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Which Strategy Maximizes the Innovation Output of Firms in China: Using a Control or an Entrepreneurial Sphere?

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Abstract

Innovation is a key stimulus for firms' survival and growth. However, many of Chinese firms fail to make it due to the lack of adequate financial resources. Previous studies have been deeply investigated the relationships between financial resources and firms' innovation performance. This paper extends such stream of the literature by focusing on a vital question for entrepreneurs: how to maximize innovation output under resource constraints. Based on an extensive dataset collected at Zhongguancun Science Park (ZSP), Beijing, China, over the period 2011-2014, this paper discusses whether entrepreneurs should pursue extra public funding (control sphere). Besides, this paper also provides empirical evidence for entrepreneurs to make proper choices about resource allocation (entrepreneurial sphere). This paper hypothesizes that enterprises allocating resources by using the entrepreneurial sphere, rather than the control sphere, can advance innovation output. To test our hypothesis, this paper adopts a dynamic panel model estimated by a bootstrap-based bias correction procedure. We find that, in advancing innovative performance, the entrepreneurial sphere is more effective than control. Indeed, at the overall level, the crowding out effect merely offsets the additionality effect when enterprises pursue extra public funding. Therefore, the control sphere does not play an essential role in advancing innovation performance. Thus, extra efforts in that direction will turn out to be in vain. Consequently, as a policy implication we claim that entrepreneurs should spend more time and energy on productive activities rather than lobbying and rent-seeking. In addition, managers should allocate resources properly for internal knowledge creation, external knowledge absorption and S&T activities.

Keywords

control sphere; crowding out effect; additionality effect; entrepreneurial sphere; resource allocation; absorptive capacity; internal knowledge creation capacity

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1.Introduction

Innovation has long been recognized as a major stimulus for economic growth and the survival of firms (Ernst and Kim, 2002; Guan and Chen, 2012). In recent years, the Chinese government has been making every effort to curb the power of bureaucrats in government spending in order to create a more favorable innovation environment. Due to fierce international competition, the ability of firms to create and commercialize breakthrough innovative technology is vital to their success (Pahnke *et al*., 2015). Many recent studies indicated that financial constraints are major factors in the innovative performance of Chinese companies (Guariglia and Liu, 2014; Song *et al*., 2015; Zhang and Guan, 2021).

Government intervention like subsidies or R&D tax credits, is designed to alleviate financial constraints caused by capital market imperfections (Carboni, 2017; Meuleman and De Maeseneire, 2012). However, Du and Mickiewicz (2016) elaborated that non-transparent governments like the Chinese one allocate subsidies unevenly. When it comes to allocating credits, some governments prefer to adopt a "picking the winner" strategy (Antonelli and Crespi, 2013). In China, the government always gives priority to prior grants and minority state-ownership enterprises (Boeing, 2016). As the strongest stakeholder, government is of vital importance for entrepreneurs: it provides public funding to firms, which may lead to legitimacy and prestige to fund-received firms. (Tang and Tang, 2012). Firms who have *guanxi* seem to get government funding more easily (Yu *et al*., 2016). This advantage might even apply to other types of funding (Li *et al*., 2008). It is crucial for entrepreneurs in China to know how to "deal with" the government. As observed by Du and Mickiewicz (2016), "*one of the most successful Chinese entrepreneurs, Liu Chuanzhi, the CEO of Lenovo, recalled that when his company was small, he had to spend more than 70% of his time and energy in maintaining relations with the 'external environment', 'governments in particular'*". Following previous studies, we define such kind of unproductive influence and rent-seeking activities as the *control sphere*. The control sphere becomes significant in governments like China where rules are not transparent. As a result, entrepreneurs will spend less attention on the *entrepreneurial sphere*, namely, the allocation of resources to develop innovation performance under conditions of resource constraints (Du and Mickiewicz, 2016; Keupp and Gassmann, 2013; Kornail, 1986).

Establishing connections with the government leads to high rent-seeking costs. The set-up cost of building connections is especially high for start-ups (like Lenovo in its initial stage). Therefore, some start-ups will in their initial period rely on social capital (Du and Mickiewicz, 2016). From the aforementioned example of start-ups, we can see that two types of resources are frequently discussed in the control sphere: public funding and social capital. The former often refers to subsidies, governmental venture capital (in short: GVC) funds, public R&D and so on (Dang and Motohashi, 2015; David *et al*., 2000; Grilli and Murtinu, 2014; Howell, 2017; Wu *et al*., 2021; Zhao and Ziedonis, 2020). They often stand for the support of the "visible hand". The latter mainly involves private equity, angel investment, venture capital (VC) and so on (Dutta and Folta, 2016; Wadhwa *et al*., 2016), which are commonly viewed as the power of the "invisible hand". The increase of public funding usually causes two main effects: a crowding out effect and an additionality effect. A crowding out effect means that "*eligible firms simply substitute R&D investments they originally planned to undertake with the public financial resources made available*" (Marino *et al*., 2016: 1715). It may have negative impact on the innovation output of firms (Antolín-López *et al*., 2015). As to the additionality effect, Takalo *et al*. (2013) defined it as "*whether public support increases private R&D investment rather than crowds it out*". They believe that enterprises who received public support will be considered legitimate and prestigious. Such firms will draw more investors' attention, which will benefit

their development (Söderblom *et al*., 2015). Studies are usually interested in the impact of these two effects on firm performance or market failure. However, evidence on innovation output remains an open question. In addition, analysis on advancing innovation performance by the two effects has not always adopted a firm perspective. We attempt to alleviate the research gap by examining the final influence of above two effects on innovation performance from a firm's perspective.

Financial constraints are one of the most influential factors for innovation endeavors in China (Guariglia and Liu, 2014; Song *et al*., 2015). However, extant evidence on whether resource constraints promote innovation output is conflicting. Some scholars argue that resource constraints impede innovation (Audia and Goncalo, 2007; Camison-Zornoza *et al*., 2004), while others oppose. They argue that it is the resource allocation capacity of entrepreneurs that matters most in innovation process (Katila and Shane, 2005; Gibbert and Scranton, 2009). In short, resource constraints are vital to innovation in any case. It is generally accepted that capital is closely related to innovation, yet not only capital resources but also their allocation matters. Resource allocation is a core activity for enterprises. Some scholars suggest that resource allocation capacity may nurture the competitive advantage for enterprises (Lin *et al*., 2013). Therefore, firms need to make trade-offs in allocating resources and prioritize decision-making (Purchase *et al*., 2016). When facing resource constraints, firms are forced to make resource allocation decisions to undertake more entrepreneurial innovation strategies (Galia and Legros, 2004; Keupp and Gassmann, 2013), or adjust resource combination (Bradley *et al*., 2010). Some scholars empirically found that resource allocation seems to outweigh intensity in advancing innovation outputs (Klingebiel and Rammer, 2014). They demonstrated that, during today's innovation endeavors, increasing quality and quantity of innovation resources cannot efficiently face up to commercial uncertainty. Consequently, it has emerged that the allocation of available resources is of the utmost importance. Moreover, Purchase *et al*. (2016) also indicated that multiple resources rather than a single resource type are essential in innovation processes. This result still holds under conditions of resource constraints (Hoegl *et al*., 2008).

Another purpose of this paper is to find the promotion mechanisms of the entrepreneurial sphere on the innovation output of enterprises. After receiving funds, companies always need to decide how to allocate capital for seeking maximum revenue. As observed by Keupp and Gassmann (2013), they "*must make allocation choices concerning which innovation activities to pursue, which to postpone, and which to abandon*". To avoid the risk of misjudging, Klingebiel and Rammer (2014) suggested that greater resource allocation breadth can increase product innovation performance. In addition to this, there is still a research gap about where funds make the most effective impact on innovation performance. This paper measures the entrepreneurial sphere as three resource allocation activities: internal knowledge creation, external knowledge absorption and science and technology (S&T) activities. Most importantly, this paper acts as an attempt to observe the external knowledge absorption dynamically. Following the four aspects of absorptive capacity defined by prior research (Forés and Camisón, 2016), this paper takes their methods as reference and measures the external knowledge absorption as acquisition, assimilation, transformation and application process. Thus, in order to obtain a dynamic and systemic analysis about the promotion mechanism of capital, this paper analyzes two main strategies, namely use of the control sphere and of the entrepreneurial sphere. In this way, we can find which strategy maximizes the innovation output of firms in China. Considering a new perspective, this investigation adds to a growing body of literature delineating the relationship between capital and the innovation output of enterprises.

