an innovative idea. Regarding VC funds, the implication was that they should not step in a new venture's operation too early. The best way for them to support a new venture is to provide more resources to new ventures in the implementation phase of innovative projects.

Still another interesting finding emerged from this study. Network heterogeneity in general played a less important role in improving a new venture's innovation than network density. Network heterogeneity affected innovation through knowledge digestion (Figure 3); however, in the M-type sample, the path from network heterogeneity to knowledge digestion was not significant. The total effects of network heterogeneity on innovation in M-type and I-type samples were 1.1% and 14.6%, respectively. In contrast, the total effects of network density on innovation in M-type and I-type samples were 65.3% and 48% respectively. The example of wechat—an instant message application—might help illustrate this result. Wechat was supported by Tencent from the very beginning. The heterogeneity of their group members was relatively low for most of its founding members were from same company, Tencent. However, this did not stop the success of wechat. The founding group still made it the most popular instant message application by working intensively with each other. Moreover, they kept adding new features into their product on a continuous basis. Therefore, this indicates that it is more useful for new ventures to build a dense team in which members work closely with each rather than focusing on recruiting unnecessarily heterogeneous members, especially for M-type ventures.

5. Conclusions

The paper investigates the impacts of the social network, particularly the internal social network, on new ventures' innovation. Using a comprehensive framework, the current paper integrated the stream of social network, innovation, and absorptive capacity. The authors distinguished this paper from others by highlighting the full mediating effect of absorptive capacity in the relationship of the social network and innovation. The study also extended previous research by comparing the effect of social networks in the different types of new ventures. The main conclusions are shown as follows:

An internal social network can improve the innovation of a new venture through its absorptive capacity, that is, the absorptive capacity (or firm's learning skills) acts as a mediator in the relationship of internal social network and innovation. The communication within the organization is a profoundly social and interactive process, which enables the transference of knowledge and creation of new ideas. A higher network density indicates a closer connection between the members [69,70], which would greatly improve the acquisition, digestion [104,105], and application of knowledge [109] (absorptive capacity). Concurrently, the heterogeneity of the internal social network would equip the organization with a variety of knowledge, leading to a better grasp of new knowledge (knowledge digestion) [112].

The current research further shows that, of the three dimensions in absorptive capacity, the skills of knowledge digestion and application seem to be strong determinants of innovation in new ventures. The knowledge acquisition skill, per se, has little influence on innovation. What really matters is the process of internalizing the new knowledge and creating new ideas. These findings provide insights for new ventures regarding how to make the best use of their internal social networks to improve their absorptive capacities, as well as their innovation.

A deeper understanding of the effect of the internal social network on innovation can be gained by comparing the two different types of new ventures. Based on whether the new venture has external support, the authors classify new ventures into two types: the new venture supported by mature enterprises (M-type) and the independent startups (I-type). The authors show that the effect of the social network on innovation through knowledge digestion skill is greater in those I-type new ventures. This finding is especially important to those VC funds who expect high innovation performance from the ventures they support, as it indicates that it is not always best to support new ventures throughout the whole process of innovation. The best way for them to support a new venture is to provide resources to it in its late phase of the innovation process, essentially the implementation phase of innovative projects.

The research contributes by examining the interactive effects of the internal social network and absorptive capacity on innovation for new ventures. However, the paper still has certain limitations that further research might try to overcome. First, the research focuses on Chinese new ventures. Although the approach is appropriate, it is still too early to arrive at a general conclusion that might be applied to all countries. Therefore, further research across the world or in other countries is strongly recommended. Second, the data has an acceptable but not perfect level of performance on KMO index (EFA) and factor loadings (CFA); future research might try to increase the sample size or develop a new questionnaire to have a better statistical result. Third, the questionnaires in the current research were randomly distributed to different industries. As the economy develops, some emerging industries are demonstrating new characteristics that differ from traditional sectors. The authors believe that the different characteristics of these sectors deserve attention in future research. Fourth, the changes in business settings might bring new insights to this research. Specifically, technological progress, such as internal Web 2.0 tools and augmented reality, is offering tremendous potential in terms of internal collaboration and knowledge management [98]. Via the display of situationally relevant information in the most comprehensible manner, those technologies might greatly enhance firms' absorptive capacities, which could further improve the role of the absorptive capacity in the relationship between the internal social network and innovation. Therefore, it would be interesting to verify that in the next step. The authors believe there are other factors that might affect innovation in new ventures. As innovation is becoming more and more important, continued exploration of the potential factors under innovation would be insightful.

Acknowledgments: The authors are very grateful for the insightful comments and suggestions of the anonymous reviewers and the editor, which have helped to significantly improve this article. Furthermore, this research was supported by the National Natural Science Foundation of China (No. 71371025), and Beijing Natural Science Foundation (No. 9182010).

