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Business Incubators and Regional Innovation Performance
Evidence from China

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-- Evidence from China

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Abstract

This study focuses on an innovation debatable player, namely business incubators. The Chinese government has advocated Innovation-driven development since 2006 (Li et al., 2016; Wang et al., 2020). Information from the Ministry of Science and Technology shows that the number of business incubators in China had been about 4069 (Wang et al., 2020). Thus, China provides an important case to explore the link between the development of business incubators and regional innovation performance. This study further examines the role of different density development levels and capacities of business incubators in fostering innovation performance at the regional level. Although the role of communication infrastructure has been seen as critical within the regional innovation system, few studies have considered the impact of communication infrastructure on regional innovation performance in emerging economies, such as China. Moreover, the moderation role of communication infrastructure on the relationship between business incubators capacities and innovation performance has received considerably less attention despite its recognised role as an essential element of the regional innovation system.

In examining this relationship, this thesis empirically analyses the impact of business incubators density and capacities using a balanced panel dataset for 31 provincial-level regions from China over the period 2008-2017. This thesis adds to the growing literature from recent years on regional innovation and the development of business incubators. The contribution of this thesis is fourfold: First, this thesis adds insights to the literature on regional innovation and business incubators by simultaneously studying the mutualism and competition relationship between business incubators and regional innovation performance. Second, this thesis also explores the impact of business incubators' basic, finance and incubation capacities on regional innovation performance. This study develops the argument for the vital role of business incubators capacities facilitating China's regional innovation performance, extending their influence on regional innovation and business incubators literature. Third, our result identifies situations in which communication infrastructure contributes to regional innovation performance in China. Thus, our study enriches the literature on regional innovation by demonstrating how the communication infrastructure influences regional innovation performance. Fourth, this study enriches and give a better understanding of regional innovation system theory by identifying the critical moderation role of

communication infrastructure on the relationship between capacities of business incubators and regional innovation performance.

Key words: Business Incubator; Regional Innovation; Performance; Communication Infrastructure

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Contents

Contents of Table

Contents of Figure

Chapter 1. Introduction

1.1 Introduction

The first chapter presents an overview to comprehend the linking between business incubators (density and capacities) and regional innovation performance, and how the communication infrastructure moderates the impact of business incubators capacities on regional innovation performance. Then, this chapter specified the problem statement, the research objectives, research questions, importance, structure, and contribution of this thesis.

1.2 Research Background

In the context of emerging economies, although figures may vary considerably across countries, the business incubators have been increasing rapidly, and the incubation program has been widely seen as a significant policy mechanism to facilitate innovation and economic development in the regional level (Etzkowitz et al., 2005; Dahlstrand and Stevenson, 2010; Manimala and Vijay, 2012; Mian, 2014; Hong et al., 2017; Surana et al., 2019; Wang et al., 2020; Bodolica and Spraggon, 2021). Meanwhile, business incubators are a key platform to support the incubation program (Scaramuzzi, 2002; Tang et al., 2013; Mian et al., 2016; Bodolica and Spraggon, 2021). However, limited studies have examined the impact of business incubators density and capacities on the regional innovation performance, especially in emerging economies (Fu et al., 2012; Chatterjee and Sahasranamam, 2018; Harper-Anderson and Lewis, 2018; Wang et al., 2020). Thus, the question remains whether the growth of business incubators density will contribute to the regional innovation performance of emerging economies to justify further support from governments and the industry. There is an insufficient logical indication to determine whether the density and capacities of business incubators are suitable tools for facilitating regional innovation performance (Manimala and Vijay, 2012; Hong et al., 2017). As stated by Hmieleski and Ensley (2007) and Dvouletý (2018) further empirical studies are needed to directly investigate how the capacities and density of business incubators affect the regional innovation performance and draw conclusions that make sense and provide the basis for high growth innovation development policies in the region.

Many authors suggested that technology entrepreneurs are the important locus for practising science (Howell and Sheab, 2001; O'Shea et al., 2004; Onetti et al., 2012;

Tang et al., 2013; Wang et al., 2020). For instance, the relatively recent development of the computer industry is an instance of how technical entrepreneurs practise science. From the initial exploits of Hewlett and Packard to the Software-company of Bill Gates at Microsoft, it is clear that technical entrepreneurs have played key roles in practising the science of this new area of software and hardware computer-related activities (Oakey, 2003; Cusumano, 2010:35; Wang et al., 2020). However, they often lacked physical facilities and equipment, administration support as well as financial support. Nowadays, many technology entrepreneurs are facilitated by business incubators, which refer to mechanisms and platforms for technology transfer to promote the growth of innovation and entrepreneurship (Clarysse et al., 2005; Dahlstrand and Stevenson, 2010; Rubin et al., 2015; Wang e al., 2020). The incubator literature usually classifies business incubator capacities into three aspects namely basic service, finance and incubation (Howell and Sheab, 2001; Hughes, 2007; Manimala and Vijay, 2012; Rakthai et al., 2019), and therefore, the development in these three aspects is quite significant for business incubators (Tamasy, 2007; Rakthai et al., 2019; Surana et al., 2019). Business incubators not only provide the space for people to meet at unconventional settings for knowledge sharing and transfer but also attract venture capitals and talented volunteers and groups (Onetti et al., 2012; Meyer, 2013; Mian et al., 2016; Sleator, 2016). Business incubators are usually seen as a catalyst enabling the process of knowledge transfer and innovation commercialization through providing office space, equipment, mentoring services, venture capitalists as well as other administrative supports for technology entrepreneurs (Sonne, 2012; Bramwell et al., 2012; Bruneel et al., 2012; Rubin et al., 2015; Clayton et al., 2018; Wang et al., 2020), this might be worth more research.

In addition to the internal capacities of business incubators, one external factor, the communication infrastructure, deserves more attention in the studies on regional innovation. Communication infrastructure is an information and knowledge exchange tool and has been widely regarded as a predictor of innovation (Doloreux, 2002; Vedovello and Godinho, 2003; Tamasy, 2007; Chege and Wang, 2020). The rapid development of communication technology changes the range and the speed of access to technology and information (Malhotra, 2002; Vedovello and Godinho, 2003; Chege and Wang, 2020). Therefore, the communication infrastructure significantly influences the way business incubators access technologies and do innovation (Vedovello and

Godinho, 2003; Runiewicz-Wardyn and Runiewicz-Wardy, 2013). Unfortunately, existing studies are still unclear about the way regional communication infrastructure moderates the relationship between business incubators' capacities and regional innovation performance in China (Chege and Wang, 2020; Wang et al., 2020).

In China, despite the reform and opening-up over the past three decades, the density of business incubators began development rapidly, and start-ups were encouraged to create innovation (Chandra and Fealey, 2009; Tang et al., 2013; Wang et al., 2020). Furthermore, the evolutionary and adequate infrastructure networks such as communication, and internet usage reduce the cost of doing business (Mahmoodzadeh et al., 2009), accessing knowledge and advanced technology, raising private sector competitiveness and improving the manufacturing base (Antonelli et al., 2000), which facilities entrepreneurship (Steinmueller, 2002). Meanwhile, prosperity depends on a country's productivity, and innovation is the feedstock of productivity growth (Bramwell et al., 2012; Bodolica and Spraggon, 2021). To this end, the government has to construct a knowledge-based entrepreneurial society to focus on innovation and make their products stand out from the crowd for higher value creation (Chandra and Fealey, 2009; Dahlstrand and Stevenson, 2010; Chege and Wang, 2020). In contrast to the mainstream innovation conducted by researchers or scientists based in universities, formal research institutes or R&D departments, technology entrepreneurs typically lacked essential resources such as finance, technology, facilities, equipment and human capital (Bramwell et al., 2012; Chatterjee and Sahasranamam, 2018). Technology entrepreneurs are also subject to criticisms in terms of risks in finance, health and safety, legal and ethical standards (Chege and Wang, 2020). Therefore, business incubators are regarded as important homes to small technology entrepreneurs to provide important platforms for knowledge sharing and innovation activities and promote innovation and technology entrepreneurship (Dahlstrand and Stevenson, 2010; Mian et al., 2016; Hong et al., 2017). With the improvement of the regulatory system and development policies for venture capital and further promoting business start-ups and innovation initiatives, the business incubators get fast development. China's business incubators have increased nearly dozens of times and reached 4063 in 2017 (Ministry of Science and Technology, 2018), and have become a new engine fuelling China's innovation (Fu et al., 2013; Tang et al., 2013; Hong et al., 2017). Furthermore, existing literature suggested that China cover huge geographical areas and where, commonly, there are

substantial regional disparities in terms of density of business incubators and innovative performance (Ramasamy et al., 2012; Li et al., 2016; Wang et al., 2020). Thus, this study expected that business incubator density development has different impacts on innovation performance in different regions.

1.3 Business Incubators and Regional Innovation Performance

Several emerging economies use the business incubator as a part of innovation and entrepreneurship policies to support the regional innovation performance development (Manimala and Vijay, 2012; Onetti et al., 2012; Mian et al., 2016). In general, the business incubator is a kind of social and economic organization geared to support and nurture small and medium-sized start-up enterprises (Chandra and Fealey, 2009; Fu et al., 2012; Hong et al., 2019). The business incubator provides assistance to start-up enterprises in early stage to achieve the development of business and innovation, which is an important aspect of the incubation process (Mian, 2014; Dvouletý, 2018; Chege and Wang, 2020). As a vehicle for start-up enterprises, the capacities of business incubators could help start-up enterprises access to advanced knowledge, expertise, and industrial networks (Rakthai et al., 2019). Previous studies of business incubators assessed the innovation benefits of various supports services offered by capacities of business incubators (Soetanto and Jack, 2013; Rakthai et al., 2019), including basic services (e.g., shared office, business assistance etc.), finance service (e.g., venture capital or funds availability etc.) and incubation service (e.g., successful graduate) (Howell and Sheab, 2001; Hughes, 2007; Manimala and Vijay, 2012). Therefore, the business incubators create an internal context and leverage external resources to exploit the business and innovations of entrepreneurs that are assessed to have commercial potential (Xiao and North, 2018), thereby contributing to the formation and early development of new technology-based start-up enterprises (Clayton et al., 2018). This is likely to involve refining business and innovations of China's regions through a process of co-production between the capacities of the incubator and the start-up enterprises (Rakthai et al., 2019).

1.3.1 Density of Business Incubators and Regional Innovation Performance

In line with organizational ecology and density dependence theory, the nature of the relationship between the density of business incubators and regional innovation performance is both positive and negative effects (Hong et al., 2019). On the one hand,

regional innovation should benefit from “agglomeration economies”, when numerous business incubators are clustered in the region (Cavallo et al., 2020). Agglomeration supports the initiation and development of inter-incubators relationships due to the increased possibility of communication, casual meetings and conversations, allowing the identification of shared interests and reducing the uncertainty of innovation activity and knowledge transaction costs (Vásquez-Urriago et al., 2016). In addition, a region with an initial growth of the business incubators may provide broader opportunities for innovation activity, knowledge transfer, and experience sharing (Runiewicz-Wardyn and Runiewicz-Wardy, 2013; Soetanto and Jack, 2013; Rubin et al, 2015). Thus, the initial development of business incubators density, the more valuable for regional innovation performance. (Huggins and Johnston, 2009).

On the other hand, the further increase in business incubators density brings great competition (Hong et al., 2019). Many authors suggested that the business incubators may adjust the length of the development period (i.e., intensity of innovation) in response to their subjective belief in the degree of competition in its location (i.e., perceived competition) (Harper-Anderson and Lewis, 2018; Hong et al., 2019). Furthermore, the extant literature has identified that there are two conflicting factors influencing the business incubators expected present value for the innovation maximizing length of the development period (Howell and Sheab, 2001; Hughes et al., 2007, Huggins and Johnston, 2009). A longer period reduces innovation costs but also the revenues from it. In a similar vein, great competition increases the probability of a competitor being the first with a finished innovation, which would lower the performance other business incubators expects from their own innovation (George et al., 2002; Hong et al., 2019). Some scholars, such as Peneder and Woerter (2014) suggested that when the initial growth of business incubators density, the competition (or a threat of a competitor winning the competition) exists at a low to medium level in the region, the business incubators may increase their innovation efforts (Peneder and Woerter, 2014; Hong et al., 2019). But, with the competition increases beyond the medium level, the business incubator reduces its own innovation efforts and thus may unfavourable for regional innovation performance development (Peneder and Wörter, 2014).

1.3.2 Capacities of Business Incubators and Regional Innovation Performance

Whether the business incubator can facilitate effective regional innovation performance is a debatable point (Barbero et al., 2012). Extant studies noted that in the earlier stage of some business incubators in Europe has relaxed their entry criteria in an effort to fill up space and generate rental income, rather than being totally dedicated to the creation of new technology-based start-up enterprises (Sonne, 2012; Soetanto and Jack, 2013). In contrast, some literature suggests that support capacities provided by the business incubators evolved over time from just providing physical working spaces and a shared infrastructure to facilitating access to external resource and knowledge (Bruneel et al., 2012). The majority of recent studies have shown not only the new generation of European business incubators is more focused on new technology-based firms than were previous generations (Clarysse et al., 2005), but greater emphasis is now placed on innovation investment such as those with business angels, venture capitalists and other business partners (Bøllingtoft and Ulhøi 2005; Aerts et al., 2007; Bruneel et al. 2012). Furthermore, some literature generally agrees on a positive relationship between investments in internal or external R&D resources and innovation performance (Li et al., 2016; Xiao and North, 2018), while the mechanisms by which business incubator development leads to better regional innovation performance still need further study. From these various ways, the business incubators offering the nurturing environment for the creation and early development of innovative enterprises ventures through enhancing the availability of key resources that start-up enterprises may have difficulty in sourcing on their own from elsewhere (Howell and Sheab, 2011; Colombo and Delmastro 2002; Lee and Osteryoung 2004; Fu et al., 2012).