In conclusion, entrepreneurs will face two alternative strategies under resource constraints. One is using the control sphere, an extra effort for pursuing resources (especially public funding); the other

is using the entrepreneurial sphere, *i.e.*, the allocation of multiple available resources for promoting innovation performance (Katila and Shane, 2005; Gibbert and Scranton, 2009). The energy of entrepreneurs is limited. Therefore, they will naturally pay less attention to the entrepreneurial sphere when focusing on "dealing with" the government. Hence, the question of which strategy advances the innovation output of firms more effectively is vital for enterprises, especially for start-ups. In China, enterprises like Lenovo spend a great deal of time and energy building relationships with government (Du and Mickiewicz, 2016). The demonstration effect of the above-mentioned successful examples drives entrepreneurs to go for using the control sphere like rent-seeking. However, this kind of behavior is recognized as unethical and wasteful (Boatright, 2009 Dunfee and Warren, 2001). The rent-seeking costs might be high in practice, resulting in small gains. Therefore, some entrepreneurs turn to the entrepreneurial sphere to advance their firms' innovative performance (Du and Mickiewicz, 2016). On the basis of the above considerations, this paper focuses on multiple resources, explores the influence of the control sphere on innovation output in China and carries out a comparative analysis with the entrepreneurial sphere.

The remainder of this paper is divided as follows. Section 2 reviews literatures about the relationship of capital and innovation performance. In Section 3, we develop research hypotheses about the control and the entrepreneurial sphere. Section 4 introduces our database and data processing methods and highlights the econometrical models' variable selection, specification and estimation. Findings about the control sphere and the entrepreneurial sphere are reported in Section 5. Section 6 contains a discussion and conclusion.

2. Literature Review

2.1. Public funding and the innovation of enterprises

The most common forms of public funding for innovation activities are subsidies and fiscal incentives. A large number of empirical papers elaborate on the relationship between subsidies and innovation inputs. The reason why policy makers should deploy subsidy programs is well-explained in prior studies. Arrow (1992) raised the economic rationale that due to technological spillover, private investment cannot lead to a socially optimal equilibrium. As a result, this kind of market failure needs public support to be handled properly. Another reason for providing subsidies is the awareness of capital market imperfections, such as informational asymmetries (Broekel *et al*., 2015). Recent articles also indicate that, at least to some extent, subsidies correct market failure (Zúñiga-Vicente *et al*., 2014). Large groups of researchers devote themselves to explaining the influence of subsidies on innovation inputs. A much-discussed issue in this context is the crowding out effect of public subsidies. The majority of the aforementioned studies verified the existence of a crowding out effect (Arias and Beers, 2013; Goolsbee, 1998; Kelette *et al*., 2000; Yu *et al*., 2016). Their common results imply a negative influence of subsidies on enterprises' innovation. However, some scholars noted that a positive effect of subsidies, *i.e*., an additionality effect on private investment, cannot be ignored (Hud and Hussinger, 2015; Wonglimpiyarat, 2016; Zúñiga-Vicente *et al*., 2014).

Recently, some researchers turned to analyzing the relationship between subsidies and a firm's innovation output (Bronzini and Piselli, 2016). Branstetter and Sakakibara (2002) used Japanese company data and found that firms, which joined in research consortia supported by government subsidies, had increasing patenting activities. Evidence from Canadian firms also supported this conclusion (Bérubé and Mohnen, 2009). Except for subsidies, many investigations aimed at exploring fiscal incentives and their

influence. Based on a large-scale empirical survey in China, Guan and Yam (2015) explored the effects of government financial incentives on the innovation performance of firms. Their findings pointed to a failure of all governmental financial incentives. Some empirical analyses also examined the effect of tax credits. However, conclusions about the influence of tax credits on innovation performance are conflicting (Cappelen *et al*., 2012; Czarnitzki *et al*., 2011). Due to these uncertain and mixed results, it is a necessary for scholars to further study on this direction.

There are many other types of public funding not mentioned in this review. Although there is no space to cover these in detail, it is important to understand the diversity of public funding. Studies targeting public funding and innovation output are rare, and so is the literature analyzing the effect of subsidies and fiscal incentives (Bronzini and Piselli, 2016). Discussing the potential effect of diverse public funding on innovation output may have significant implications for entrepreneurs. In our view it also provides a breakthrough for theoretical research.

2.2. Social capital and the innovation of enterprises

Investigations have shown that innovation activities of Chinese firms are subject to financial constraints. This is especially true for Chinese private firms and holds to a somewhat lesser extent also for foreign firms (Guariglia and Liu, 2014). Based on the panel data of 269 Chinese private enterprises, Song *et al*. (2015) concluded that in an incomplete market environment, market resources are not only dominated by a "visible hand", but also need the work of an "invisible hand". It means that the work of social capital also matters. The most frequently highlighted types of social capital in researches are VCs, angels, and other private equities.

It is necessary to make it clear how VCs influence innovation in enterprises. Start-ups with high growth potential always come along with a high level of uncertainty. With the help of VCs start-ups can have better prospects for sustained development (Hoenig and Henkel, 2015). Therefore, venture capital will advance the innovation output of firms (Wadhwa *et al*., 2016). However, some scholars present a new light and they found that a VC exerts a negative influence on innovation output. For example, future patent applications of a firms in which a VC has invested are affected negatively (Lahra and Mina, 2016). From the above, VCs are more likely to rationalize patenting outputs. Recent studies believe that focusing on VCs solely may be biased, and that this is the reason for the outcome of the Dutta and Folta (2016) investigation. They introduced angels and provided a comparison with venture capitalists. The empirical finding demonstrates that VCs have a more significant influence than angels. More interestingly, when angels show up, the influence of VCs almost disappears. In addition, other kinds of social capital except for VCs and angels also have effect on innovation output. As a main instrument of gathering funds, private equity provides finance to invest in turnaround companies and leveraged buyouts (LBOs) (Wonglimpiyarat, 2013). A similar observation holds with respect to bank loans (Majumdar, 2016).

Investigations as described above emphasize the different types of capital and their influence on enterprises' innovation. Their studies illustrated clear theoretical frameworks with significant implications for entrepreneurs and policy makers. However, earlier studies paid more attention to the relationship between capital and the innovation activities of firms, especially R&D expenditure. The ultimate goal, namely the innovation output, seems to be ignored (Bronzini and Piselli, 2016). Moreover, the discussion on whether enterprises should seek rent is necessary. Hence, this paper is designed to fill this knowledge gap by analyzing the integrated effect of the crowding out and additionality on innovation output.

2.3. Control sphere and entrepreneurial sphere

Due to resource constraints, enterprises usually lay special stress on the link with government when they search for external resources. Enterprises will use the control sphere (like rent-seeking activities) if the potential cost is less than the potential benefit (Gao, 2011). Thus it can be seen that using the control sphere results from resource constraints, but so is using the entrepreneurial sphere (Lin *et al*., 2013; Miller and Shamsie, 1996; Purchase *et al*., 2016). This paper attempts to explore the relations between the two spheres and innovation output. Previous works analyzed the relations between firm performance and organizational strategy, management skills, social network or other type resources (Tong *et al*., 2016). However, evidence on the impact of control sphere on innovation is still scare. A comparison of the influence on firm innovation by using the control sphere or the entrepreneurial sphere warrants further examination.

3. Hypothesis Development

There are two main effects when using the control sphere: a *crowding out effect* and an *additionality effect*. According to prior theoretical and empirical analysis, the two effects mainly occur between public funding and social capital. In this paper, the term crowding out effect or additionality effect refers to the battle between what we have referred to as the visible and the invisible hand (Song *et al*., 2015). The discussion about this battle, however, needs to be enriched, especially the aspect of its influence on innovation output. As to the entrepreneurial sphere, prior studies mostly focused on aspects related to management strategy such as breadth, selectiveness and innovative intent (Hauser *et al*., 2006; Klingebiel and Rammer, 2014; Leiponen and Helfat, 2010). These studies moreover showed that the flow and destination of funds are crucial factors in the innovation management of enterprises. In this paper, we will demonstrate three dimensions of a resource allocation strategy and their performance on firms' innovation output: internal knowledge creation, external knowledge absorption and S&T activities. According to prior studies, we posit that these three dimensions all have an influence on innovation output (Forés and Camisón, 2016; Hall and Bagchi-Sen, 2002; Lin *et al*., 2016; Paradkar *et al*., 2017; Smith *et al*., 2005; Yu, 2013).