Author Contributions: Wei Shan and Chu Zhang conceived and designed the model and experiments; Jingyi Wang performed the experiments; Wei Shan, Chu Zhang and Jingyi Wang analyzed the data; Wei Shan and Chu Zhang wrote the paper. All authors read and approved the final manuscript.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

A.1. Questionnaire

Internal social network

Internal social network density

- Members have discussion meetings on a regular basis (SND1).
- Members often communicate and collaborate on work (SND2).
- Members often discuss issues with each other (SND3).
- Members get along with each other (SND4).

Internal social network heterogeneity

- Members have large differences in the level of education (SNH1).
- Members have different working experience (SNH2).
- Members have different ways of thinking (SNH3).
- Members have different years of working in this group (SNH4).
- Members have difference in working styles, knowledge sets, and experiences (SNH5).

Absorptive capacity

Knowledge acquisition

- Members frequently collect industrial technological information and managerial insights in a detailed manner. (KAC1)
- Members often evaluate technology and management information obtained externally (KAC2).
- Members communicate with other people to acquire new knowledge on a regular basis (KAC3).
- Members often compare the difference between obtained and existing technology and management knowledge (KAC4).

Knowledge digestion

- Members can store up new technology and knowledge (KAS1).
- Members can quickly catch (grasp) the new technology and business mode from outside (KAS2).
- Members can quickly understand and analyze the change of market demand (KAS3).
- Members can quickly spot new opportunities in current business environment (KAS4).

Knowledge application

- Members have strong ability in adapting the newly absorbed knowledge to products/operations. (KAP1).
- Members often utilize new technology and ideas in the development process of new products (KAP2).
- Members often integrate the new technology with new ideas to develop new products or increase the efficiency of operations (KAP3).
- Teams/ members have been rewarded for applying new technology or new managerial approach (KAP4).

Innovation performance

- Team/company often uses new products and service (GIP1).
- Team/company often introduces new technology to improve workflow (GIP2).
- Team/company often uses new methods to improve product performance (GIP3).
- Team/company often makes use of new methods to improve group performance (GIP4).
- Team/company often develops new products and service that can be accepted by the market (GIP5).
- Team/company can change the service project and method based on the customers demand (GIP6).

Note: GIP5 and GIP6 were deleted in our pilot survey.

A.2. EFA Analysis Result of Pilot Study

1. Result of explanatory factor analysis (EFA) (Original Questionnaire).

Rotated Composition Matrix							
	Components						
	1	2	3	4	5	6	7
KAP 3	0.834	0.154	0.143	−0.017	−0.031	−0.123	0.105
KAP 2	0.825	0.105	0.066	0.210	−0.083	−0.070	0.137

KAP 1	0.763	0.228	0.121	−0.016	0.180	−0.094	0.053
KAP 4	0.701	0.176	0.136	0.066	−0.025	−0.077	−0.369
GIP 3	0.097	0.888	0.153	0.043	−0.040	−0.072	−0.008
GIP 2	0.216	0.798	0.176	−0.085	−0.016	−0.183	0.103
GIP 4	0.269	0.653	0.331	0.151	−0.135	−0.214	0.011
GIP 1	0.365	0.637	0.093	−0.045	0.030	−0.214	0.314
GIP 6	0.004	0.557	0.188	−0.205	0.069	0.299	0.427
SND 3	0.211	0.149	0.846	0.056	0.049	−0.018	0.098
SND 2	0.034	0.198	0.828	−0.079	0.085	0.141	0.060
SND 1	0.036	0.119	0.825	0.151	−0.138	−0.051	0.089
SND 4	0.195	0.180	0.598	−0.121	0.190	0.156	−0.159
KAS 3	−0.031	−0.019	0.170	0.800	−0.098	−0.040	0.259
KAS 2	0.114	−0.038	−0.077	0.796	−0.059	0.138	−0.249
KAS 4	−0.002	−0.091	0.071	0.793	0.195	−0.121	0.207
KAS 1	0.121	0.109	−0.110	0.743	−0.209	0.034	−0.190
SNH 5	−0.112	0.054	−0.052	−0.004	0.739	−0.030	−0.025
SNH 4	−0.156	−0.033	0.151	−0.185	0.707	0.016	−0.213
SNH 3	0.018	−0.224	0.184	−0.067	0.704	−0.096	−0.024
SNH 1	0.139	0.096	−0.062	0.081	0.680	0.166	0.055
SNH 2	0.411	−0.055	−0.080	−0.051	0.628	0.062	0.258
KAC 2	−0.039	−0.057	0.048	0.131	0.017	0.786	0.059
KAC 3	−0.139	−0.104	0.280	0.019	−0.005	0.744	−0.048
KAC 4	−0.053	−0.201	0.111	−0.154	0.169	0.666	0.039
KAC 1	−0.089	−0.005	−0.212	−0.009	−0.074	0.647	0.042
GIP 5	0.105	0.303	0.084	0.066	−0.070	0.085	0.784

Extraction Method: principal component analysis.