Much has been written about the basic services of business incubators provide professional service to start-up enterprises in assisting their survival and early development. (Aerts et al., 2007; Bruneel et al. 2012). These basic services may include advice on business, legal protection and sharing space, although they are also likely to embrace networking between start-up enterprises within the business incubator (Chege and Wang, 2020 Bruneel et al. 2012) and with potential business partner, customers and venture capitalists (Manimala and Vijay, 2012). Meanwhile, others have also found that such basic service is the base of innovation activity because a professional counsellor and a strong legal system also contributed to the surge of innovation performance (Dvouletý, 2018). In a similar vein, the business incubator in emerging economies plays a more direct role in assisting start-up enterprises to adapt to the country's economic

environment and in addressing institutional failures (Hong 2017; Dutt et al. 2016). In the context of China, the role played by the business incubators reflects the disparities of the business environment in substantial regional, with new business ventures needing to be guided through constantly developing procedures, regulations, government funding sources and property rights (Dahlstrand and Stevenson, 2010; Ahlstrom and Ding 2014).

The developed economies field of studies has investigated the business incubators (Fu et al., 2012; Harper-Anderson and Lewis, 2018). The literature suggested that start-up enterprises are most likely to be created by academic entrepreneurs who have already developed their innovations within academic institutes before being selected to enter an incubator (Hong, 2017). However, the empirical study provides us with the limitation of technology entrepreneurs and their start-up enterprises (Mian et al., 2016). As start-up entrepreneurs, they often lack the skills, capital, knowledge and experience required to exploit a business opportunity (Park, 2005). Therefore, the entrepreneurs and their start-up enterprises usually in need of business support and networking support including offering working space and assist with accessing funds or venture capital to help launch their business (Hughes et al., 2007). On the other side, this may not always be the case, especially for business incubator are located in emerging economies (Aerts et al., 2007). In emerging economies like China where regional innovation system with fast development and continuous reform, extant literature provides us with mixed evidence, much has been written about the inconclusive results and call for further research (Chandra and Fealey, 2009; Chege and Wang, 2020).

The extant literature has identified the importance of financial support (e.g., venture capital) by business incubators to creating and growing new innovative ventures (Berry et al., 2006; Bramwell, 2012). On the one hand, financial support may help fund activities directly related to developing innovations (e.g., funding research and hiring academic personnel). On the other hand, financial support may also facilitate the new technology or business concept commercialization (Hughes et al., 2007). In a similar vein, this study would argue that the financial support is primarily focused on the innovation process can also facilitate the early development of start-up enterprises to a point where they are commercially viable and ready to graduate from the business incubators (Manimala and Vijay, 2012).

1.4 The Importance of Communication Infrastructure

Extensive incubator studies pointed out the importance of the provision of specific types of support by the business incubator to reduce and relieve the constraints that start-up enterprises have in progressing and commercializing innovations (Huggins and Johnston, 2009; Bramwell et al., 2012). Regarding the main constraints of the start-up enterprises include difficulties in affordable infrastructure (such as the office or working space), knowledge and advanced technology; a lack of management, business skills and access to the business network; financial constraints and insufficient entrepreneurial development (Howell and Sheab, 2001). To this end, in deciding on the nature of these supports the business incubators will be taking account of various regional conditions, including the strength of the venture capital market, innovation systems, and knowledge development (Malhotra, 2002; Rubin et al., 2015). Therefore, this requires business incubators can get enough correct information of those local conditions in time and provide the information correctly (Huggins and Johnston, 2009). For instance, by providing support via regional communication infrastructure, the business incubators aim to remove or reduce the constraints that start-up enterprises experience in accessing scientific knowledge and resources that are affordable to them (Mahmoodzadeh et al., 2009; Bramwell et al., 2012; Manimala and Vijay, 2012; Mian et al., 2016). In advanced economies, this is likely to be achieved through enabling the business incubator to communicate network with scientists from universities and research institutes (Steinmueller, 2002; Tamasy, 2007; Tang et al., 2013; Rubin et al., 2015). Whereas literature that has begun examining the business incubators in emerging economies identify that the direct provision of the information of facilities knowledge and technology by the business incubators via communication infrastructure is more likely (Bruneel et al., 2012; Runiewicz-Wardyn and Runiewicz-Wardy, 2013; Xiao and North 2018).

Regional level studies provide evidence of the benefits of communication infrastructure use (Cieślik and Kaniewska, 2004; Deng, 2013). Communication infrastructure helps business incubator introduce more service, be more communication with the academic institution, and respond better to start-up enterprises demands -- in other words, to innovate (Dahlstrand and Stevenson 2010; Fu et al., 2012; Deng 2013; Elburz et al., 2017; Dvouletý, 2018). Furthermore, some authors argued that regional scientists and research facilities stock are seen to be associated with a region's attractiveness to

entrepreneurs (Audretsch and Keilbach, 2007; Elburz et al., 2017; Dvouletý, 2018). Therefore, the business incubators continuous communication with regional scientists and research facilities is even more important (Fu et al., 2012; Deng 2013). The research focusing on the effective transfer of scientific knowledge from academics to business incubators pointed out that more frequent interaction with academic scientists enabled the business incubator to help the start-up enterprises refine their innovative ideas and arrange to work with academics (Dahlstrand and Stevenson 2010; Cavallo et al., 2020). Developed communication infrastructure help the business incubators gain access to scientific knowledge resources (i.e., academic scientists, knowledge, equipment and laboratory or workspace), positively assisting to entrepreneurial innovation inputs and outputs (Elburz et al., 2017; Dvouletý, 2018; Chege and Wang, 2020).

In a similar vein, as regards the relationship between communication infrastructure and regional innovation performance, previous literature suggested that communication infrastructure adoption is only important when it truly leads to improvements (Fu et al., 2012; Elburz et al., 2017). The effects of communication infrastructure may be realised through the testing of different situation and decision-making scenarios, learning, the generating of effective business plans, accessing databases and enhancing communication and social networking (George et al., 2002; Harper-Anderson and Lewis, 2018). With the increase of each opportunity, strong and dynamic business incubators are also needed to seize the benefits of the entrepreneur by integrating them into organizational strategies and creating the right corporate culture for start-up enterprises adoption, use, and innovation diffusion (Hong et al., 2017; Soetanto and Jack, 2013; Rakthai et al., 2019). Hence, following the above argument, the more developed communication infrastructure within the region is likely to improve the ability of the business incubators to reduce the costs of conducting innovations by facilitating the transferring the resource and engaging with the expert (Sonne, 2012; Surana et al., 2020). Accordingly, this study expects that the regional innovation performance will vary depending on the development of communication infrastructure from the region (e.i. province or municipality) in which business incubators is located (Dahlstrand and Stevenson 2010; Fu et al., 2012; Elburz et al., 2017).

1.5 Research Question and Objectives

1.5.1 Research Question

China is considered a land of opportunity and is seen as attractive by global innovators and attains status as one of the fastest-growing economies in the world (Chandra and Fealey, 2009; Chatterjee and Sahasranamam, 2018). As mentioned above, this study will analyse the role of density and capacities of business incubators in regional innovation performance. The main research theme in this thesis is the impact of business incubators density and capacities on regional innovation performance. For the particular subject studied in this thesis and given the examination of the relevant literature, the Research Question (RQ) can be refined to:

RQ1. How does the business incubators density development affect regional innovation performance?

RQ2. How does the capacities of business incubators affect regional innovation performance?

RQ3. Does the communication infrastructure positively associate with regional innovation performance?

RQ4. How does the communication infrastructure moderate the impact of business incubators capacities on regional innovation performance?

These questions focus on three main areas of the business incubator and regional innovation performance: the initial growth of business incubators density; the further growth of the business incubators density; the capacities of business incubators, and the communication infrastructure that moderates the impact of business incubators capacities on regional innovation performance. From these questions, this study proposed specific hypotheses and further discuss the details in Chapter 4.

1.5.2 Research Objective

The main goal of the research study is to examine the impact of business incubators density and capacities on regional innovation performance and the moderating effects of communication infrastructure in China. The question of this study can be divided into the following objectives (OBJ):

OBJ 1. To analyse the impact density of business incubators on regional innovation performance, specifically focusing on the impact of different levels of business incubator density on innovation performance in different regions.

OBJ 2. To analyse the impact of business incubators capacities on regional innovation performance, to evaluate each capacity by pointing out their priority with reference to their impact strength on regional innovation performance.

OBJ 3. To analysis the role of communication infrastructure on regional innovation performance, specifically focused on the impact of communication infrastructure on innovation performance in the context of China.

OBJ 4. To analysis the moderation role on the relation between capacities of business incubators and regional innovation performance.

1.6 Research Method and Delimitations of the Research

This thesis pursues an empirical study analysis the impact of business incubators density and capacities on innovation performance in three geographical area and 31 provincial regions in China.

A clarification about the business incubators is necessary. In this study, the business incubators refer to nation business incubators. Compared with private incubators, the national business incubators follow the unified identification and evaluation standards, which play a particular exemplary role in the context of China (Zhuang and Ye, 2020). Therefore, this paper mainly takes the national business incubators (hereafter called the business incubator) as the research object. Following the China Torch Statistics Yearbook and official documents from the Ministry of Science and Technology, this study uses the business incubators data from 2008 to 2017 (China Torch statistical yearbook, 2018). It is mainly because before 2008, the business incubators in China were collectively referred to as national entrepreneurship service centres and lack of unified and clear statistics and evaluation standards (Xiao, L. and North, 2018; Zhuang and Ye, 2020). In 2007, the Ministry of Science and Technology promulgated the documents, criteria and list of the business incubators. In other words, the reliable and clear data of the business incubators available since 2008 (China Torch statistical

yearbook, 2018). Therefore, this study will not consider the data before 2008. The number of national business incubators was up by 18.9% from 2008 to 2017 (China Torch statistical yearbook, 2018). Thus, China provides an appropriate context to explore the link between the business incubators and innovation performance in the region.

Most previous studies on business incubators have used mainly primary data or case analysis and focused on the development of business incubators in advanced economies (Corsi and Di, 2014; Ratinho and Henriques, 2010; Lobosco et al., 2019; Lukeš et al., 2019; Sedita et al., 2019). However, the business incubators in emerging economies have not been extensively analysed (Özdemir and Şehitoğlu, 2013; Xiao and North, 2018). To our knowledge, this study is one of the first to research the impact of business incubators density and capacities on regional innovation performance, and the moderation role of communication infrastructure on capacities of business incubators and regional innovation performance in emerging economies using secondary data on empirical research.

Quantitative research methods were adopted to provide deductive, explanatory, and empirical data. Quantitative design gathered data from statistics yearbook collected in the sector from 2008 to 2017. While this thesis also using explanatory mono-method in the data analysis: descriptive statistics, multilevel modelling and other relatively econometric methods such as the entropy method are applied to analyse the quantitative data collected.

1.7 Significance Contribution of the Study

1.7.1 Significance of the Study

The research findings of the study will contribute to theory and practice, and an expansion of previous studies on regional innovation development by focusing on examining the impacts of business incubators density and capacities on regional innovation performance in the context of China. In addition, utilizing data from China, one of the emerging economies, contributes to the literature of business incubators and regional innovation, which traditionally concentrates on innovation performance and business incubators of advanced economies rather than innovation performance and business incubators in emerging economies. Using data from China to test theories of

innovation helps to confirm and expand the scope of theoretical applications.

Better information about the experience of the emerging economies regional innovation system will permit the discrimination and the investigation of contending zones and in addition general obstacles and reciprocities, which are of fundamental significance for the usage of real and latent joint activities. After studying the regional innovation system and comprehending the achievement of emerging economies in catching up with the leading economies. This study would present several perceptions for other developing countries.

In addition, this research desires to expose the diverse impacts of national innovation systems of emerging economies via indicating the key elements and systems aspect, how these aspects have committed to the running of the whole systems and interpreted inside the economic development of these nations. Through carrying out this, the research tries to extend the effectively present research literature on regional innovation system in emerging economies. Moreover, the present research literature has assessed the density and capacities of the business incubators in the context of China and evidence of that taken experience from China to other developing nations.

The facts and figures from this study might likewise be a perspective for policy (or strategy) makers in different countries in their endeavour to draw up science and technology strategies (or policies), in view of the interrelationship (or correlation) between components of the regional system of innovation and system variation involving the emerging economies. At last, this study would likewise reveal new chances of research into different territories of the innovation system in the context of China. Such as, the uneven distribution of innovative and incubation activity, is particularly apparent in many emerging economies.

1.7.2 Theoretical Contribution

This study investigates the effects of the density and capacities of business incubators on regional innovation performance. It also examines the moderating effect of communication infrastructure between the business incubators capacities and regional innovation performance. In particular, this study focuses on China as a representative emerging economy that has been promoting entrepreneurship and innovation in past

decades. This study constructed a dynamic panel regression model of the Chinese regional level panel dataset between 2008 and 2017. Against this background, this thesis makes four contributions.