3.1. Control sphere and enterprises' innovation

Rent-seeking is a typical activity in the control sphere (Du and Mickiewicz, 2016). It "*is defined broadly as activities intended to gain a monopoly position, usually through lobbying for government favors*" (Boatright, 2009: 541). A large amount of studies on corporate social responsibility criticized rent-seeking as a waste of social resources. Consequently, enterprises should refrain from rent-seeking (Boatright, 2009; Jaworski, 2014). Yet in practice rent-seeking occurs frequently. Therefore, this study verifies the effectiveness of rent-seeking on innovation promotion. According to prior investigations, enterprises have preference for pursuing the maximization of profit by seeking rents when there is no legal restraint (Fan, 2002; Gao, 2011; Sanyal, 2005). It is also widely-verified that in China, enterprises who have *guanxi* with government will obtain a much larger amount of scarce resources or more information (Li *et al*., 2008; Su and Littlefield, 2001; Yu *et al*., 2016). Many successful CEOs spend plenty of time and money on establishing and maintaining connections with government (Du and Mickiewicz, 2016). In this way, they obtain positive government support like licenses, quotas, permits or resources support. As a consequence, other companies will follow them and also seek rent (Gao, 2011). Furthermore, firms supported by government

will be perceived as legitimate and prestigious, which benefits a firm's survival and development (Söderblom *et al*., 2015). Hence, a successful control sphere (like rent-seeking) will cause extra government support, like receiving more subsidies or tax deduction than others, through the additionality effect. However, as mentioned before, the increase of public funding will simultaneously bring about a crowding out effect. All in all the final impact of rent-seeking on innovation output is still a puzzle.

Previous research claims that rent-seeking is synonymous with 'profit seeking'. It pursues value increasing and is thought to increase social welfare (Jaworski, 2014). Moreover, rent-seeking can help enterprises to obtain monopolistic resource, receive special treatment, reduce transaction cost or receive policy information in advance (Fan, 2002; Su and Littlefield, 2001). Therefore, rent-seeking will improve a firm's performance. However, developing and maintaining *guanxi* with the government, especially in China, are time-consuming and costly activities for enterprises (Lovett *et al*., 1999; Du and Mickiewicz, 2016). Although corporations can temporarily acquire benefits from rent-seeking, it is in no way an effective option in the long run (Fan, 2002). It seems that an increase in public funding would lead to an increase in a firm's credit (Söderblom *et al*., 2015). However, the actual condition of Chinese enterprises is that most of them are in debt (Fan, 2002). In addition, using the control sphere is an informal profit-seeking means which bypasses the law. Therefore, rent seekers cannot be sure that 'the opposite side' will keep their promise, even though the *guanxi* transaction is completed because there are no punitive measures for those who break their promise (Fan, 2002). Hence, the intervention of the control sphere (like rent-seeking activities) doesn't reduce uncertainty. On the contrary it may increase the uncertainty related to recent and future innovation activities. Moreover, the crowding out effect caused by using the control sphere will impede innovation. As to the additionality effect, the existence of rent-seeking enterprises in debt might weaken the promotion effect (Fan, 2002). From the above, we propose that

H1: Enterprises pursuing public funding by using the control sphere (rent-seeking) cannot benefit in terms of innovation output.

3.2. The entrepreneurial sphere and innovation

The precise balance or division of multiple resources is vital for enterprises in innovation process (Gibbert and Scranton, 2009; Katila and Shane, 2005; Liu *et al*., 2011). As Keupp and Gassmann (2013) pointed out: entrepreneurs "*must make allocation choices concerning which innovation activities to pursue, which to postpone, and which to abandon*". Therefore, using the entrepreneurial sphere as a strategy to make more efficient innovation decisions is vital for managers. As mentioned before, three resource allocation activities are studied in this paper, namely:

Internal knowledge creation. It is widely accepted that internal knowledge creation capability can positively affect innovation output (Forés and Camisón, 2016; Smith *et al*., 2005). According to prior studies, internal knowledge creation capability can not only help enterprises have the capability of independent innovation, but also facilitate external knowledge absorption process (Beneito, 2003; Forés and Camisón, 2016; Zahra and George, 2002). Enterprises should allocate resources to enhance the internal knowledge creation capability. Therefore, internal knowledge creation is an important resource allocation activity for advancing innovation output. The capability is "*generated by R&D investment and internal problem solving*" (Forés and Camisón, 2016: 832). The so-called internal problem solving mainly depends on the *teamwork* of a firm. And the *teamwork* of a firm can be affected by the skills or experience of employees (Smith *et al*., 2005). Therefore, enterprises will enhance their internal knowledge creation ability by attracting and retaining qualified human capital. That is to say, resources allocated on R&D

investment and human capital will promote the internal knowledge creation capability and then advance the innovation performance. Besides, innovation knowledge creation also promotes innovation performance through creativity and experimentation (Forés and Camisón, 2016). In conclusion we may state that internal knowledge creation can positively affect innovation output.

External knowledge absorption. Theoretically, absorptive capacity serves to convert external knowledge into internal resources, then advance or expand existing technology and products, influencing indirectly the innovation performance (Forés and Camisón, 2016). Many scholars have tested the moderating role of absorptive capacity with respect to impact on promoting the innovation performance of firms (Huang *et al*., 2015; Leal-Rodríguez *et al*., 2014; Yu, 2013). As a result, enterprises with a higher level of absorptive capacities will have more possibilities to advance their innovation performance than those who have lower level capacities, even if they belong to the same network (Lee *et al*., 2001). Prior scholars observed absorptive capacity through acquisition, assimilation, transformation and application capabilities (Cohen and Levinthal, 1990; Forés and Camisón, 2016; Jiménez-Barrionuevo *et al*., 2011; Zahra and George, 2002). This dynamic viewpoint helps scholars better understand the impact of absorptive capacity on innovation performance. Following the dynamic view of absorptive capacity, this paper observes external knowledge absorption through four activities: resource allocation on acquiring, assimilating, transforming and applying external knowledge. The effects of acquisition, assimilation, transformation and application will advance the innovation performance of firms (Hernandez-Espallardo *et al*., 2012; Ritala and Hurmelinna Laukkanen, 2013). Therefore, to promote the absorptive capacity, resource allocation on external knowledge absorption is of great importance. That is to say, enterprises with superior external knowledge absorption have more possibilities to advance their innovation performance.

Expenditure related to S&T activities. Except for above two activities, we also observe expenditure related to S&T activities. It will play a role in advancing innovation performance by combining the other two activities. Recently S&T activities have generated considerable research interest. We mention for instance, Moutinho and Godinho (2005) who adopted a broad set of data, dividing forty-six variables into eight composite indicators covering S&T, social and economic aspects. After clustering they found that S&T activities are highly correlated with technology diffusion, innovation and S&T culture. Another comparative study explored the difference between scientific and technologically-based innovation with learning-by-doing, by-using, and by-interacting (DUI) innovation. Interestingly, they found that S&T-based innovation on its own has a stronger effect on technological innovation than DUI innovation (Parrilli and Heras, 2016). There is, moreover, a growing body of research focusing on science, technology and innovation (STI) policies (Padilla-Pérez and Gaudin, 2014; Parrilli and Heras, 2016; Zhang *et al*., 2013; Zhang *et al*., 2014). These investigations consistently confirm that STI policies provide a favorable environment for national innovation systems. These results indirectly prove that S&T activities are important for innovation. Based on these considerations we propose the following hypothesis:

H2: Enterprises allocating resources by using the entrepreneurial sphere advance innovation output. More specifically:

H2a: Superior internal knowledge creation leads to outstanding innovation performance.

H2b: Enterprises with superior external knowledge absorption have more possibilities to advance their innovation performance.

H2c: S&T activities are positively related to the innovation performance of a firm.