Total variance explained.

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.488	20.325	20.325	5.488	20.325	20.325
2	3.267	12.101	32.426	3.267	12.101	32.426
3	2.680	9.926	42.353	2.680	9.926	42.353
4	2.484	9.201	51.553	2.484	9.201	51.553
5	1.776	6.577	58.131	1.776	6.577	58.131
6	1.612	5.969	64.100	1.612	5.969	64.100
7	1.047	3.878	67.978	1.047	3.878	67.978
8	0.989	3.663	71.641			
9	0.899	3.329	74.970			
10	0.845	3.130	78.099			
11	0.772	2.861	80.960			
12	0.608	2.252	83.212			
13	0.538	1.993	85.205			
14	0.525	1.944	87.149			
15	0.489	1.812	88.961			
16	0.436	1.614	90.575			
17	0.395	1.462	92.037			
18	0.351	1.300	93.337			
19	0.323	1.197	94.533			
20	0.291	1.077	95.610			
21	0.265	0.982	96.593			
22	0.215	0.797	97.389			
23	0.191	0.708	98.098			
24	0.172	0.635	98.733			
25	0.128	0.474	99.207			
26	0.117	0.435	99.642			
27	0.097	0.358	100.000			

2. Result of EFA analysis after deleting two items in innovation.

Rotated Composition Matrix						
	Components					
	1	2	3	4	5	6
KAP 3	0.830	0.133	0.191	0.001	−0.013	−0.124
KAP 2	0.801	0.042	0.209	0.216	−0.050	−0.026
KAP 1	0.738	0.107	0.299	−0.017	0.203	−0.056
KAP 4	0.729	0.161	0.058	0.048	−0.054	−0.131
SND 2	0.035	0.836	0.178	−0.066	0.075	0.120
SND 3	0.187	0.827	0.221	0.070	0.058	0.004
SND 1	0.010	0.800	0.209	0.159	−0.129	−0.014
SND 4	0.234	0.646	0.023	−0.127	0.152	0.070
GIP 3	0.090	0.170	0.854	0.014	−0.046	−0.040
GIP 2	0.187	0.167	0.848	−0.099	−0.002	−0.120
GIP 1	0.350	0.094	0.692	−0.045	0.053	−0.175
GIP 4	0.251	0.323	0.681	0.135	−0.130	−0.173
KAS 3	−0.052	0.139	0.091	0.818	−0.076	−0.002
KAS 4	−0.015	0.049	−0.022	0.813	0.209	−0.110
KAS 2	0.134	−0.065	−0.123	0.782	−0.082	0.103
KAS 1	0.144	−0.096	0.030	0.727	−0.231	0.005
SNH 5	−0.129	−0.042	0.054	−0.015	0.737	−0.018
SNH 3	0.027	0.204	−0.270	−0.061	0.691	−0.143
SNH 4	−0.164	0.162	−0.080	−0.194	0.689	0.002
SNH 1	0.125	−0.047	0.094	0.073	0.685	0.175
SNH 2	0.390	−0.082	0.015	−0.035	0.656	0.080
KAC 2	−0.053	0.054	−0.041	0.124	0.031	0.818
KAC 3	−0.118	0.314	−0.198	0.015	−0.020	0.704
KAC 1	−0.104	−0.210	0.009	−0.020	−0.057	0.683
KAC 4	−0.047	0.133	−0.239	−0.151	0.170	0.648

Extraction Method: principal component analysis.

Total variance explained.

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.214	20.858	20.858	5.214	20.858	20.858
2	3.174	12.695	33.553	3.174	12.695	33.553
3	2.661	10.644	44.196	2.661	10.644	44.196
4	2.375	9.500	53.697	2.375	9.500	53.697
5	1.696	6.784	60.481	1.696	6.784	60.481
6	1.344	5.376	65.857	1.344	5.376	65.857
7	0.982	3.929	69.786			
8	0.903	3.614	73.400			
9	0.861	3.443	76.842			
10	0.803	3.211	80.053			
11	0.638	2.550	82.603			
12	0.584	2.337	84.941			
13	0.512	2.049	86.990			
14	0.483	1.932	88.922			
15	0.461	1.844	90.766			
16	0.352	1.407	92.173			
17	0.336	1.343	93.516			
18	0.322	1.288	94.805			
19	0.280	1.120	95.925			
20	0.256	1.023	96.948			
21	0.212	0.850	97.798			
22	0.186	0.744	98.542			

23	0.135	0.541	99.082
24	0.131	0.522	99.605
25	0.099	0.395	100.000

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