First, this study links the concepts of organizational ecology and density dependence (mutualism and competition) with the impact of business incubators on innovation performance. This study argues that the development of business incubators density in the region has beneficial and detrimental effects on regional innovation performance. Thus, this thesis adds insights to the literature on regional innovation and business incubators by simultaneously studying the mutualism and competition relationship between business incubators and regional innovation performance.

Second, this study argues that business incubators contribute to regional innovation performance through their capacities. Following the previous literature, this thesis separate capacities of business into basic, finance and incubation capacity. Consequently, we develop arguments for the vital role of each capacity of business incubators facilitating China's regional innovation performance, provide a better understanding of their influence on regional innovation and business incubators literature.

Third, this study focuses on the communication infrastructure at the regional level. Communication infrastructure is part of the regional innovation system and represents the coordination of transferring and sharing capabilities and resources. Therefore, this study enriches the literature on regional innovation by demonstrating how the communication infrastructure influences regional innovation performance.

Finally, this thesis enriches the literature of regional innovation theory by determining the positive moderation role of communication infrastructure among capacities of the business incubator and regional innovation performance.

1.7.3 Practical Contribution

The purpose and conclusion of this thesis will have implications for the business incubators manager and innovation policymaker. For the business incubators, this study presents new empirical evidence on the interaction between capacities of business

incubators and regional innovation performance, which could be used to shape a wider understanding of how the business incubator contributing to the regional innovation performance. Furthermore, the density of business incubators can shape the different results of regional innovation performance. For instance, the impact taken by the high density of business incubators may reduce the regional innovation performance. Therefore, understanding the importance of the different results and the key agents in the regional innovation performance development can inform business incubators managers, and policymakers to make critical decisions to facilitate the business incubator and regional innovation performance health development (Sedita et al., 2019).

Although different regions in China have exhibited different levels of business incubator capacities (middle and western regions are generally weaker than eastern regions), the positive influence of business incubator capacities on the regional innovation performance is quite stable across regions. From this vein, both the western region and the middle region should consider more on how to mobilize the business incubators within the national innovation momentum in order to advance the development of regional innovation.

Furthermore, from the perspective of practical implications, the findings of this study suggest that the capacities of business incubators may bring more benefits beyond just providing additional entrepreneurial opportunities. In this sense, attention is deserved from policymakers to consider the impacts on innovation performance when designing policies to promote business incubators. It is important to realise that the development of business incubator capacities may in turn facilitate technological development beyond the boundary of business incubators to the regional level. This recommendation, however, is tempered by the condition that certain levels of pre-existing regional communication infrastructure in the region can harness the benefits of business incubators. As the communication infrastructures of many regions in China (as is the case in most other emerging economies) are still far behind those of most developed countries (Li et al., 2016; Wang et al., 2020), steady investment and development of the communication infrastructure will be necessary to establish a healthy regional innovation system.

1.8 Thesis outline and structure

1.8.1 Thesis Outline

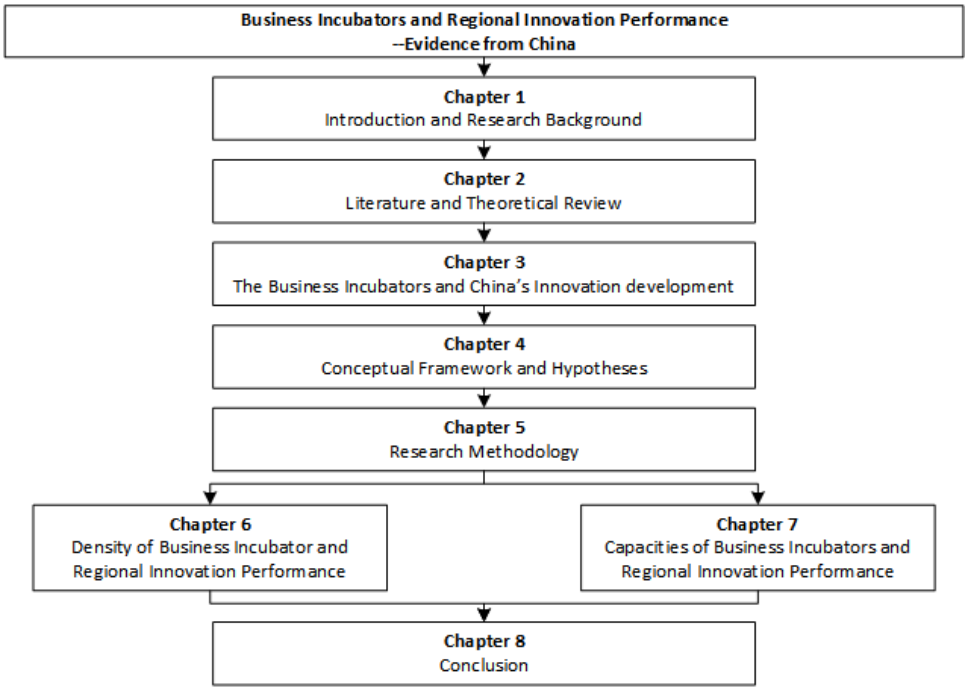

Figure 1 Research Outline

The thesis is organised into seven chapters (see Figure 1). The main analytical chapters, Chapters 6 and 7, are organised following a published journal article structure; they also following the presented specific aspects of the literature review (chapter 2), hypothesis (Chapter 4) and methodologies (chapter 5) that apply specifically in the above chapter.

Furthermore, the aim of this structure is twofold. First, the author expected that this thesis would improve the theoretical foundation and interpretation of the results in each chapter. Second, the author expected that this structure will facilitate the transformation of each chapter into journal articles. However, this structure may inevitably repetition of some content of the thesis. Thus, the methodology chapter (Chapter 5) will be reorganised to minimise repetition since the specific review of variable measurement and methods will be included in each analytical chapter (Chapter 6 and 7).

1.8.2 Thesis Structure

(1) Introduction of Thesis

The first present introductory, background which aims at presenting the importance of the problem statement, objectives, research questions the significance of the study, main

contents of this thesis and innovation of the study.

(2) Theoretical Background and Literature review

This chapter presents the theories, concepts and different approaches regarding business incubators, density and capacities of business incubators, communication infrastructure and regional innovation performance.

(3) The Business Incubators and China's Innovation Development

This chapter also introduced the development of business incubator and innovation performance in the context of China.

(4) Conceptual Framework and Development of Hypotheses

In this chapter, the conceptual framework has been presented and the hypotheses regarding all the variables including mediators and moderators are developed.

(5) Data Collection and Research Model

This chapter presents the research methodology discussing population, sampling, data collection, and piloting & testing of validity & reliability of research tools.

(6) Density of Business Incubators and Regional Innovation Performance

Chapter 6 presented the details about the result and discussion of business incubators density and regional innovation performance. Meanwhile, all the details regarding the variable measurement and GMM regression method are discussed in this chapter.

(7) Capacities of Business Incubators and Regional Innovation Performance

All the details regarding the results and analysis of business incubators capacities and regional innovation performance are discussed in chapter 7. This chapter also presented the details about the variable measurement and estimation methodology (GMM) of this study.

(8) Conclusion, Implications, Limitations and Future Recommendations

From chapter 8 which is about the conclusions and practical implications of this thesis, we can get a detailed picture about the conclusions we have obtained a result of these research studies as well as the practical implications of these studies. This is the last

part of this thesis presents the details about the limitations of this study. It also places some directions on the future researchers to work on new and other areas which have many other dimensions.

1.9 Summary

This introductory chapter has set out the purpose and research questions that this thesis aims to address. The study seeks to contribute to the literature on regional innovation and business incubators development by analysing the role of density and capacities of business incubators.

In particular, this study using a regional level panel dataset and quantitative analysis methods to better understand the relations between the business incubators and regional innovation performance. The results from this thesis will have implications for the business incubators and regional innovation performance development. Furthermore, it will also be possible to extract from the thesis policy implications for emerging economies that are developing innovation and entrepreneurship policies to promote regional innovation performance growth.

Chapter 2. Literature and Theoretical Review

2.1 Introduction

Chapter 2 reviews the relevant literature on business incubators in particular the previous studies relating to the relationship between business incubator density and capacity, communication infrastructure and the impact of business incubators (density and capacity) on the regional innovation performance. We also identify the existing gaps by reviewing the previous studies on business incubators and regional innovation performance. In short, the review of the literature will serve as a foundation for the empirical analysis and discussion of subsequent chapters.

This chapter also provides the definition of our critical subject. This chapter is organised as follows. Section 2.2 presents the definition of business incubators, business incubators density, business incubator's capacities, regional innovation performance and communication infrastructure. Section 2.3 presents the theoretical foundation. This study mainly draws upon regional innovation system theory and density dependence theory, further, we are also taking psychological capital theory, synergy theory, knowledge sharing theory and organizational ecology theory to explain the interaction between our empirical settings. Section 2.4 and Section 2.5 present the existing gaps and theoretical discussion. Finally, Section 2.6 summarises the chapter.

2.2 Key Definitions

2.2.1 Definition of Business Incubators

Considering the data availability and following the mainstream of extant study, the business incubators in this thesis mean the national business incubators (Lukeš et al., 2019, Wang et al., 2020). While the extant literature didn't agree on the collective definition of the business incubator (Allen and Rahman, 1985; Hackett and Dilts, 2004; Mubarak and Busler, 2010; Lamine et al., 2018; Lukeš et al., 2019). As a debatable point in the academic literature, and just as many have been accepted by industry associations and officials in different economies, revealing local cultures and national policies (Plosila and Allen, 1985; Hughes et al., 2007 Schwartz and Hornych, 2010; Jin; et al., 2018; Hong et al., 2019; Wang et al., 2020). Comprehensive definitions of the business incubator are explained in Appendix II.

The business incubator, as defined by Hughes et al. (2007), is a tool that helps small

firms to grow into competitive businesses in a concise span of time. The purpose of incubators is to provide support to the businesses in the development and sell the business ideas in an environment that minimizes the risk of failure (Aerts et al., 2007; Hackett and Dilts 2004; NAIB, 2007; Mubarak and Busler, 2010; Bruneel et al., 2012). The NBIA (2010) provides, perhaps, an even more descriptive notion of Business Incubation detailing its strategic intent and alluding to its economic worth as such: "A business supports a process that accelerates the successful development of start-up and fledgeling companies by providing entrepreneurs with an array of targeted resources and services (NBIA, 2010). These services are usually developed or orchestrated by incubator management and offered both in the business incubator and through its network of contacts (Dahlstrand, 2007). A business incubator's main goal is to produce successful firms that will leave the program financially viable and freestanding." (NBIA, 2010). Despite their seemingly varied nature, these definitions all converge around common factors such as strategic support, provision of office space, business mentoring, shared resources (secretarial and office equipment), and networking activities (Alavi and Leidner, 2001; Aerts et al., 2007; Bubou and Okrigwe, 2011). Hence, regardless of their geographical location, historical background or seemingly varied primary purpose in some cases, there are common strands that tether the notion of Business Incubation to a mutual goal stimulating growth, which has been generally measured in terms of employment creation, profit generation and sales growth (Barbero et al., 2010; Bøllingtoft et al., 2012).

These definitions also define some impacts of business incubator Smilor and Gill (1986) Suggests business incubator as economic development tool while the Hughes et al. (2007) and Eshun (2009) points that business incubator help create jobs and provide support to businesses and increases innovation. The National Business Incubation Association (NBIA) (2007) further conceives business incubators as tools to revive regional economies and strengthen innovation performance. The implied assumption here is that supporting companies in their early years protected from competitor aggressiveness will improve their chances of success and long-term survival through the business incubator (Mubarak and Busler, 2010; Schwartz and Hornych, 2010).

There is a notable divergence in current literature regarding the role and effectiveness

of incubators in the entrepreneurial process (Li et al., 2012; Margaça et al., 2020). On the one hand, the author's opinion incubators as an important service that adds to enterprise development and gives growth to an environment favourable to the success of the small business (Maples et al., 2017; Lukeš et al., 2019). For instance, business incubators have been defined as organisations that provide protected environments for business start-ups (Bruneel wt al., 2012). Cabrera et al. (2016), Bubou et al., (2011) and Chandra and Medrano (2012) observe that incubators were devised to address market failures such as inequitable access to capital, information and lack of relevant business advice to small businesses. Scholars define a business incubator as a facility providing favourable controlled conditions to aid the growth of new ventures (Crals and Vereeck, 2005; Cohen and Winn, 2007; Cowell et al., 2018). In a similar vein, the United Nations Economic Commission for Europe (Cebrián and Junyent, 2015) describes Business Incubation as a "systematic way to support the establishment and growth of a new company". Dahlstrand (2007) and Ellison et al. (2010) also affirm that Business Incubation is a program that organizes the process of creating successful new enterprises by offering prospective entrepreneurs a comprehensive and combined range of services.