4. Data and Methodology

4.1. Data sources and sample selection

Zhongguancun Science Park (ZSP) is the first National Ranking High-tech Zone and the first National Independent Innovative Demonstration Zone in China. It is the most active center within China for technical innovative and entrepreneurial activities. ZSP is also famous for its fast-growing firms and advanced technology, which is why many scholars regard ZSP as their first choice for innovation studies (Filatotchev *et al*., 2011; Tan, 2006). The ZSP dataset was jointly collected by the Beijing Municipal Bureau of Statistics and the Management Committee of ZSP. Respondents are all recorded enterprises in the Zhongguancun Demonstration Area that satisfy one of the following conditions. Either they obtained and still had the certification of National High-Tech Enterprise, or they satisfy any of the following three conditions:

(1) Enterprises whose main products or main business activities fall in the scope regulated by *the New and High Technology Areas with the Government's Primary Support*. And they also meet at least one of the following standards: (a) the S&T personnel accounts for at least 10% of all personnel; (b) spending on R&D activities accounts for at least 3% of the total revenue; (c) owning independent intellectual property; (d) the ratio of high-tech products and technical sales revenue over the total revenue in the current year is at least 0.4;

(2) High-Technology Services Enterprises or Cultural and Creative Enterprises;

(3) Scientific and Technological Headquarters Enterprise and Science and Technology Services Industry Enterprises.

Concrete details and classification standard of enterprise can be found in relevant documents[1].

This dataset contains basic information and statistical data of more than 15,000 enterprises. The time span of our dataset in this paper is from 2011 to 2014. The competitive climate in ZSP and unprecedented government support leads to a large turn-over in membership of ZSP. For this reason we carefully checked if all companies in our study are included for the full four years. This selection criterion leads to a panel data of 9,039 companies (all firms). To test the robust of our conclusions, we design other two panels sampled from all firms: national high-tech enterprise and listed company. In our dataset, a firm can be entitled as national high-tech enterprises or listed companies. If a firm does not belong to either of the above two types, it will be a regular firm. The panel of high-tech enterprises is unbalanced. It contains 4,967 firms. 4,176 of them are certified as national high-tech enterprises for the whole four years. As to the listed companies, these form a balanced panel of 231 firms included for the whole four years (2011–2014).

4.2. Definitions of variables

Dependent variables. Dependent variables must reflect innovation output characteristics. Various methods have been used in prior investigations. The reasons of various innovation output metrics used for appropriate measurements have been debated (Guan and Ma, 2003; Guan and Yam 2015). Several scholars regard the number of valid patents (Y_1) as the measurement of innovation output. However, Arqué-Castells (2012) argued that it is the depreciated sum of past patents that should be used to examine patenting activities. It can reflect the cumulative process of innovation activities and the established technological base of a firm. In this paper, we adopt Y1 as dependent variable and handle the cumulative

[1] The policy original is available at: http://www.bda.gov.cn/cms/bszngx/130913.htm

process and established technological base by setting the dynamic panel data model. Whereas some authors believe that not all innovations are patented or patentable, it is reasonable that several other informal mechanisms can reflect innovation outputs of enterprises (Bronzini and Piselli, 2016). More accurately speaking, patents reflect inventions rather than innovation. Thus, scholars still doubt whether patents can be used as the only proxy for innovation (Bertoni and Tykvová, 2015).

On the basis of above considerations, this paper also chooses another dependent variable - new product sales (Y_2). As mentioned before, patent counts should not be the only metric measuring innovation output. The Oslo Manual (OECD, 2005) suggests that the ratios of innovation sales can be used to represent the innovation performance. This index is defined as the percentage of new-product sales over total product sales (Guan and Yam, 2015). Back to our research, there are a large number of zero values in our database. If we adopt that method, it would lead to many missing values. For this reason we simply use new-product sales revenue, and not a ratio, as our dependent variable. In addition, firms with high prior innovation output will make more new innovations (Yanadori and Cui, 2013). That is to say, innovation endeavors are dynamic in nature. For this reason we think that using a dynamic panel model is a suitable approach.

Independent variables. The first purpose of this paper is to test the use of the control sphere and its effectiveness. Except for social capital and public funding variables, this paper also makes use of dummy variables and control variables. Concretely, the following aspects are included in our investigations.

Social capital. Although there exist many different definitions, social capital generally refers to "the sum of the actual and potential resources embedded within, available through, and derived from the network of relationships possessed by an individual or social unit" (Nahapiet and Ghoshal, 1998: 247). Venture capital is no doubt a vital one. In this paper, the corresponding variable is the amount of venture capital in the current year (S_1). Based on literature review, we posit that other financing constraints, besides venture capital, also advance a firm's innovation output. Prior studies indicated that debt is an important kind of social capital (Corbett and Jenkinson, 1997; Majumdar, 2016). Private lenders like banks will monitor firms more closely and effectively. They are more likely to push firms into making safer investments (Majumdar, 2016). However, for innovative firms, high profit exists with the high risk and uncertainty. Therefore, banks are reluctant to loan money to most of them (Berger and Udell, 1990; Guariglia and Liu, 2014). In sum, the discussion about debt finance with innovation performance for innovative firms remains. In this paper, we adopt bank loans (S_2) as a proxy of debt finance to explore the relationship with innovation performance. In addition, the most costly resource, namely equity-based finance, is in practice still the preferred choice of most firms (Guariglia and Liu, 2014). Empirical evidence proves that equity indeed helps considerably in innovation performance (Majumdar, 2016). Therefore, newly created equity in the current year (S_3) is regarded as another social capital in this paper.

Public funding. When it comes to public funding, the first option should be subsidies or tax credits. Tax credits can stimulate innovation activities of enterprises by reducing the cost of R&D. Therefore, it isn't a real fund. For this reason, our paper just chooses government subsidies (G_1) as a proxy of public funding. Besides, there has been increasing interest in discussing science, technology and their relations with innovation (Padilla-Pérez and Gaudin, 2014; Pfotenhauer *et al*., 2016). Based on these considerations and our dataset, we introduce two S&T-based metrics: S&T activity funds from government departments (G_2) and government procurement projects obtained this year (G_3).

Table 1 presents correlations of dependent and independent variables in the present study. As shown in the first two columns of the Table 1, there are positive correlations between dependent and

independent variables. It means that social capital and public funding help to advance innovation performance of firms. In addition, correlations between independent variables are positive, small and significant. This will reduce the possibility of multicollinearity of our proposed models.

Table 1 Pairwise correlations coefficients

	LnY_1	LnY_2	LnRDP	LnS_1	LnS_2	LnS_3	LnG_1	LnG_2	LnG_3
LnY_1	1								
LnY_2	0.413***	1							
LnRDP	0.547***	0.409***	1						
LnS_1	0.030***	0.026***	0.025***	1					
LnS_2	0.280***	0.218***	0.231***	0.030***	1				
LnS_3	0.084***	0.063***	0.056***	0.064***	0.075***	1			
LnG_1	0.283***	0.226***	0.223***	0.021***	0.227***	0.081***	1		
LnG_2	0.401***	0.232***	0.359***	0.032***	0.176***	0.069***	0.272***	1	
LnG_3	0.087***	0.095***	0.063***	0.035***	0.082***	0.044***	0.121***	0.123***	1

Note: ***Correlation is significant at the 0.01 level (2-tailed), **Correlation is significant at the 0.05 level (2-tailed)

Dummy variables. In order to test the two effects in relation to using the control sphere, two dummy variables were designed to describe social capital or public funding. The variable D_1 is assigned to 1 if the company received at least one of the three kinds of social capital; this variable is set equal to 0 if it accepts no social capital (of any kind). The processing procedure of D_2 is the same as for public funding. If a dummy variable can bring out a negative change, this means that a crowding-out effect of social capital or public funding exists. And if the change is positive, an additionality effect occurs. As we mentioned before, some start-ups will rely on social capital in their initial period. And some of them will spend much of their time and energy in seeking rent. To make sure our regression results are robust, this paper introduces the third dummy variable – young firm (D_3). Following the definition from Coad *et al*. (2016), we define enterprises less than 10 years old as young firms. The variable D_3 is assigned to 1 if the company is a young firm, and set equal to 0 if it is an old firm (more than 10 years).

Resource allocation. In order to test our hypotheses H2a-c, we introduce nine variables to measure the three resource allocation activities. These three activities are measured as follows:

Internal knowledge creation. In our hypothesis, internal knowledge creation is grounded on R&D investment and human capital. This paper adopts R&D internal funds (X_1) to measure the internal knowledge creation. According to the definition from National Bureau of Statistics of the People's Republic of China, X_1 refers to the actual expenditures for R&D activities such as basic research, applied research and experimental development within enterprises. On the basis of definition, X_1 also reflects the effect of creativity and experimentation in some ways. Therefore, it can be used to measure the effort of R&D investment in enterprises. In addition, enterprises will enhance their internal knowledge creation ability by attracting and retaining qualified human capital. Despite other influence factors like leadership, skilled employees which are irrelevant to our theme, this paper only observes the endeavor of a firm on investment in human capital. Resource allocation like wages can attract skilled employees and motivate them to innovate (Afonso, 2013; Xu *et al*., 2017). Therefore, this paper measures that endeavor as wages, bonuses, allowances and subsidies for the employees (X_2).

External knowledge absorption. There are four variables describing the external knowledge absorption: outlay for the introduction of foreign technology (X_3); outlay for purchasing domestic technology (X_4); outlay for absorbing introduced technologies (X_5) and R&D expense weighted deduction with tax reliefs (X_6). The ZSP dataset surveys and provides those variables. Prior scholars observed absorptive activities through acquisition, assimilation, transformation and application capabilities. Taking their criticisms into account, this paper makes an attempt to measure the external knowledge absorption from a dynamic perspective. There are four processes in external knowledge absorption. We measure acquisition process as outlay for technique introduced from the external environment (X_3 and X_4), assimilation and transformation process as outlay of absorbing introduced technology (X_5). As to the application process, we measure it as R&D expense weighted deduction with tax reliefs (X_6). The reasons of using X_6 as the proxy are shown as follows:

In their pioneering research, Cohen and Levinthal (1990) adopted R&D intensity as a proxy for absorptive capacity. Theoretically, R&D intensity can reflect a firm's overall capacity of acquisition, assimilation, transformation and application. Therefore, R&D intensity can be used as the proxy of absorptive capacity (Cohen and Levinthal, 1990; Todorova and Durisin, 2007). However, this method is heavily criticized by Lane *et al*. (2006). They criticized that that proxy regards absorptive capacity as being static resources rather than a process. They more truly believed that absorptive capacity is a dynamic or dyad learning process (Zahra and George, 2002). Actually, R&D intensity is shown in many aspects, such as import of equipment and instruments, paying for patent licensing fees or introduction of skilled experts. It seems that R&D intensity could be a "perfect" proxy. Practically however, the majority of R&D expenditure is used for licensing fees. Thus, specifically with regard to absorptive capacity, R&D can strongly reflect the application, but weakly reflect the knowledge acquisition and transformation process (Huang *et al*., 2015). X_6 refers to R&D expenses for developing new techniques, products or processes. A company will benefit from the R&D cost deduction policy preferentially only if it creates a new product or a substantive improvement of an original product[2]. Therefore, X_6 can reflect the application process of external knowledge absorption (Forés and Camisón 2016; Lane *et al*., 2006).

S&T activities. According to our data sources, S&T activities related expenditure refers to following aspects: (1) administrative fees, service charges, outsourced process costs and other expenditures for S&T activities within the enterprise; (2) transfer of appropriation made to cooperating enterprises; as well as (3) fixed assets formation for S&T activities or intangible assets formation (like purchasing patents) in the year. There are three variables in our dataset: S&T activities funding within the enterprise (X_7); S&T activities funding paid for cooperating enterprises (X_8); and fixed assets formation for S&T activities during the current year (X_9). These three variables stand for the expenditure used for S&T activities.

Control variable. Many studies have observed that R&D personnel influences the innovation activities of companies (Guan and Yam, 2015; Li *et al*., 2013). Hence, we introduce R&D personnel as our control variable. Summary statistics of the variables are shown in Table 2.

4.3. Dynamic panel model: bootstrap-based bias correction

Innovation endeavors are dynamic in nature. The dynamic relationship of a panel data model is characterized by the presence of a lagged dependent variable. It can reflect prior capital accumulation and

[2] The definition and policy are available at:
http://www.chinatax.gov.cn/n810341/n810765/n812171/n812675/c1190645/content.html

Table 2 Summary statistics of variables

Variable	Units	Mean	SD	Min	Max
The number of valid patents (Y_1)	Number	6	57.14	0	3111
New product sales revenue (Y_2)	Thousand Yuan	35299	681515.79	0	65948810
R&D personnel (RDP)	Person	12	98.75	0	7414
Amount of venture capital in current year (S_1)	Thousand Yuan	134	12336.37	0	2210199
Bank Loan (S_2)	Thousand Yuan	38946	552967.89	0	37534352
Newly created equity in current year (S_3)	Thousand Yuan	1575	138391.51	0	25741065
Subsidy (G_1)	Thousand Yuan	808	8163.03	0	438072
S&T activity funds from government departments (G_2)	Thousand Yuan	473	10020.65	0	1257940
Government procurement project obtained this year (G_3)	Thousand Yuan	1388	44397.57	0	4323063
R&D internal funds (X_1)	Thousand Yuan	3751	42138	0	2009039
Wages, bonuses, allowances and subsidies for the employees (X_2)	Thousand Yuan	20307	132765	0	15284828
Outlay for the introduction of foreign technology (X_3)	Thousand Yuan	141	5106	0	543844
Outlay for purchasing domestic technology (X_4)	Thousand Yuan	97	5167	0	472063
Outlay for absorbing introduced technologies (X_5)	Thousand Yuan	9	492	0	50999
R&D expense weighted deduction with tax reliefs (X_6)	Thousand Yuan	126	2110	0	268595
S&T activities funding within the enterprise (X_7)	Thousand Yuan	8534	55705	0	2569846
S&T activities funding paid for cooperating enterprises (X_8)	Thousand Yuan	1074	27793	0	2117335
Fixed assets formation for S&T activities during the current year (X_9)	Thousand Yuan	677	12715	0	981849

other related factors (such as reputation). In this way the dynamic panel model can eliminate irregular factors and variables. Guan and Yam (2015) also pointed out that the delay issue between output and input of innovative process should not be overlooked. Following the guidelines of the Oslo Manual (OECD, 2005), three years as a time slice is appropriate. Such an approach can properly reflect current technical changes and avoid the incorporation of outdated technology. A common method to handle the delay issue is using three-year averages. However, as we want to include dynamic effects – using a dynamic panel model – we require an extra year as a lag period. Thus, this paper uses four year time periods. As a result, our panels have a large number of observations (N) and a limited number of time periods (T).

When N tends to infinity and T is finite, a popular estimation method for dynamic panels is the difference GMM (Generalized Method of Moments) and system GMM. However, GMM estimators require decisions on the appropriate choice for instrumental variables. Improper operations always lead to an over-identifying issue. Using a bootstrap-based bias correction procedure, Everaert and Pozzi (2007) avoided possible unstable estimation caused by the selection of the instrument. Monte Carlo simulations show that this procedure is virtually unbiased for samples with a very small T. This model allows for a general pattern of heteroscedasticity and contemporaneous cross-sectional dependence. De Vos *et al*. (2015) extended the suitability of that model by automatically recognizing and dealing with unbalanced panels. This approach perfectly solves the estimation problem of unbalanced national high-tech enterprise panels.