2.2.2 Definition of Business Incubators Density

In this study, the density of business incubators is the number of the business incubators accumulative in China's region (Dahlstrand, 2007; Chandra et al., 2012; Carayannis et al., 2016; Cavallo et al., 2020). The Business incubators are spatially concentrated and are related to the role of mutualism and competition in addition to the geographic concentration of innovation (Baldwin et al., 2010; Chandra et al., 2012; Carayannis et al., 2016; Cavallo et al., 2020). The density of geographic agglomeration of the business incubators differs between regions within any one nation, giving the business incubator cluster a local character and highlighting its importance in the regional innovation system (Dahlstrand, 2007; Cowell et al., 2018). The existing study pointed out that there is a dependency relationship between business incubators (Ellison et al., 2010). Meanwhile, two types of dependency relationship have been identified in the current literature as playing a vital role in the process of innovation: mutualism and competition (Hanadi and Aruna, 2013; Filieri and Alguezaui, 2014). In general, the initial growth of business incubators density makes mutualism, but the great level of business incubators' density makes competition (Hanadi and Aruna, 2013; Grimaldi and Grandi, 2015).

With regard to the debate on mutualism, Hillemane et al. (2019) formalized the work of Cohen and Winn, (2007); Baldwin et al., (2010); Bruneel et al., (2012); Mudambi and Swift, (2012); Carayannis et al., (2016) and Cavallo et al. (2020) on geographic concentration of industries. They put forward the concept of Marshall–Arrow–Romer (MAR) externalities, whereby the agglomeration of an industry at the regional level facilitates knowledge transfer between enterprises and improves the innovative capability (Essletzbichler and Rigby, 2007; Mudambi and Swift, 2012). Many studies suggesting that MAR externalities not just between firms but also between organisations, such as the business incubators (Wang et al., 2009; Mudambi and Swift, 2012; Wang et al., 2016). Literature supporting the MAR externalities emphasize that knowledge transfer within the same or similar industries is an effective way to enhance innovation in the cluster for several reasons (Wang et al., 2016; Cavallo et al., 2020). First, the knowledge and R&D resource can be shared among business incubators with lower transmission costs within the region (Mudambi and Swift, 2012; Wang et al., 2016). Second, proximity between business incubators facilitates the knowledge, and R&D resource transfer as advanced knowledge and resource is often embedded through the mobility of talents (Wang et al., 2009), collaborative R&D activities (Essletzbichler and Rigby, 2007) and communications (Carayannis et al., 2016). Finally, the intense use of infrastructure by the business incubators within the region is more efficient than its use by scattered business incubators (Mudambi and Swift, 2012; Wang et al., 2016).

In contrast to the MAR externalities, with regard to the debate on the competition (Mudambi and Swift, 2012). Existing literature argues that investors and stakeholders of business incubators sometimes prefer a less competitive environment (Cebrián and Junyent, 2015) in which valuable knowledge and R&D resources are concentrated (Wang et al., 2009). This kind of knowledge and R&D resources concentration fosters the creation of new technologies or products (Wang et al., 2016). Therefore, many authors have argued that the less competitive environment protects innovation and that powerful business incubators within the region can reallocate knowledge and R&D resources more efficiently and pursue more innovation performance (O'gorman and Kautonen, 2004). Meanwhile, scholars supporting this point of view claim that highly competitive is not conducive to technological innovation (Usai, 2011); business incubators often take to gain competitive advantage in the region through increasing

marketing input, distracted business incubators attention from the innovation activities (Wiggins and Gibson, 2003). In addition, some literature suggested that the ever-increasing of competition in the region may reduce communication between business incubators (Camagni, 2017). However, the interactive effect of communication between different business incubators, especially complementary sectors, is thought to be a crucial form of R&D and innovation activities (Mudambi and Swift, 2012). In other words, the high density and competition of business incubators reduce the regional R&D activities and innovation performance (Hou et al., 2019; Wang et al., 2020).

2.2.3 Definition of Business Incubators Capacities

Business incubators provide a way to assist small, young firms in developing into successful businesses quickly and with relatively less risk (Rippa and Secundo, 2019). In order for that to happen, the incubators themselves must perform well and be capable (Pavic et al., 2007). Following the existing study, this thesis is further subdivided business incubators capacities into three major classes, such as basic, finance and incubation capacities. Furthermore, the existing literature in the fields of regional study, entrepreneurship and innovation have identified that entrepreneurship is one of the key factors of regional innovation development in emerging economies (Hillemane et al., 2019). In the context of China, entrepreneurship has the potential to accelerate regional innovation performance and promote regional development (Hong et al., 2019). Meanwhile, significant resources have been allocated to start-up enterprises growth and development by the Chinese government (Zhao et al., 2017; Sun et al., 2019; Si et al., 2020). Despite this input, start-up enterprises face many challenges that impede their growth and development (Rui and Yip, 2008).

(1) Basic Capacity

The number of infrastructures is the basic capacity is common for business incubators and the core of their value proposition (Grimaldi and Grandi, 2015; Jin et al., 2018; Hillemane et al., 2019). This consists of office space rented in favourable conditions to incubate (Colombo and Delmastro, 2002). Furthermore, business incubators often have small production facilities or mixed units available to their tenants (Lalkaka, 2013; Mudambi and Swift, 2013; Eveleens et al., 2017). Shared resources such as reception, clerical services, meeting rooms, conference rooms or car parking (Crals and Vereeck, 2005; Bruneel et al., 2012) complement the office space and are normally available in

business incubators (Lesakova, 2012). More specialized resources, such as laboratories and research equipment, can also be placed under infrastructure (Chan and Lau, 2005; Cebrián and Junyent, 2015).

Furthermore, the staff in the business incubator provide management support services for entrepreneurial teams. Management support is related to accelerating the learning curve of nascent companies (Carvalho and Galina, 2015; Carayannis et al., 2016). New firms often lack the necessary management skills and experience to cope with sudden environmental shifts and rapidly changing environments (Grimaldi and Grandi, 2005; Luthans et al., 2007; Hanadi and Aruna, 2013; Lukeš, 2019). Through a process of learning-by-doing, new firms change their behaviour and develop a set of routines. These routines include forms, rules, procedures, and strategies around which organizations are constructed and through which they operate (Pérez-Alemán, 2005; Qian et al., 2011; Markovitch et al., 2017).

(2) Finance Capacity

For start-up enterprises, the shortage of capital can affect the normal production and operation activities, reduce the market competitiveness of the enterprise, and restrict further development (Baraldi and Havenvid, 2016; Camagni, 2017). Thus, the finance service is another capacity of business incubator to help start-up firms overcoming their capital resource scarcity (Colombo and Delmastro, 2002). Capital may be sourced from private donors, public grants and funds, commercial institutions or a combination of these (Lalkaka, 2003, Lesakova, 2012). Business incubators typically manage a network of professionals who can provide access to capital resources. Literature shows that start-up enterprises in the business incubators overcome their capital resource constraints through finance service and thereby accelerate firm growth (Mian et al., 2012; Baraldi and Havenvid, 2016; Hillemane et al., 2019).

(3) Incubation Capacity

As mentioned above, one of the most critical things to attract more start-ups and improve the incubation rates is transferring several resources to technology entrepreneurs and start-up enterprises (Sindakis et al., 2015), business incubators can also promote the transfer of knowledge through enhanced social relationships between innovators and entrepreneurs (Parida and Örtqvist, 2015; Ramesh, 2017), which is a

key part of the incubation capacities of business incubators (Rubin et al., 2015; Sentana et al., 2017).

Fundamentally, the principle of knowledge transfer is a process meant to obtain experience from others and carries out innovation activities (Sun et al., 2019). While referring to Whittington et al., (2009) mentioned that knowledge transfer refers to the preparation of task information, know-how to collaborate with others to facilitate people, problem-solving, implement policies, or promote innovation. Wallsten (2001) and Witherspoon et al., (2013) suggested that knowledge transfer is a process in knowledge management that used to create, harvesting, and sustaining business processes. The evolution of knowledge transfer is trendy, according to the importance and used of knowledge transfer towards the business (Evers et al., 2010; Mian et al., 2012; Parida and Örtqvist, 2015). Hence, knowledge transfer is the practices of exchange and disseminates the idea, experience, and knowledge with the others to ensure the knowledge continues, sustain and retain in the business (Alavi and Leidner, 2001; Evers et al., 2010; Allameh and Zare, 2011; Panahi et al., 2013; Geisler and Wickramasinghe, 2015).

Meanwhile, Alavi and Leidner (2001) pointed out that knowledge held by the business incubators must consequently be passed along to the start-ups for its value to be appropriated. Allameh and Zare (2017), pointed out that knowledge in the business incubators plays an important role in improving the company's technological innovation ability. Furthermore, knowledge transfer is an important segment and a challenge of knowledge management (Cabrera et al., 2006; Filieri and Alguezaui; 2014). Wang et al. (2020) believe that after the business incubators have acquired the required knowledge, it can increase the ability of the enterprise to create value through knowledge transfer, and then enhance the innovation ability of the entire region.

2.2.4 Definition of Regional Innovation Performance

(1) Regional Innovation Performance

Literature reveals that regional innovation mainly focuses on interaction across different actors (such as a university, government, and industry) (Watkins et al., 2015). The purpose of this interaction is to facilitate the exchange of knowledge amongst the aforementioned parties (Klerkx and Leeuwis, 2008). Several iterative processes are also

involved during knowledge exchange (Fazey et al., 2013). These processes are managed through different innovation systems and its models (Cooke et al, 1997; Pohlmann et al., 2005; Schulze et al., 2015; Shaikh and O'Connor, 2020).

Regarding the concept of regional innovation performance, there is no unified viewpoint and understanding in existing research, and many scholars have given some interpretations from different perspectives (Iammarino, 2005: 499; Ivanova and Leydesdorff, 2014). Shaikh and O'Connor (2020) discussed regional innovation performance as the potential of a specific region to continuously generate innovations linked to business. Kaiser (2009) believes that regional innovation performance is the ability of regional innovation subjects to adapt to environmental changes in innovation activities and the ability to use existing resources. Jiao et al. (2016) defined regional innovation performance as the ability of a region to transform knowledge into new products, new processes and new services. Zhao et al. (2020) believes that regional innovation performance is a concept of capability combination, which reflects the ability of creative integration of innovation resources in a region.

Another literature studies regional innovation performance from the perspective of regional innovation systems. Cooke et al. (1998: 1564) define RIS as systems "in which firms and other organizations are systematically engaged in interactive learning through an institutional milieu characterized by embeddedness". Iammarino (2005: 499) adds that RIS constitute the localised network of various actors and institutions in different sectors whose activities and interactions generate, absorb, and diffuse new technologies within and outside the region. Now, this term is familiar around the globe especially among policymakers and the research community (O'gorman and Kautonen, 2004; Afzal et al., 2007; Zhao et al., 2020). The term RIS includes several elements which are used to enhance the interaction of process and also link with the performance and economic growth (Doloreux, 2004; Chan and Lau, 2005).

Regional innovation performance is reflected in the integration of the capabilities of different innovation entities in the region (Stek and van, 2016), and the interaction of different innovation entities determines the results of regional innovation performance (Wang et al., 2019). Thus, regional innovation performance is manifested in the scale and efficiency of innovation input and innovation output (Li, 2019). From the

perspective of the innovation value chain, regional innovation capabilities can be expressed by the output or efficiency levels of different innovation stages (Bi et al., 2016). For instance, in the two-stage value chain model, regional innovation includes two parts: technology development and innovation achievement transformation. In the three-stage value chain framework (Du et al., 2019), regional innovation can be divided into three processes: knowledge innovation, scientific research innovation and product innovation (Bi et al., 2016; Eveleens et al., 2017; Du et al., 2019).

In this study, regional innovation performance refers to the ability of all innovation entities such as enterprises, universities, scientific research institutions in a region to produce new technologies and new products by inputting innovation elements, and it is directly reflected in the scale of innovation output. Therefore, in this study regional innovation performance comprehensively measured by the input and output of regional innovation.

(2) Evaluation of Regional Innovation Performance

According to the Knowledge Production Function (KPF) proposed by Griliches (1979), capital and labor are the basic inputs for R&D and innovation activities, and the level of R&D investment often has a decisive impact on the innovation capability of a country or region (Fan, 2007). Freeman and Wang et al. (2019) found that the difference in the intensity of R&D investment is the main reason for the gap in innovation capacity among OECD countries. Watkins et al. (2015) used national and province panel data to conduct empirical analysis and found that and Zhao et al., (2020) the improvement of China's innovation capabilities mainly relies on R&D investment. From the perspective of production function, human capital is also an important innovative production factor, which plays an important role in promoting innovation activities (McGuirk et al., 2015). Ding and Knight (2009) believe that the accumulation of human capital is an important reason for the continuous improvement of China's innovation ability after the reform and opening up. Qian et al. (2011) pointed that human capital has a significant positive correlation with regional technological innovation activities. Sun et al. (2019) found that when the level of human capital exceeds the critical value, the role of human capital in promoting the innovation capability of China's manufacturing industry becomes more obvious.

Corresponding to innovation input is innovation output capability. Regional innovation output refers the ability of a region to converts the knowledge to new product or patent (Fu, 2008; Li et al., 2016). Not all innovations are patented, but patent counts are the favoured measure used in most previous research because they provide a more accurate indication of innovation performance than alternative measures such as "new product" sales (Acs et al., 2002; Nelson, 2009; Honget al., 2019; Wang et al., 2020). This is because "new products" are often loosely defined and can be potentially over-recorded by firms in order to gain subsidies in many countries such as China (Li et al., 2016; Wang et al., 2020).