Based on the above hypotheses, our research design for the comparison of the two strategies is

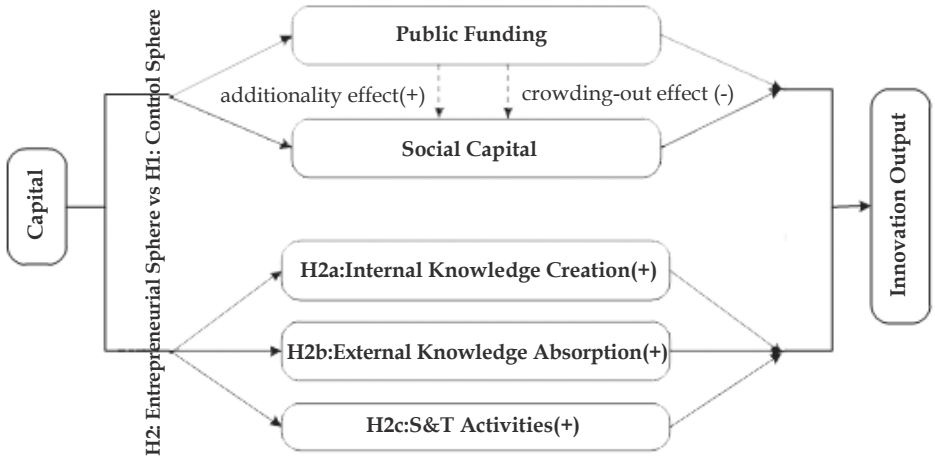

Fig. 1 Research design

presented in Figure 1. According to the research design, this paper modifies the model specifications of Guariglia and Liu (2014) and Dutta and Folta (2016) to test the use of the control sphere as follows:

$$LnY=a+\beta_0 LnY_{t-1}+\beta_1 LnRDP+\gamma_i LnS_i+\Psi_i Lng_i+\delta_k D_k+\varepsilon \quad (1)$$

where Y is the index describing a firm's innovation output, measured as the number of valid patents and new product sales. RDP stands for the R&D personnel. S_i and G_i represent social capital and public funding variables respectively (see Table 2 for details). D_k stands for two dummy variables (D_1 and D_2). Considering that some variables include many zero values, we added 1 to each data before taking logarithms. The estimation of the above models is operated by a new command, *xtbcfe*, from Stata 13.0.

Before estimation, there are some options to be clarified. The residual sampling scheme draws from the normal distribution with period (t)-specific estimated variance. And the initialization scheme for the bootstrapped lagged variable is the default option. As recommended by De Vos *et al*. (2015), this paper sets the number of bootstrap iterations to the minimum level due to the enormous dataset. As to the convergence criterion, this paper takes the default value. Standard errors and confidence intervals are inferred by the dispersion of the fixed effect estimator over the bootstrap interactions (De Vos *et al*., 2015). Once all options are settled, the command will remove collinear variables. Following those instructions, we get converged regression results for all models. Results are shown in Table 3 and Table 4 and will be explained in detail in the main findings of Section 5.1.

Table 3 The number of valid patents as dependent variable

	Model 1-1	Model 1-2	Model 1-3	Model 1-4	Model 1-5	Model 1-6
LnY_{1t}	0.5632***	0.5621***	0.5600***	0.5598***	0.5629***	0.5631***
	(78.709)	(78.988)	(79.343)	(79.311)	(79.050)	(79.120)
LnRDP	0.0652***	0.0646***	0.0629***	0.0629***	0.0654***	0.0648***
	(13.071)	(16.041)	(15.594)	(15.577)	(16.170)	(16.090)
LnS_1	-0.0127	-0.0131*			-0.0131**	-0.0142**
	(-1.477)	(-1.828)			(-1.830)	(-2.000)
LnS_2	0.0047***	0.0040**			0.0041	0.0041**
	(2.802)	(2.086)			(2.170)	(2.130)

(continued)

Table 3. (continued)

	Model 1-1	Model 1-2	Model 1-3	Model 1-4	Model 1-5	Model 1-6
LnS_3	0.0026	0.002			0.0021**	0.0022
	(0.671)	(0.423)			(0.440)	(0.460)
LnG_1			0.0095***	0.0094***		
			(4.177)	(4.136)		
LnG_2			0.0271***	0.0271***		
			(9.206)	(9.165)		
LnG_3			-0.0019	-0.0019		
			(-0.640)	(-0.638)		
D_1				0.013		
				(0.792)		
D_2		0.0707***				
		(5.659)				
LnG_1* D_3						-0.0040
						(-1.510)
LnG_2* D_3						0.0151***
						(3.380)
LnG_3* D_3						0.0142**
						(2.430)
D_2* D_3					0.0321**	
					(2.180)	
Year3	0.0849***	0.0847***	0.0851***	0.0849***	0.0863***	0.0856***
	(13.550)	(13.643)	(13.843)	(13.754)	(13.960)	(13.800)
Year4	0.0772***	0.0750***	0.0763***	0.0761***	0.0771***	0.0758***
	(13.766)	(10.310)	(10.573)	(10.512)	(10.530)	(10.250)
N	27117	27117	27117	27117	27117	27117

Note: The values in the parenthesis denote t-test results; * p <.1; ** p <.05; *** p <.01

Table 4 New product sales revenue as dependent variable

	Model 2-1	Model 2-2	Model 2-3	Model 2-4	Model 2-5	Model 2-6
LnY_{2t}	0.6045***	0.6041***	0.6020***	0.6019***	0.6044***	0.6049***
	(101.982)	(101.938)	(102.202)	(102.266)	(102.16)	(102.300)
LnRDP	0.2313***	0.2293***	0.2201***	0.2201***	0.2312***	0.2282***
	(14.947)	(14.904)	(14.283)	(14.266)	(14.95)	(14.830)
LnS_1	-0.0051	-0.0058			-0.0057	-0.0110
	(-0.183)	(-0.205)			(-0.20)	(-0.400)
LnS_2	0.0042	0.0039			0.0042	0.0037
	(0.572)	(0.526)			(0.57)	(0.500)
LnS_3	0.0717***	0.0712***			0.0715***	0.0709***

(continued)

Table 4. (continued)

	Model 2-1	Model 2-2	Model 2-3	Model 2-4	Model 2-5	Model 2-6
	(3.875)	(3.845)			(3.86)	(3.830)
LnG_1			0.0325***	0.0322***		
			(3.728)	(3.676)		
LnG_2			0.1017***	0.1014***		
			(8.930)	(8.881)		
LnG_3			0.0047	0.0048		
			(0.413)	(0.416)		
D_1				0.0802		
				(1.269)		
D_2		0.1502***				
		(3.113)				
LnG_1* D_3						0.0033
						(0.330)
LnG_2* D_3						0.0643***
						(3.720)
LnG_3* D_3						0.0455**
						(2.040)
D_2* D_3					0.0542	
					(0.96)	
Year3	-0.1412***	-0.1430***	-0.1450***	-0.1467***	-0.1401***	-0.1392***
	(-5.976)	(-6.04)	(-6.191)	(-6.240)	(-5.950)	(-5.890)
Year4	-0.1606***	-0.1618***	-0.1611***	-0.1627***	-0.1581***	-0.1547***
	(-5.651)	(-5.695)	(-5.708)	(-5.752)	(5.54)	(-5.360)
N	27117	27117	27117	27117	27117	27117

Note: The values in the parenthesis denote t-test results; * p <.1; ** p <.05; *** p <.01

To explore how entrepreneurial sphere influences innovation performance and test our hypotheses H2a-c, as well as make a comparison with control sphere, we designed the following explorative equations (2):

$$LnY=a+\beta_0 LnY_{t-1}+\beta_1 LnRDP+\xi_k D_k{}^{X}X_n+D_{3-k}+\varepsilon \quad (k=1,2;\ n=1...10) \tag{2}$$

where D_k is a dummy variable, the interaction terms of D_k and resource allocation activities X_n depict the objective of expenditure of social capital or public funding. Considering that some firms could receive two kinds of capital simultaneously, we introduced another dummy variable into our explorative equations (2). X_n represents the nine variables of resource allocation. Introducing one of these variables once at a time, we can get the influence of a certain resource allocation activity. The estimation values ξ_k are shown in Tables 5 and 6 and will be explained in detail in the main findings of Section 5.2.