2.2.5 Definition of Communication Infrastructure

Communication infrastructure is defined as interconnected dyadic technological tools (Parida and Örtqvist, 2015), these tools used to communicate and to create, disseminate, store, and manage information, resource and knowledge (Ning et al., 2016). Indeed, it has been suggested that communication infrastructure is considered to be one of the most important factors in assist the success of business incubators contribution to regional innovation performance (Grimaldi and Grandi, 2005). Entrepreneurship and innovation are a dynamic process that requires links and relationships not only between individuals but also between several organisations (Panahi et al., 2013; Wang et al., 2020). Through communication infrastructure, the business incubators have access to more resource (or knowledge) and may have a greater chance of solving entrepreneurs' problems expeditiously (Alzaghal and Mukhtar, 2017), which may strongly facilitate innovation performance through knowledge sharing, scientific research, technology and venture capital acquisition (Breznitz et al., 2018).

Hargreaves et al. (2008) argued that infrastructure is essential for innovation activities during 1996-2000. The author studied 36 countries from Sub-Saharan Africa in reaching the conclusion (Hargreaves et al., 2008). By using time-series data during 1960-2005 for innovation performance in Malaysia, Ali et al. (2010) examined the infrastructure as a driving element for MNEs preferred locations. They found that an increased level of communication systems promotes innovation performance (Ali et al., 2010). Anyanwu and Yameogo (2015) applied mobile phone as a subscriber per thousand inhabitants, as well as telephone mainlines as the determinant of innovation performance. Using the dataset from 1970 to 2010 for 53 African countries, the authors

concluded that communication infrastructure is among the essential factors affecting innovation activities (Anyanwu and Yameogo, 2015).

By applying the 25 developed Economies (1970-2014) panel data, Ding et al. (2021) showed that communication infrastructure is a key factor for firms adopted the innovation activities, the authors applied infrastructure proxied by communication production and applied techniques. Pradhan et al. (2016) conducted a study on annual data from 1961 to 2013 about communication and transportation infrastructure impact on innovation performance in the Indian economy. Using the ARDL methodology, the authors found communication and transportation infrastructure as an important factor for enterprises innovation activities (Fan et al., 2018). They applied the infrastructure data on the individual and aggregate level. Communication and transportation data were treated separately in estimation (Andersson et al., 1990).

Blyde and Molina (2015) examined that cross-border production by MNEs depends on communication and transportation. The authors extracted the results by examining 230 economies and concluded that physical infrastructure may affect innovation production. Khadaroo and Seetanah (2010) studied Mauritius by applying the ARDL technique. In the same study, the authors extended the study by applying the fixed effect model on twenty African economies (Koh, 2006). The authors concluded that communication infrastructure is the main driver of innovation development in these countries during 1960-2004; hence, the communication infrastructure is among the key factors in influencing innovation performance (Markard et al., 2011; Díaz-Roldán and Ramos-Herrera, 2021).

2.3 Theoretical foundation

2.3.1 Regional Innovation System Theory

Inferred from studies in Germany and the United Kingdom, the concept of Regional Innovation System refers to in which firms and other organizations (e.g., business incubators) are systematically engaged in interactive learning through an institutional milieu characterized by embeddedness (Cooke et al., 1997; Clarysse et al., 2005; Afzal et al., 2007; Bi et al., 2016; Breznitz et al., 2018). Subsequently, the literature added that the regional innovation system is the localised network of various actors and institutions in different sectors whose activities and interactions generate, support and

diffuse new technologies within and outside the region (Andersson and Karlsson, 2006). Furthermore, extant literature suggested that regional innovation theory is particularly appropriate when examining the determinants of innovation performance in the context of the country that has a massive territory (e.g., China) and where generally with substantial regional disparities in terms of informatization progress and innovative capabilities (Chen et al., 2014).

Several studies have identified some drivers of regional innovation performance. Such as the business incubators are recognised as a booster for regional innovation (Colombo and Delmastro, 2002). Equally, the regional informatization level is a strong direct and indirect driver of regional innovation performance (Liu and Nijkamp, 2019). Wang et al. (2020) suggested that the development of regional informatization worthy of consideration since it can be conducive to knowledge transfer and then stimulating innovative behaviour in local business incubators. Most of the study considering the business incubators as one entire piece to explore the relationship with regional innovation performance (Lesakova, 2012; Schulze et al., 2015; Xiao and North, 2018); this study aimed to further investigate the impact of the various capacities (basic, finance, and incubation capacities) of business incubators on regional innovation performance and the moderation relationship of regional informatization level among them (Colombo and Delmastro, 2002; Watkins et al., 2015; Shih and Aaboen, 2019).

2.3.2 Psychological Capital Theory

The psychological capital theory defines the personal performances are functions of psychological capital which are affected by factors such as confidence, optimism, hope and resilience (Peterson et al., 2011; Cavus and Gokcen, 2015). Psychological capital theory, which has grown out from the intersection of psychology, and social science (Krueger, 2003). This theory can be used to explain people's cognitions and behaviours in social and economic activities, such as innovation or entrepreneurial activities (Shepherd and Krueger, 2002; Krueger, 2003). It views the motive power of entrepreneurial activities as the development of psychological states (Brandstätter, 2011). As Luthans et al. (2007) and Peterson et al. 2011 stated, the positive development of the psychological state is reflected in the confidence and abilities of entrepreneurship. Thus, psychological capital theory has been recently receiving special attention in business incubator literature (Baraldi et al., 2016; Baluku et al., 2019), as this construct

has been found to result in positive entrepreneurship behaviours, such as increased confidence, optimism and resilience (Cavus and Gokcen, 2015; Newman et al., 2019).

Extant studies suggested that psychological capital can be measured and further developed. Specifically, psychological capital can be reflected in the following four dimensions:

(1) Self-efficacy, which refers to the confidence that entrepreneurs have when putting efforts to succeed in some challenging tasks.

(2) Optimism, which is about how entrepreneurs can make positive contributions to current and future success.

(3) Hope, which refers the entrepreneurs having goals and persevering toward the goals to succeed.

(4) Resiliency, which means the sustaining and bouncing back when the entrepreneurs beset by problems and adversities to attain success (Luthans et al., 2007).

To this end, developing psychological capital means enhancing the psychological capabilities and innovation strengths of entrepreneurs, which leads to improved innovation output of the start-up enterprises (Newman et al., 2019).

Most studies around the psychological capital theory have focused on its impacts at the personal level though some scholars started to study it at the organizational or platform levels (Luthans et al., 2007; Avey et al., 2015; Alzaghal and Mukhtar, 2017). From the perspective of the personal level, the psychological capital theory has been found to have a positive impact on personal lives as well as work lives (Cavus and Gokcen, 2015; Baluku et al., 2019). Such as, extant literature found that entrepreneurs' psychological capital was positively related to their overall well-being due to their capabilities in stress (Peterson et al., 2011; Siu, 2013; Baron et al., 2016). On the other side, literature on psychological capital mainly investigated the relationship between psychological capital and workspace outcomes, such as business incubators and entrepreneurs' innovation behaviours (Nelson, 2009; Newman et al., 2019). Luthans et al. 2007;

Peterson et al. 2011 and Baluku et al. 2019 suggested that business incubator delivery of basic services like incubation space, business guide and management support, which have significantly raised self-efficacy, optimism, hope and resiliency of entrepreneurs, and entrepreneurs could be more relaxed and calmly face the innovation challenges and therefore improving the innovation output (Gupta et al., 2019). In which case it is reasonable to suppose that basic service capacity may have a significant impact on the innovation performance of regions in which business incubators are based (Peterson et al. 2011; Siu, 2013).

2.3.3 Synergy Theory

Previous studies suggested that synergy means working together, which needs a platform for participation through the development of dialogues, between disciplines and people (Harwood, 2000: 523-529). Naudé et al., (2002, p. 2) add that synergy theory constitutes the ability of two or more institutions or companies to generate greater value working together than they would work apart. The funds of business incubator usually from multiple sources (Wonglimpiyarat, 2016). For instance, privately and publicly sponsor (Baraldi and Havenvid, 2016; Apa et al., 2017; Baluku et al., 2019; Du et al., 2019). Private sectors sponsor includes corporate money and direct donations (Somsuk et al., 2012; Newman et al., 2019). Public sector sponsors include federal state and local governments (Zawacki et al., 2018). It has been suggested that financing is a key element in innovation and foundation for entrepreneur activities (Stam, 2015). Thus, the synergy theory could explain why the finance service capacity of a business incubator has an impact on innovation performance.

The synergetic means that business incubators, start-up enterprises and financial institutions utilize resources to break through the barriers (e.g., unequal information etc.) between innovation subjects (Somsuk et al., 2012), and then fully release the vitality of innovation elements (e.g., government funds or loan from a financial institution), among each other for realizing deep cooperation (Pradhan et al., 2016). Extant studies pointed out that the development of start-up enterprises in business incubators generally goes through the stage of financing from internal or outside of business incubators (Grimaldi and Grandi, 2005; Tamasy, 2007).

In the stage of incubation, capital input is important for start-up enterprises (Xu, 2010).

It shows the participation of financing capacity in the business incubators (Xu, 2010). In the process of start-up enterprises development, as demanders for advanced technology, start-up enterprises usually need to allocate funds for relevant research (Wonglimpiyarat, 2016).

The advantages of business incubators financing capacity lie in their ability to synergy various source of financial and lets start-up enterprises have enough financial ability to engage the possession of high-quality talents or advance technology (Tamasy, 2007; Stam, 2015), which plays an important role in business incubators (Somsuk et al., 2012). Meanwhile, the more reasonable the financial input in R&D activities of start-up enterprises in business incubators is the more innovation and practical value the cooperation will achieve (Peterson et al., 2011; Pradhan et al., 2016). The capital allocated in the R&D stage not only have a direct impact on the intermediate output (Mudambi and Swift, 2012), such as patents and designs but also promote the innovation performance in the stage of incubation (Colombo and Delmastro, 2002; Doloreux, 2004; Benneworth et al.,2009; Baraldi and Havenvid, 2016; Fan et al., 2018).

2.3.4 Knowledge Sharing Theory

The concept of knowledge sharing refers to the process or activity of knowledge exchange (Bouncken and Aslam, 2019). The concept has been applied not only to individuals but also to groups or organisation. Extant literature has defined knowledge sharing theory as the knowledge communication from the source in such a way that it is applied or accessed by the recipient (Alavi and Leidner, 2001). In a similar vein, some study proposed that knowledge sharing means the provision of task information and know-how to help others and to collaborate with others to solve problems, develop new ideas, or implement policies and procedures (Lin et al., 2020). The increasing development in the area of business incubators facilitating knowledge sharing (Carayannis and Von, 2005), and ensuring its broad diffusion among the entrepreneurs, start-up enterprise and talents that work by business incubators creates an innovation space that supports knowledge sharing activities (Sofouli and Vonortas, 2007).

Many authors have suggested that the greater adoption of business incubators as a knowledge sharing platform spanning incubation network, has recently attained significant attention in the field of academic and industry (Klerkx and Leeuwis, 2008;

Mudambi and Swift, 2012; McGuirk et al., 2015; Spender et al., 2017; Newman et al., 2019). There is also have considerable literature that recognized business incubators as an important platform that make it possible to freely join together large sets of entrepreneurs, who can access or exchange knowledge, and express thoughts, experiences and perceptions (Chen et al., 2014; Eveleens et al., 2017; Elia et al., 2020). Meanwhile, the extant study has pointed out that business incubator encourages entrepreneurs to share their knowledge via incubation network, because it facilitates efficient information flow and innovation within and between teams (Hausberg and Korreck, 2021). It helps describe what, how and where to find the knowledge to promote entrepreneurship and innovation activities (Lesakova, 2012).

Tamasy (2007) and Tsai et al. (2009) argued that business incubators integrate various knowledge resource of entrepreneurship and innovation in the regional to implement the start-up enterprises development. Therefore, business incubators provide social network connections for start-up enterprises, access to social network is the business incubators contribution to help start-up enterprises overcoming their inherent resource scarcity (Pohlmann et al., 2005; Somsuk et al., 2012; Liu et al., 2019). Research shows that these firms overcome their resource constraints through networking and thereby accelerate firm growth (Grimaldi and Grandi, 2005; Brandstätter, 2011; Fan et al., 2018). As a platform for knowledge sharing, business incubators not only promote learning among start-up enterprises within the incubators (Chaminade and Vang, 2008), but also integrate the transfer of tacit knowledge flows such as technology and experience from universities and academic institutions (Alavi and Leidner, 2001; Fazey et al., 2013), which significantly promotes the technological achievement transforms for start-up enterprises (Klerkx and Leeuwis, 2008; Jiao et al., 2016; Lin et al., 2020). To this end, the incubation capacity is dedicated to the development of start-up enterprises in business incubators, promote the flow of knowledge achievements through access to social networks and promote the development of regional innovation. (Chaminade and Vang, 2008; Fu, 2012; Schulze et al., 2015; Zhao et al., 2020).