Table 5 The patent performance of different directions of capital in different types of enterprises

Y_1	All Firms		National High-tech Enterprise		Listed Company	
	Social Capital	Public Funding	Social Capital	Public Funding	Social Capital	Public Funding
X_1	0.0106***	0.0064***	0.0051	0.0033	**-0.0225****	-0.0080
	(3.856)	(3.032)	(1.220)	(0.917)	**(-2.446)**	(-0.779)
X_2	0.0040**	0.0091***	0.0039	0.0056**	-0.0030	0.0022
	(2.130)	(6.500)	(1.328)	(2.474)	(-0.355)	(0.328)
X_3	0.0111	0.0375***	0.0130	0.0479**	0.0178	-0.0012
	(0.697)	(3.105)	(0.534)	(2.484)	(0.323)	(-0.020)
X_4	-0.0123	-0.0212*	-0.0051	-0.0234	-0.0471	-0.0632
	(-0.717)	(-1.862)	(-0.239)	(-1.276)	(-0.813)	(-1.161)
X_5	-0.0458*	0.0004	-0.0027	0.0184	0.0142	-0.0838
	(-1.773)	(0.020)	(-0.067)	(0.477)	(0.150)	(-0.715)
X_6	0.0193***	0.0139***	0.0144**	0.0045	0.0059	-0.0106
	(5.207)	(3.828)	(2.304)	(0.890)	(0.421)	(-0.729)
X_7	**0.0040****	**0.0143*****	0.0078**	0.0094***	-0.0084	0.0035
	(5.105)	**(9.163)**	(2.169)	(3.868)	(-0.974)	(0.460)
X_8	0.0155***	-0.0010	0.0100	0.0003	-0.0161	-0.0123
	(4.088)	(-0.273)	(1.617)	(0.066)	(-0.946)	(-0.915)
X_9	0.0171***	0.0184***	0.0176***	0.0180***	0.0017	0.0305**
	(5.787)	(7.388)	(3.777)	(4.158)	(0.120)	(2.138)
N	27117	27117	27117	27117	27117	27117

Note: The values in the parenthesis denote t-test results; * p <.1; ** p <.05; *** p <.01

Table 6 The commercial performance of different directions of capital in different types of enterprises

Y_2	All Firms		National High-tech Enterprise		Listed Company	
	Social Capital	Public Funding	Social Capital	Public Funding	Social Capital	Public Funding
X_1	0.0157	0.0174**	0.015	0.0118	-0.0471	**-0.2208*****
	(1.462)	(2.152)	(0.977)	(0.708)	(-0.960)	**(-2.591)**
X_2	0.0175**	0.0214***	0.0002	0.0709*	0.0394	-0.2787
	(2.414)	(3.947)	(0.018)	(1.835)	(0.992)	(-1.002)
X_3	0.1137*	0.0774*	0.1344	0.1069	-0.0322	0.0429
	(1.848)	(1.669)	(1.492)	(1.489)	(-0.170)	(0.151)
X_4	0.1133*	0.1425***	0.1425*	0.1713**	0.2553	0.1463
	(1.709)	(3.248)	(1.789)	(2.520)	(0.956)	(0.573)
X_5	0.103	0.0539	0.145	-0.0533	-0.1064	-0.3249
	(1.041)	(0.664)	(0.984)	(-0.374)	(-0.237)	(-0.640)
X_6	0.1530***	0.1598***	0.1443***	0.1416***	0.0752	**0.1356***
	(10.723)	(11.558)	(6.247)	(7.557)	(1.308)	**(1.755)**

(continued)

Table 6. (continued)

Y_2	All Firms		National High-tech Enterprise		Listed Company	
	Social Capital	Public Funding	Social Capital	Public Funding	Social Capital	Public Funding
X_7	0.0463***	0.0453***	**0.0258***	**0.1144*** **	0.0214	0.0757
	(6.139)	(7.529)	**(1.948)**	**(6.684)**	(0.551)	(0.641)
X_8	0.0690***	0.0688***	0.0678***	0.0592***	0.0700	-0.0029
	(4.738)	(4.867)	(2.955)	(3.790)	(0.855)	(-0.040)
X_9	0.0563***	0.0499***	0.0453***	0.0431***	0.0859	0.0302
	(4.914)	(5.204)	(2.605)	(2.613)	(1.382)	(0.373)
N	27117	27117	27117	27117	27117	27117

Note: The values in the parenthesis denote t-test results; * p <.1; ** p <.05; *** p <.01

5. Main Findings

5.1. Control sphere

The main results are presented in Table 3 and Table 4. It can be seen that social capital and public funding generally advance the innovation of firms. As shown, the coefficient on the venture capital is negative and weakly significant, which is in accordance with Lahra and Mina (2016). Venture capitalists are commonly viewed as "impatient" investors. They are usually drawn to companies with a high innovative performance. Thus, the innovation performance of an enterprise is not due to venture capitalists. Conversely, it is the reason why VCs select a firm as their investee. Therefore, venture capital more likely rationalizes rather than increases innovation output. In addition, according to prior researches, ethical problems in entrepreneurial finance may also have influence on innovation output of firms (Fassin and Drover, 2017). Therefore, ethical problems like trust or new venture legitimacy judgment may hinder the promotion effect of venture capital in China (Hain *et al*., 2016; Fisher *et al*., 2017).

Another related concern is the observed positive effect of bank loans (S_2), which is inconsistent with recent research (Guariglia and Liu, 2014; Majumdar, 2016). These authors believed that the critical criteria for firms or the effective monitoring behavior excludes the majority of innovative firms, while the truth in our sample is that the threshold of banks for enterprises is the lowest. When taking the average value into consideration, bank loans dominate in three kinds of capital. From the valid number of fund-obtained firms, bank loans rank the first (the number of S_1, S_2, S_3 are 81, 6986 and 211 respectively). Thus, perhaps, being in debt is more comfortable in China than elsewhere. For this reason bank loans have a positive effect on innovation performance. Otherwise, public funding is better than social capital in the two innovation indices. The "visible hand" plays a crucial role in promoting innovation output in China, especially the dominant role of S&T activity funds from government departments (G_2). This may be an explanation of why firms having *guanxi* and obtaining public funding easily seem to be more innovative.

There exists a certain crowding out effect between social capital and public funding. In the first two columns of each table of Table 3 and Table 4, we observe a slight change of social capital after introducing public funding into model. It seems that a crowding out effect indeed takes place in innovation endeavors from the results, although it is rather weak. Based on model 1-1, model 1-2 imports one dummy variable D_2, which stands for public funding. It can be seen that the effect of social capital on valid patents weakens when public funding shows up. The same phenomenon also occurs in model 2-1 and model 2-2, which means that public funding crowds out market investment activities. As

shown in models 1-3 and 2-3, coefficients of public funding decrease slightly when social capital shows up. In conclusion, social capital and public funding have negligible crowding out effect mutually. However, entrepreneurs and scholars are more interested in the final effect of pursuing extra public funding. That is to say, the question of whether using the control sphere to advance innovation attracts more attention. As shown in Tables 3 and 4, there exists a negligible change when public funding enters into the basic models. It seems that the crowding out effect merely offset the additionality effect when enterprises pursue extra public funding. This suggests that extra effort for establishing political connections or influence (rent-seeking) activities is invalid at the end. Entrepreneurs should spend more time and resources on productive activities. In summary, capital is vital to enterprises for their innovation endeavors. Social capital or public funding has positive effect on innovation performance. However, the trifling impact of the final effect means that using the control sphere is not an effective means to advance enterprises' innovation.

In our hypothesis development, we find there exists a herd effect in the control sphere: enterprises will follow the success examples of firms which pursues public funding in start-up stage. Therefore, we posit that using the control sphere also advances the innovation output of a certain kind of young firms. To test if that inference is true, we introduce the dummy variable D_3. Results are shown in model 1-5 and model 2-5. Comparing model 1-2 with model 2-2, we can find that the crowding out effect is still negligible for young firms and the coefficient of public funding is decreasing. Hence, H1 is also true of young firms. Therefore, our inference is robust. However, this inference still cannot fully explain why some enterprises still use the control sphere. For this reason, this paper studies the effects of various types of public funding. Results are displayed in models 1-6 and 2-6. Compared with models 1-3 and 2-3, it can be perceived that young firms can only improve their own innovation performance through pursuing G_3. Extra effort for pursuing G_1 and G_2 is ineffective at improving innovation performance. It can be seen that young firms will get benefit from a few kinds of public funding. That's why some enterprises will use the control sphere. It can be also seen however, that the extra effort for the majority of public funding is in vain. Therefore, using the control sphere is not an effective strategy. In addition, firm size and ownership may also influence the effect of using the control sphere, which might also explain the puzzle why some enterprises would like to use the control sphere. It could be the future direction in the research. In conclusion, enterprises pursuing public funding by the control sphere (rent-seeking) cannot advance the innovation output. Therefore, the hypothesis H1 is still stable and true robustly for young firms, except for the situation when young firms only pursue G_3.