2.3.5 Organizational Ecology Theory

The theory of organizational ecology emerged in the 1970s (Singh and Lumsden, 1990). It has received more and more attention because of its ability to systematically explain the interaction between individual and organizational populations and clearly explain

the dynamic development process of the interaction between the organization and its environment (Amburgey and Rao, 1996; Baum, 1999). It is developed based on the theory of population ecology of organizations and is a cross-discipline that combines the principles of sociology and ecology (Ruef, 2000). Specifically, Organizational ecology is concerned with the capacity of the environment to support organizations and the rate of growth and decline of organizations within the environment (Kearney, 2003). At the same time, individuals in the same organizational population have common needs for environmental resources (Fischer and Jasny, 2017). Thus, they need to compete for resources. Organizational ecology theory analyses the interaction between the organization population and its environment to explain the interdependence between individuals in the organization population and between the organization population (Morin, 2020), and finally explores how the organization populations generate growth and extinction (Haveman and Wetts, 2019).

The development trend of organizational ecology is to regard the organisation's development as a dynamic and evolving process (Hannan et al., 1995; Baum, 1999; Fischer and Jasny, 2017). The entire process from the establishment to the death of the organization and the surrounding environment constitute a co-evolutionary system that changes all the time (Ruef, 2000; Kearney, 2003). A typical application of the organizational ecosystem is in business management, especially in ecosystem issues with the enterprise (Oertel and Walgenbach, 2009; Gawer and Cusumano, 2014). After it has been applied to sociology and management, it has greatly expanded the existing research horizons and strengthened the interpretation of practical problems. In recent years, organizational ecology has also been introduced to emerging research fields, such as technological innovation in emerging markets (Winn and Pogutz, 2013; Watkins et al., 2015), e-commerce (Javalgi et al., 2005), product and, international trade (Wenting and Frenken, 2011). Meanwhile, Organizational ecology theory acknowledges that an organization's dynamic and adaptation to environmental constraints is impacted by its resources and capabilities (Freeman and Hannan, 1989; Kearney, 2003). Such as, the lack of resources caused by fierce competition in the business incubators may cause the new venture to lack technological innovation (Soetanto and Jack, 2013).

2.3.6 Density Dependence Theory

The quantitative changes of organizations follow a similar way (Kooijman, 2001). For

instance, railway companies, labour unions, telephone companies, banks, and newspaper companies emerged in news organisations (Javalgi et al., 2005). The initial was less but increased rapidly, and then stabilized or gradually declined (Ruef, 2000). To explain this phenomenon, Freeman and Hannan (1989) proposed a density dependent model using the dynamic evolution model of the organization population and the new institutional theory. This model reflects the influence of population size and quantity on the organization growth process (Bolívar et al., 2012). The dynamic impact of population density on organizational development reflects two opposing processes: Legitimacy and competition. When a new organization population appears, the increase in the organization population density facilitates the organization's cognitive legitimacy and promotes the organisation's development speed (Xu, 2018). On the other hand, when the population's density is high, the competition could hinder the further development of the organization population (Fischer and Jasny, 2017). Considering these two processes, Freeman and Hannan (1989) predicted that the density of an organized population had an inverse U-shaped relationship with the establishment speed of the organisation population.

Specifically, when the density of the new organization population is low, the competition of the organization population is weak (Ning et al., 2016; Xu, 2018). However, the mortality of the organization is still high, which is mainly due to the low legitimacy of the organization (Eilstrup-Sangiovanni, 2020). In these circumstances, the investors, suppliers, consumers, and workers may keep vigilant to the organizational population (Fischer and Jasny, 2017). The leaders of such organizations are also difficult to find a successful mould to imitate, which reduces the survival rate of the organizational populations (Xu, 2018). And then, the increase in the number of new organization populations strengthens the organisation population's legitimacy, mainly including the cognitive legitimacy and political and social legitimacy of the organization (Naude et al., 2002; Javalgi et al., 2005), and improve the organization population's institutional foundation and political power, thus enhancing the organisation populations chances of survival (Fischer and Jasny, 2017). Finally, with more organizational populations being created, the competition among the organizational populations gradually intensified, resulting in threats to the survival of the organizational populations. As a result, the mortality rate began to rise again (Xu, 2018; Eilstrup-Sangiovanni, 2020).

Based on the research of Freeman and Hannan (1989), many scholars extended the density dependence model to specific organizational populations, discussed the establishment rate and mortality of various industrial organization populations, and tried to verify the density dependence theory (Javalgi et al., 2005). For instance, Barnett and Carroll (1987) took American telephone companies as the research object and explored the influence of regional density on the establishment and mortality of telephone companies. Furthermore, some scholars apply density dependence theory to the study of organizational growth and failure (Freeman and Hannan, 1989). Such as, Baum and Mezias (1992) analysed the impact of local competition in Manhattan hotels on the failure rate of hotel companies from 1898 to 1990 based on the density-dependent model.

Zhang and Schoonhoven (2009) explore the influence of development zone density in inter-provincial regions on the growth of individual development zone based on organizational ecology and density dependence theory. Greve (2002) used the data of the Tokyo Banking Industry from 1894 to 1936 to prove that the density dependence theory is not only feasible within the region but also shows that it also exists between adjacent regions. Finally, Zhou and Xin (2003) discussed the evolution and development of enterprise clusters in China's high-tech development zones. They found that competition density and the development of enterprise innovation production in China's high-tech zones present an inverted U-shaped relationship (Zhou and Xin, 2003).

2.4 Gaps in literature

There is a rapid development of technology entrepreneurs and innovation in many emerging economies (Hanadi and Aruna, 2013; Marcotte, 2014; Ray et al., 2017; Wang et al., 2020). For instance, the extant literature has suggested that technology entrepreneurs have contributed to R&D activities in the areas such as molecular biology (Wadhwa et al., 2017; Jin et al., 2018), recombinant DNA technologies, (Maples-Keller et al., 2017), bioinformatics and their applications, genetic engineering and gene editing technologies (Hanadi and Aruna, 2013; Marcotte, 2014; Matos et al., 2020; Deligianni et al. 2019). In contrast to the mainstream innovation conducted by researchers or scientists based in universities, academic institutes or research and development

departments of enterprises, technology entrepreneurs typically lacked essential resources such as finance, technology, facilities, equipment, and human capital (Wadhwa et al., 2017; Wang et al., 2020; Rush et al., 2021). Technology entrepreneurs are subject to criticisms in terms of risks in finance, health and safety, legal and ethical standards (Crals and Vereeck, 2005; Matos et al., 2020; Si et al., 2020). The incubation concept has increased worldwide popularity for its potential to provide a favourable environment in entrepreneurship and innovation development. (Tamasy, 2007; Mian et al., 2012). However, this section proves that some gaps in the literature of business incubators and regional innovation performance are still awaiting elucidation.

2.4.1 Existing Gaps

Contentious results on the relationship between the business incubators density development and regional innovation performance are reported in the previous study (See Table 3). On the one hand, Klofsten et al. (2020) assert that the density development of business incubators is important in achieving efficiency and networking benefits for incubation and innovation activities, and thus the development of business incubators density has a positive impact on regional innovation performance. Barbero et al. (2012) suggested that business incubators' key functional and role is conducive to regional innovation performance, including assistance technology new venture growth, participation in R&D programs.

On the other hand, corresponding with the organisational ecology and density dependence theory, the organizational founding and development are determined by the population density and relational density (Fischer and Jasny, 2017). The organizational ecology and density dependence literature suggest that organisations' development in certain areas is associated with reciprocal and competitive relations (Freeman and Soete, 2009). In order to fight for the limited resource, competition among all business incubators becomes increasingly intensive (Winn and Pogutz, 2013). With the density of business incubators beyond the bearing limit, the cycle may continue: business incubators have fewer resources to invest in their innovation activate, which is a brake on the regional innovation performance (Watkins et al., 2015). In which case, the impact of business incubators density on regional innovation performance still needs further study to get a better understanding.

It is also worth noting that few studies further consider how the business incubators impact the regional innovation performance through their capacities in the contest of China. Meanwhile, previous studies also stress the importance of communication infrastructure on regional innovation development in the context of advanced economies. Still, the significance of communication infrastructure in China provinces for innovation performance development largely has been ignored in prior research, likely due to the newness of this phenomenon and the challenges in obtaining ample empirical data. Table 1 summarise the existing gaps based on the most representative literature in the file of business incubators, communication infrastructure and regional innovation.

Table 1 Gaps in literature

Literature Category	Authors	Main Findings	Identified Research Gaps
Density of business incubators and regional innovation performance	Lalkaka (2002)	The exponential business incubators development positively related with innovation performance	Previous studies have links business incubators with innovation development. But these studies haven't come to a unanimous conclusion that whether business incubators are conducive to regional innovation performance when its density further develops in the region.
	Tamasy (2007)	The development of business incubators may have negative impact on innovation performance.	
	Xiao and North (2018)	The development of business incubators has positive impact on innovation performance	
	Baskaran et al., (2019)	The development of business incubators may have both positive impact on innovation and regional development.	
	Sedita et al., (2017)	The development of business incubators has positive impact on innovation performance, but limited by the portfolio of collaborations for innovation	
	Lukeš et al., (2019)	Business incubators have negligible impact on innovation and economic growth	
	Sun et al. (2020)	The disparities between pure technical efficiency and scale efficiency may reduce innovation	

Literature Category	Authors	Main Findings	Identified Research Gaps
		performance.	
	Lalkaka (2003)	Business incubators facilitate innovation activities in development countries	
	Sedita et al., (2019)	The development of business incubators has positive impact on innovation performance	
	Özdemir and Şehitoğlu (2013)	The development of business incubators has positive impact upon regional innovation performance	
	Ratinho and Henriques (2010)	Business incubators have been widely accepted as essential sources of innovation	
	Kreusel et al. (2018)	The private sectors precipitate into incubation activities may change the established theoretical framework for entrepreneurial and innovation activities	
	Yamockul et al. (2019)	Business incubators contributing to innovation and its own performance development by providing management, support and precipitate services.	
Capacities of business incubator and regional innovation performance	Corsi and DiBerardino (2014)	Business incubators promote knowledge development, the robust determined by the founder's team of incubators and environment	A substantial body of previous research studies the impact of business incubators on innovation performance development. But few studies are involved in the depth analysis for each capacity of business incubators on regional innovation performance.
	Battistella et al. (2018)	Business incubators contributing to innovation development by providing infrastructure, funding and entrepreneurs network etc.	
	Samaeemofrad and Van (2018)	Business incubator contributing to innovation and support technology-based start-ups through access to networks, monitoring, knowledge	

Literature Category	Authors	Main Findings	Identified Research Gaps
		development and dissemination, finance and administrative mobilization, and creation of exposure	
	Binsawad and Hawryszkiewyc (2019)	Business incubators positively support innovative technology via knowledge donation and collection	
	Zhang and Schoonhoven (2009)	The geographical aggregation of business incubators has both mutualistic and competitive effects on each other	
	Gawer and Cusumano, 2014	As innovation and incubation platform, business incubators organized start-ups to develop their own products, technologies, and services	
	Takeru and Günter (2020)	Communication infrastructures have positive effect on transportation innovation in the context of European countries.	
	Higón (2012)	Communication infrastructure facilitated UK small and medium-sized enterprises innovation performance by enhance their efficiency	In the most of previous studies, communication infrastructure is frequently related to the innovation and economies of advanced economies. But few studies have investigated that effort from communication infrastructure on regional innovation development in emerging economies, such as China.
Communication infrastructure and regional innovation performance	Ollo and Aramendía (2012)	Communication infrastructure facilitated innovation performance in the glass, ceramics and cement concrete industries	
	Arvanitis et al. (2013)	Communication infrastructures have positive impact on process, product and services innovation in the context of Greek	
	Lin, 2019	China is one of emerging economies with the potential to fully utilize communication	

Literature Category	Authors	Main Findings	Identified Research Gaps
		infrastructure	
	Wei et al., 2020	Adopting communication infrastructure to deliver socio-economic growth is common practice in China	
	Jayakar and Liu (2014)	Development and application of communication infrastructure is one of key strategy of China's government.	
	Zhang et al., 2018	Development and application of communication infrastructure breaks space restrictions, but it generates different effects due to uneven development in each region.	
	Gera and Gu (2004)	Communication infrastructures positively effects the relation between productivity and innovation performance	
	Bartel et al. (2007)	Communication infrastructures lead to changes in the production processes, which facilitate the product innovation	Existing studies generally acknowledged that communication infrastructure have a moderation effect on innovation performance development in the context of firms, but very few studies have links communication infrastructure with business incubators, and further investigate the moderation role of communication infrastructure on the capacities of business incubators and regional innovation performance
The role of communication infrastructure on capacities of business incubators and regional innovation performance	Hempell and Zwick (2008)	Communication infrastructure spur firms to improve their functional flexibility and thus promote product and process innovation.	
	Engelstatter (2012)	Communication infrastructure positive moderate the relationship between management process and innovation performance	
	Kleis et al., (2012)	Communication infrastructure influences the extent to which knowledge from external institutions and applied to the firms.	

2.4.2 Density of Business Incubators and Regional Innovation Performance

- **There is no unanimous conclusion about whether business incubators are conducive to regional innovation performance when its density further develops in the region. (Research Gap 1)**

Although previous studies have continuously suggested how business incubators density development in the region driving economic and innovation development (Ratinho and Henriques, 2010; Özdemir and Şehitoğlu, 2013; Alzaghal and Mukhtar, 2017; Hausberg and Korreck, 2021), the role of business incubators in the region innovation system is a contentious subject (Lalkaka, 2003; Tamasy, 2007; Lesakova, 2012). There are no unanimous conclusions that whether business incubators are conducive to regional innovation performance. While many studies offer evidence supporting the business incubators effects associated with its density development in the region, the findings on innovation performance development are not consistent in the context of both emerging and advanced economies. As shown in Table 6, Tamasy (2007) found no correlation between the increase of business incubators density and innovation performance by using the sample of US, UK, New Zealand, Germany. Baskaran et al. (2019) tested the effect of the development of business incubators on innovation by using the sample of Japan, Malaysia and Singapore, then detected that the development of business incubators on average have a positive effect on country innovation development. Sedita et al. (2017) tested the development of business incubators in northern Italy. They detected that business incubators positively affect innovation but is limited by the portfolio of collaborations for innovation.