5.2. The entrepreneurial sphere

On the basis of our econometric analysis, we can draw the conclusion that using the control sphere is not an effective strategy. Entrepreneurs cannot gain extra advantages through public funding. More specifically, extra influencing activities such as rent-seeking will not work well in advancing a firms' innovation output. Some scholars found that the key to innovation success is not solely due to the type or quantity of resources. Identifying the precise balance or division of multiple resources is what really matters (Liu *et al*., 2011). Under such consideration, this paper studies the effects of resource allocation (entrepreneurial sphere). Since there are three dimensions of entrepreneurial spheres, which are all complicated and interacting, we demonstrated their respective effects.

Internal knowledge creation. We introduce R&D internal funds (X_1) as a proxy of R&D investment. In addition, we introduce wages, bonuses, allowances and subsidies for the employees (X_2) as a proxy of human capital investment. Tables 5 and 6 show the results of the performance of internal knowledge

creation in all the firms. It indicates that X_1 has a significant positive effect on innovation. It is also true for X_2. The results are also positive (but not significant) on national high-tech enterprises. Therefore, results support for H2a and mean that superior internal knowledge creation leads to outstanding innovation performance.

External knowledge absorption. According to our hypotheses, it is popularly believed that there exist four processes in external knowledge absorption. As we mentioned before, the outlay for the introduction of foreign technology (X_3) and purchasing domestic technology (X_4) can be regarded as a reflection of the acquisition process. Outlay for absorbing introduced technologies (X_5) reflects the assimilation or transformation process. R&D expense weighted deduction with tax reliefs (X_6) mainly reflects the application process. Tables 5 and 6 show the results of the performance of external knowledge absorption for all firms. The results are concordant in national high-tech enterprises. As shown, application process is positively and significantly related to innovation performance. Yet the other three processes do not have such significant positive effect on innovation performance. Acquisition process mainly advances the output of innovation. X_3 is positively and significantly related to innovation performance. However, the results of X_4 are conflicting. The results of X_4 are negative in Table 5 and positive in Table 6. The positive impact of X_4 in Table 6 is statistically significant. Therefore, the results only provide partial support for H2b. Nevertheless, there are still many non-significant results on acquisition effect.

Surprisingly, we find that the assimilation or transformation process does not seem to have reached the expected influence. Firms should advance their innovation performance through the spillover effects when absorbing introduced technologies. However, blockades on techniques from foreign countries disable possible spillover effects in developing countries like China (Blomström and Kokko, 1998; Blomström and Sjoholm, 1999). A more convincing explanation is that the influence of a spillover effect is not linear. Influencing factors may encounter thresholds (Cheung and Lin, 2004; Lai *et al*., 2009). Therefore, there may exist some thresholds for X_5. This conjecture still needs to be examined empirically. In sum, we measure external knowledge absorption from a dynamic perspective. The middle stage of the external knowledge absorption, namely assimilation or transformation process, needs further study. As a result, the results provide some support for H2b. Enterprises with superior external knowledge absorption have more possibilities to advance their innovation performance.

S&T activities. S&T activities have become increasingly important in China. The Ministry of Science and Technology of China has cast a wide range of Science and technology (S&T) programs to support innovation in enterprises (Liu *et al*., 2011). Therefore, this paper tests whether S&T activities advance the innovation performance of firms. Tables 5 and 6 show the analysis results of the innovation performance of S&T activities on different kinds of firms. The results show a significant positive effect of S&T activities on innovation output for the studied firms, which is in line with hypothesis H2c.

Other findings. We find inferences are consistent in all firms and national high-tech enterprises. The listed companies, however, are inferior in both forms of capital. This indicates that high-tech enterprises obtain public funding, even social capital, more easily. This inference also expands prior studies (Li *et al*., 2008; Yu *et al*., 2016) that not only ownership attributes but also the category of enterprise has a weak effect on fund raising. In sum, national high-tech enterprises are better at obtaining and utilizing funding than listed company. The results are consistent in the three activities. This is, however, not the case for the comparison between social capital and public funding. As can be seen, social capital or public funding dominates in various situations. The discrepancy emerges when allocating them to diverse usages. This also indirectly explains why using the control sphere is not an effective means.

6. Discussion and Conclusions

In this paper, we mainly compared two strategies that might affect a firm's innovation output. For seeking an effective approach, a pioneering investigation about different forms of capital and their effects on innovation has been performed. Compared with using the entrepreneurial sphere, using the control sphere is relatively inefficient, even though there exist slight crowding out effects between social capital and public funding. In fact, at the overall level, the crowding out effect merely offsets the additionality effect when enterprises pursue extra public funding. Therefore, we infer that using the control sphere is not an effective means for innovation endeavors and the entrepreneurial sphere is more effective than the control sphere. Empirically speaking, the entrepreneurial sphere is vital for innovation endeavors. The three activities are all positively related to innovation performance. However, it doesn't mean that capturing capital is not important. In line with prior literatures and our regression results, capital, especially public funding, is largely affected by managers' social network (Yang *et al*., 2015; Yu *et al*., 2016). This means that the capability of an entrepreneur in balancing these two strategies is vital for advancing innovation performance. Three important deductions can be also made: (a) Using the control sphere is not efficient and two types of funding are alternatively dominating in different situations. (b) Three kinds of resource allocation activities are studied in this paper, namely internal knowledge creation, external knowledge absorption and S&T activities. They are all positively related to innovation performance. However, the effect of middle stage of external knowledge absorption on innovation needs further study. (c) Compared with listed companies, national high-tech enterprises obtain capital more easily and are better at utilizing it.

Our study offers broad insights for understanding the influence mechanism of various resources on promoting innovation. This paper focuses on different kinds of capital and sheds new light on the relationship between capital and innovation performance (Bronzini and Piselli, 2016). It examines the impact of using control and entrepreneurial sphere on innovation performance. This paper not only expands this research stream but it is moreover the first to make a comparative analysis between the two spheres. Secondly, this paper also verifies the criticism of Huang *et al*. (2015) and expands the conclusion of Yu *et al*. (2016). We analyze three new dimensions of the entrepreneurial sphere and adopt a novel measurement for external knowledge absorption from a dynamic perspective. After empirical analysis, three prime inferences for practitioners come to the fore. Interestingly, we find that debt environment for firms is more comfortable in China than elsewhere. Therefore, bank loans have a positive effect on innovation performance. Besides, we also find that the application process plays a vital role in advancing innovation performance. And the effect of assimilation or transformation process needs further study.

An implication of our findings is that entrepreneurs should allocate their resources properly. From the findings, we can infer that three kinds of resource allocation activities are all positively related to innovation. However, we "*must make allocation choices concerning which innovation activities to pursue, which to postpone, and which to abandon*" (Keupp and Gassmann, 2013: 1459). We attempt to make some suggestions for entrepreneurs based on the results of Tables 5 and 6. When a firm wants to increase the number of valid patents, the most efficient and economical way is allocating public funding to increase absorptive capacity. This result holds more when the company is a national high-tech enterprise. Secondly, different investors are supposed to care for different output indices when they assess whether their investment will have worthy profit. Private investors ought to seek for patent oriented firms and measure the improvement in the number of valid patents. As for government administrators, they should pay more attention to new product sales. In this way investors and entrepreneurs will come to a win-win situation.

Our study suggests several fruitful directions of future research. As shown, significant regression results for listed companies are rare in this paper. Secondly, there are other important factors that should be considered, such as the procedure or mechanism of investors searching and evaluating target companies. As mentioned before, raising funds and making it incremental are complicated management activities for enterprises. VCs' intervention and the entrepreneurial talent of managers can also influence capital allocation and innovation performance. Besides, the ethical problems in entrepreneurial finance also matters. These should be the future directions. Lastly, the negative influence of assimilation or transformation process in external knowledge absorption is still confusing: this point needs a more specific elaboration. This paper only answers this question from the perspective of technological gaps. There may be other influential factors such as the capacity for indigenous innovation, the position of a global value chain and so on. Future research should empirically verify the impact of these factors on innovation, hopefully leading to an explanation from different perspectives.

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