In the context of China, most previous studies suggested that the density development of business incubators is conducive to regional innovation performance (Lalkaka, 2003; Wang, 2017; Xiao and North, 2018; Sun et al. 2020). Following the organizational ecology and density dependence theory, the impact of business incubators may have an opposite tendency under the different densities, particularly in some emerging economies which have huge territory and uneven regional innovation development (Tamasy, 2007). In contrast, China is typically an emerging economy covering huge geographical areas with substantial regional disparities in terms of business incubators and innovation capabilities. Based on the reviewed literature, there are still so few studies that have comprehensively and concurrently examined the effect of business incubators under the different densities on regional innovation performance. Especially

in a resource-constrained environment, the further development of business incubators density whether it might be at all possible to have some negative impact on regional innovation performance. Furthermore, the current level of business incubators density in China has an obvious regional difference (Liu and Nijkamp, 2019; Lin et al., 2020). Therefore, the effect of business incubators density on regional innovation performance is a subject in the regional innovation system to be further studied.

2.4.3 Capacities of Business Incubators and Regional Innovation Performance

- **There is still lack of investigation on the impact of business incubators capacities on regional innovation performance. (Research Gap 2)**

Past research has reported that business incubators provide a platform for technology entrepreneur innovation activities and thus contributed to the regional innovation performance. For example, Kreusel et al. (2018), Sun et al. (2018), and Yamockul (2019) stress the impact of business incubators on innovation performance. They described that whether in private or public, the development of business incubators performance is conducive to innovation performance. Furthermore, Corsi and Di Berardino (2014), Battistella et al. (2018), Samaeemofrad and Van (2018), Binsawad and Hawryszkiewycz (2019) found that business incubators specializing in financial support and incubation network to promote or assist in the learning and sharing of technological capabilities. They found that business incubators facilitated the technology transferring and utilization, suggesting that business incubators can increase the regional innovation performance. Based on these findings, it is reasonable to suppose that the business incubator is an important driver of regional innovation performance. However, previous studies generally agree that the business incubators is conducive to the regional innovation performance by their incubation performance and integration resources. In contrast, the mechanisms by which business incubator capacities development leads to better regional innovation performance still need further study (Chaminade and Vang, 2008).

In a similar vein, the development of business incubators in China has increased dramatically since 2010. Business incubator figures published by the China torch statistics yearbook, for example, show that the number of business incubators in China increased nearly dozens of times between 2007 and 2017 (Ministry of Science and

Technology, 2018). Zhang and Schoonhoven (2009), Xiao and North (2018) suggested that the fast development of business incubators accounted for indigenous innovation policy inaugurated, advocated formats entrepreneurship and innovation and regard them as a new engine fuelling China economic growth. They also found that industry structure, labour supply and global trade also contributed to the surge of the business incubator (Zhang and Schoonhoven, 2013; Xiao and North, 2018). The previous study also pointed out that business incubator is an important part of the national and regional innovation system, it plays an increasingly important innovation-oriented society (Gawer and Cusumano, 2014). However, the above research is taking the business incubator into consideration as a whole, and these kinds of literature have in common a marked impact of business incubator upon innovation but stop short of telling us how this influence unfolded by business incubator capacities (Chan and Lau, 2005).

2.4.4 Communication Infrastructure and Regional Innovation Performance

- **Not many studies have investigated the effort made in communication infrastructure on regional innovation performance in the context of China. (Research Gap 3)**

While empirical results on the relationship between communication infrastructure and regional innovation performance are reported in the context of developed countries, such relationships involving communication infrastructure from emerging economies are rarely studied. For instance, Takeru and Günter (2020) examined the application of communication infrastructure in the UK and found that communication infrastructure contributes to the sharing economy and transport innovation. Higón (2012), confirmed the positive effect of communication infrastructure on UK small and medium-sized enterprise efficiency-enhancing technologies and innovation performance. Ollo and Aramendía (2012) study the effect of communication infrastructure on innovation in the glass, ceramics and cement concrete sectors, they found that communication infrastructure seems to favour innovation. Arvanitis et al. (2013) distinguished the communication infrastructure as both soft and hard communication infrastructure capital in Greek. They found that both soft and hard communication infrastructure capital facilitated innovation performance. The effect of soft capital of communication infrastructure on innovation performance is stronger than the effect of hard communication infrastructure capital.

However, those limited empirical research is restricted to the national contexts of a few advanced economies (Lin, 2019; Wang et al., 2020). It is also worth noting that China's communication infrastructure has been rapidly developing in the last 10 years, such as optical fibre and mobile internet (Jayakar and Liu 2014). The experience from developed countries has proved that communication infrastructure significantly improves the collection, management and exchange of innovation-related knowledge (Lin, 2019, Wei et al., 2020). The relevant study also concludes that communication infrastructure allows better sharing and transferring of technology between organisations from different sectors, that beneficial for the combination of various resources and operational technology from several domains (Jayakar and Liu 2014; Zhang et al., 2018; Lin, 2019). While the logic of communication infrastructure application in emerging economies is similar, the significance of communication infrastructure effects on region innovation performance was not taken seriously in priory study, likely because of communication infrastructure just growing fast in the past ten years and accumulate enough reliable empirical data (Zhang et al., 2018; Lin, 2018; Wei et al., 2020). Therefore, it is important to empirically investigate the effect of communication infrastructure on innovation performance in emerging economies, such as China.

2.4.5 The Moderation Role of Communication Infrastructure

- **There is lack of investigation on the moderation role of communication infrastructure on the capacities of business incubators and regional innovation performance. (Research Gap 4)**

Existing studies have discussed the critical role of communication infrastructure, but there has so far been little holistic assessment of the ways in which communication infrastructure might be integrated with business incubators, especially in the context of emerging economies, such as China. Gera and Gu (2004) study detected a relationship between communication infrastructure and innovation performance for a sample of 5501enterprises in Canada and found that the development of communication infrastructure and digital equipment significantly enhance the firm's perceptual information ability, and thus conducive to the firm's innovation performance. Bartel et al. (2007) confirmed the beneficial effect of communication infrastructure on 212 US

firms. They describe the communication infrastructure have positive effects on both product innovation and production processes progress. Hempell and Zwick (2008) examined the sample from 4500 German enterprises and detected that communication infrastructure investment and share of digital equipment adoption is positively moderated the production flexibility, and thus conducive to product and process innovation performance. Engelstatter (2012) found that German enterprises were drawn to digital management and that German firms using enterprise resource planning, supply-chain management systems and customer relationships management. Based on these findings, the authors concluded that supply-chain management systems have a positive effect on the likelihood of proceeding to process innovation, while enterprise resource planning systems have a positive effect on the number of process innovations; customer relationships management systems have a positive effect on the likelihood of proceeding to product innovation, while supply-chain management systems have a positive effect on the number of product innovations. Kleis et al. (2012) examined the relationship between communication infrastructure and product innovation for a sample of 201 large US manufacturing enterprises over the period from 1987 to 1997 and found that communication infrastructure had a robust and positive effect on the firm's patents output.

Borrowing insights from the previous literature on the communication infrastructure and innovation performance, this thesis argues for a moderating effect of communication infrastructure between the capacities of business incubators and regional innovation performance in the context of China. This thesis proposes that the communication infrastructure has a positive moderation role on the effect of capacities of business incubators on regional innovation performance. The rapid development of communication infrastructure in Chinese provinces implies stronger knowledge sharing and transferring that local business incubators are likely to enhance their capacities and thus contributed to regional innovation performance.

2.5 Theoretical Discussion

Traditionally, one of the most important research questions of the innovation and entrepreneurship literature has been focused on the relationship between business incubators and regional innovation performance (Chaminade and Vang, 2008; Adelowo et al., 2015; Alzaghal and Mukhtar, 2017). The existing literature suggests that business

incubators are providing important complements to mainstream innovation (see Table 3). Most previous research supposed that business incubators contribution to innovation performance is basically explained by quantitative development and performance (Xiao and North, 2018; Sedita et al., 2019). By contrast, more geographical aggregation-oriented research streams, and especially organizational ecology and density dependence (Markard, 2011; Fischer and Jasny, 2017), have studied innovation performance and business incubators not only in terms of mutualism characteristics but also in terms of competition (Bolívar et al., 2012). Within the same line of reasoning, a growing body of literature that embraces the organizational ecology and density dependence theory (Xu, 2018; Eilstrup-Sangiovanni, 2020) offers new insights into regional innovation performance development study. According to this influential perspective, the presence of different levels of business incubators density in the region may have different impacts on regional innovation performance (Fischer and Jasny, 2017), and thus can be used to extend the findings gained by past research on the business incubators and regional innovation performance.

Meanwhile, the extant literature identified several important drivers of regional innovation performance business incubator development, such as the amount of venture capital, human resource, technological, and organizational resources (Somsuk and Laosirihongthong, 2014), investment in R&D (Alzaghal and Mukhtar, 2017), knowledge workers (Sleuwaegen and Boiardi, 2014), as well as knowledge-based regional development policy (Fu, 2012; Fazey et al., 2013; Schulze et al., 2015). Klofsten et al. (2020) assert that the size of the business incubator is important in achieving efficiency and networking benefits for incubating enterprises, while the academic institutes have a positive impact on business incubator size rather than industry focus. Barbero et al. (2012) suggest that critical standards of business incubators' performance fall into firm growth, participation, R&D programs, input R&D, output R&D and Employment genera. Previous research generally agrees on a positive relationship between investments in internal or external resources and individual business incubator development (Fu, 2008; Li et al., 2016), while the mechanisms by which business incubator development leads to better regional innovation performance are still under investigation (Zeng et al., 2010). Limited understanding is gained on how business incubators can facilitate effective regional innovation performance (Watkins et al., 2015; Li et al., 2016; Van et al., 2018). Previous

research generally agrees on a positive relationship between investments in in-house knowledge development and innovation (Fu, 2008; Li et al., 2016), while the mechanisms by which regional R&D leads to better innovation performance are still under investigation. Limited understanding is gained on how business incubators can facilitate effective knowledge transfer and innovation performance development. (Hou et al., 2019).

China's business incubators have increased by nearly a dozen times between 2008 and 2017 (MOST, 2018) and have become a new engine fuelling China's innovation (Zhang and Schoonhoven, 2009; Li et al., 2016; Xiao and North, 2018). Business incubators are entities that help and stimulate innovation (Kreusel et al., 2018). The business incubators seek to combine technology, resources, and initial knowledge to enhance entrepreneurial talent, accelerate the development of newborn businesses, and thus accelerate the commercialization of technology (Surana et al., 2020). The business incubator is an initiative to provide a nurturing environment for technology-based businesses; innovation brought to the market creating new products and services for the technology industry (Binsawad and Hawryszkiewycz, 2019; Lobosco et al., 2019). Previous studies recognize that business incubators play an important part in the national and regional innovation system (Jiao et al., 2016; Samaeemofrad and Van, 2018). However, most of the previous literature regards the individual business incubator as the main unit of analysis, with limited understanding of the mechanisms by which the density of business incubators and their capacities influence regional innovation (Li et al., 2016; Wang et al., 2020). Therefore, China provides an appropriate context to fills the gaps for existing literature.

2.5.1 Business Incubators Density and Regional Innovation Performance

Extant literature identified a number of several important drivers of regional innovation performance, such as business incubator, human resource, technological, as well as organizational resources (Koh, 2006; Somsuk and Laosirihongthong, 2014). Klofsten et al. (2020) assert that the size of a business incubator is important in achieving efficiency and networking benefits for incubating enterprises, while the academic institutes have a positive impact on business incubator size rather than industry focus. Barbero et al., (2012) suggesting that critical standards of business incubators performance fall into firm growth, participation, in R&D programs, input R&D, output

R&D and Employment genera. However, some scholars have some different views (Haveman and Wetts, 2019; Eilstrup-Sangiovanni, 2020). For instance, some literature generally agrees on a positive relationship between investments in internal or external R&D resources and innovation performance (Fu, 2008; Bolívar-Ramos et al., 2012; Li et al., 2016), while the mechanisms by which business incubator development leads to better regional innovation performance still need further study (Chaminade and Vang, 2008). Therefore, whether the business incubator can facilitate effective regional innovation performance is a debatable point.

In the context of China, the development of business incubator has increased dramatically since 2010. Business incubator figures published by the China torch statistics yearbook, for example, show that the number of business incubator in China increased nearly dozens of times between 2007 and 2017 (Ministry of Science and Technology, 2018). Zhang and Schoonhoven (2009), Xiao and North (2018) suggested that fast development of business incubator accounted for indigenous innovation policy inaugurated, advocated formats entrepreneurship and innovation and regard them as a new engine fuelling Chinas economic growth. They also found that industry structure, labour supply and global trade also contributed to the surge of the business incubator (Zhang and Schoonhoven, 2013; Xiao and North, 2018). The previous study also pointed out that business incubator is an important part of the national and regional innovation system, it plays an increasingly important innovation-oriented society (Fan et al., 2007; Gawer and Cusumano, 2014). However, the above research is taking the business incubator into consideration as a whole, and these kinds of literature have in common a marked impact of business incubator upon innovation but stop short of telling us how this influence unfolded by business incubator capacities (Chan and Lau, 2005).

Furthermore, the emerging and growing field of research has investigated the business incubators on regional innovation performance. The literature has tried to explain the impact of the business incubators on regional innovation performance in terms of organizational ecology (Freeman and Hannan, 1987; Hannan et al., 1995; Greve, 2002; Grimaldi and Grandi, 2005; Hargreaves et al., 2008; Fu, 2012) and density dependent (Eveleens et al., 2017). The organizational ecology literature suggests that organisations' development in certain areas is associated with reciprocal and

competitive relations (Freeman, C. and Soete, 2009). Thus, in which case it is reasonable to suppose that the business incubator with escalating development facilitates the regional innovation performance through reciprocal relation (Elia et al., 2020). However, with the increasing density of the business incubators, stronger competition among business incubators leading a negative impact of the business incubators on regional innovation performance (Breznitz et al., 2018).

(1) Mutualism Relationship on Business Incubation and regional innovation performance

With the gradual increase in the density of incubators in the region, a diffuse and mutually beneficial relationship will be formed between each other, which will help enhance the legality of technology business incubators in the region (Ruef, 2000), improve the resource acquisition capabilities of individual incubators, and promote the growth and regional growth of incubating companies Innovation performance growth (Freeman and Hannan, 1989; Amburgey and Rao, 1996; Baum, 1999). Specifically, it is mainly reflected in the following aspects:

First, the information related to the business incubators spreads to the external environment that could contribute to their cognitive legitimation in the external environment (Ruef, 2000, Fazey et al., 2013). With the improvement of business incubator legality, the external environment gradually familiar with the function, form and operation of the business incubators (Freeman and Hannan, 1989). Therefore, there is a growing realization of the importance and function of business incubators (Javalgi et al., 2005). That makes many entrepreneurs and talents who have the resource of technology, capital and experience are willing to engage in entrepreneurial activities at the business incubator (Xu, 2018), which often help the business incubators access more advanced technological, knowledge and management techniques that could benefit the regional innovation performance in where business incubators are located (Essletzbichler and Rigby, 2007; Bolívar et al., 2012).

Furthermore, the increase in the density of business incubators is conducive to the diffusion and flow of knowledge between business incubators in the region (Xu, 2018), increases the learning channels and opportunities for individual business incubators, and establishes an interactive network (Eilstrup-Sangiovanni, 2020). The business

incubators are operationalized as science parks, innovation centres and accelerators; the purpose of the business incubators is to facilitate knowledge transfer and diffusion of products, thereby developing local innovative performance (Javalgi et al., 2005). Thus, the increase of business incubators means increasing knowledge transfer and diffusion in the region (Baum and Mezias, 1992). Furthermore, the business incubator establishes an interactive network in the region, which helps the business incubator communicate and developing a collective action (Ding and Knight, 2009; Xu, 2018). In which case promote the stable development of incubators in the region and inhibit competition.

Second, the increase in the density of business incubators could help to improve the socio-political legitimacy of business incubators in the region Greve (2002). Socio-political legitimacy emphasizes that key stakeholders, the general public, key opinion leaders, or government officials accept the business incubators as appropriate and right, given existing norms and laws (Zhou and Xin, 2003), which will help the business incubators increase their acceptance image in the region (Eilstrup-Sangiovanni, 2020). Zhang and Schoonhoven (2009) argue that business incubators can receive reasonable support from external organizations and institutions (e.g., government or university) to enhance their regional innovation performance by improving socio-political legitimacy.

Third, the increasing density of business incubators in the region forming a mutual interaction will help organisations and stakeholders join the business incubators Greve (2002). This provides resources for the development of business incubators, thereby promoting the development of regional innovation performance Eilstrup-Sangiovanni, 2020). Romanelli and Khessina (2005) believe that compared with the actual resource situation of the region, entrepreneurs and venture investors' perception of the attractiveness of the region has a greater impact on their investment decisions (Rush ET AL., 2021). Organizational communities are important and obvious forms of expression that reflect the identity or characteristics of a region’s industry (Romanelli and Khessina, 2005). By observing the development of related organization communities in the region, investors and potential entrepreneurs can subjectively perceive the sustainable development of related industries (Rafailidis et al., 2017). Therefore, some important external stakeholders, such as potential entrepreneurs, technical talents, entrepreneurial mentors, financial service institutions, and venture investors, will gradually enter the region to participate in regional entrepreneurship and technology development (Nelson

and Nelson, 2002), which will promote regional innovation performance development.

(2) Competition Relationship of Business Incubators and regional innovation performance

According to the theory of organizational ecology, the competitive relationship between organizations is mainly due to the common needs of such organizations for limited external resources (Hannan and Freeman, 1989; Baum and Mezias, 1992). There is a niche overlap between organizational populations (Xu, 2018). The number of resources available in thousand niches is limited, and the number of populations that can be supported is limited (Zhou and Xin, 2003; Barbero et al., 2012). The number of organisations has exceeded the carrying capacity of the resource in the region, resulting in fierce competition for resources reality (Fischer and Jasny, 2017).

In the context of the business incubators, the incubation flow and all of its dependent resources, including basic resource (e.g., incubation space, service and offices); capital resource (e.g., venture capital subsidies and loans); incubation resource (e.g., the number of incubation firms and rate of successful incubation) (Soetanto and Jack, 2013). Thus, competition between the business incubators significantly increased with the density of the business incubators increased (Winn and Pogutz, 2013). The competition among the business incubators dominates, rather than cooperative and development, it causes obstacle for the business incubator to acquire resource and decelerated development of business incubators (Watkins et al., 2015). Thus, it affects regional innovation performance, where the business incubators' density increases dramatically.

Aldrich and Ruef (2018) pointed out that the organization density exceeds the environmental carrying capacity, the development of organizations would be damaging, thus affecting the regional development. Indeed, it has been suggested that many investors primarily invest where there's less competition to obtain sustainable revenue (Morin, 2020). Existing organizations or enterprises basically occupy existing resources, and it is more difficult for new organizations to obtain resources (Kearney, 2003). Organizational boundaries can become very fragile because fierce competition makes it difficult for organizations to retain valuable employees and occupy existing positions (Fischer and Jasny, 2017).

In the context of China, the rapid and continuous increase in the density of the business incubators has intensified the competition for resources (Chan and Lau, 2005; Xu, 2018). For example, notes the fierce competition among incubators for incubation projects and entrepreneurial projects, especially projects with prospects and potential market value (Zhou and Xin, 2003). Numerous authors have suggested that government subsidies and science and technology projects are institutional resources, which the government establishes to encourage and facilitate the development of start-up enterprises in the business incubators (Zhang and Schoonhoven, 2009). However, those resources are limited, and the government subsidies and project tend to favour the business incubators with better performance (Fischer and Jasny, 2017). Therefore, many business incubators in the region would inevitably have fierce competition for institutional resources (Eilstrup-Sangiovanni, 2020). Indeed, it has been suggested that many Chinese are integrated innovation service centres (Xu, 2018). The services provided by this type of business incubator are highly homogeneous (Xu, 2018). In other words, there are highly niche overlaps of those business incubators and have a high degree of a coincidence for resource demands (Xu, 2018). Similarly, extant literature argues that the high niche overlaps could intensify the resource competition between the business incubators and that regional innovative performance is unlikely to benefit from the business incubators without enough certain resource (Javalgi et al., 2005). As the density of incubators continues to increase, the competition between incubators gradually dominates (Zhang and Schoonhoven, 2009). Greater competition might be expected to discourage innovation by reducing resources acquiring.

2.5.2 Capacities of Business Incubators and Regional Innovation Performance

In the context of China, the development of business incubator has increased dramatically since 2010. Business incubator figures published by the China torch statistics yearbook, for example, show that the number of business incubators in China increased nearly dozens of times between 2008 and 2017 (Ministry of Science and Technology, 2018). Zhang and Stough (2013), Jiang et al. (2016), Xiao and North (2018) suggested that the fast development of business incubator accounted for indigenous innovation policy inaugurated, advocated formats entrepreneurship and innovation and regard them as a new engine fuelling China economic growth. They also found that industry structure, labour supply and global trade also contributed to the surge of the business incubator (Zhang and Stough, 2013; Jiang et al., 2016; Xiao and North, 2018).

The previous study also pointed out that business incubator is an important part of the national and regional innovation system, it plays an increasingly important innovation-oriented society (Bertello et al., 2020). However, the above research is taking the business incubator into consideration as a whole, and this literature has in common a marked impact of business incubator upon innovation but stop short of telling us how this influence unfolded by business incubator capacities (Cebrián and Junyent, 2015).

(1) Basic Capacities of Business Incubators and regional innovation performance

Previous studies pointed out that the services provided by business incubators have a positive effect on participants' psychological capital (Cavus and Gokcen, 2015), which includes factors of self-efficacy, hope, optimism, and resilience (Chan and Lau, 2005; Luthans et al., 2007; Gawer and Cusumano, 2014; McGuirk et al., 2015). The synergy of those factors can directly or indirectly affect the behavioural performance of individuals and organizations (Baluku et al., 2019). Existence literature suggesting that psychological capital is a higher-level concept: individual resources, self-efficacy, optimism and so on are the key basic resources to manage and adjust other resources (Luthans et al., 2007). Furthermore, Luthans (2007) Cavus and Gokcen (2015) and Gupta et al. (2019) defined psychological capital as four kinds: self-efficacy, hope, optimism, and resilience. Self-efficacy is one's belief on one's ability to succeed in accomplishing a task (Luthans, 2007; Cavus and Gokcen, 2015). Hope is a positive motivational state that is based on an interactive effect of a derived sense of successful pathways (planning to meet goals) and agency (goal-directed energy) (Peterson et al., 2011; Gupta et al., 2019). Optimism is an attribution style that explains positive events in terms of personal, permanent causes, such as abilities (Baluku et al., 2006), and negative events in terms of external and situation-specific causes (Siu, 2013), such as luck. Resilience is the salient willpower and capacity to rebound or bounce back from adversity, conflict, and failure or even positive and challenging events (Luthans, 2007; Baron et al., 2016). Therefore, the synergy of these four factors can directly or indirectly affect the behavioural performance of the business incubator participants, and then affect regional innovation performance (Siu, 2003; Luthans, 2007; Baron et al., 2016; Baluku et al., 2019).

For instance, Baron et al. (2016) and Baluku et al. (2019) revealed that people who work in business incubators will continue to improve their entrepreneurial self-efficacy,

which has a direct positive impact on the innovation performance for start-up technology companies. Cavus and Gokcen (2015) pointed out that business incubators can further enhance the self-confidence and optimism of innovation by building a stable innovation platform and a solid basic service system. At the same time, the relaxed entrepreneurial atmosphere in business incubators helps innovators and entrepreneurs to ease their frustration when facing difficulties, thereby improving resilience psychological capital (Baron et al., 2016). Therefore, effective business incubators can actively promote the creation of strong entrepreneurial atmospheres (Peterson et al., 2019), and enhance the innovators and entrepreneurs' psychological capital (Baraldi and Havenvid, 2016; Gupta et al., 2019).

The establishment of business incubators provides physical innovation spaces for regional innovators or entrepreneurial talents (Avey et al., 2006), and also provide independent innovators and entrepreneurs with opportunities for collision of ideas (Baluku et al., 2019). In this space, both entrepreneurs and innovators can better commit themselves to research and development activities (Benneworth et al., 2009; Gupta et al., 2019), gradually strengthen their innovative ideas, and commit to continuous innovation (Baron et al., 2016). Therefore, the continuous improvement of business incubators will promote the gradual accumulation of innovation capabilities (Peterson et al., 2011), which can significantly improve the performance of technology entrepreneurs and start-up technology companies (Luthans et al., 2007), and thus enhance the overall performance of regional innovation (Siu, 2013).

(2) Finance Capacities of Business Incubators and regional innovation performance

Previous studies have suggested the important role of financial support for effective innovation by start-up entrepreneurs (Bruneel et al., 2012; Pradhan et al., 2016). The goal of corporate business incubator financial services is to provide economic support for enterprises, especially start-up innovative enterprises (La et al., 2000; Bruneel et al., 2012; Fan et al., 2018). Besides investment fund from business incubators, government and financial institutions are also continuously enhancing the financial support of innovative start-ups and technology entrepreneurs (Grimaldi and Grandi, 2005; Fan et al., 2007; Pradhan et al., 2016). Chandra and Medrano (2012) propose that synergy theory can explain why financing can promote innovation to a certain extent. The synergy effect believes that the combination and common operation of the various

entities in the system can create more value (Chandra and Medrano, 2012). The goal of corporate business incubator financing services is to provide economic support for enterprises, especially start-up innovative enterprises (Kostopoulos et al., 2011; Fan et al., 2018). Besides business incubator investment found, government are also continuously enhancing the financing support of innovative enterprises, and financial institutions such as banks have also increased the intensity of loans to high-quality enterprises (Clarysse et al., 2005; Brandstätter et al., 2011; Du et al., 2015).

Therefore, based on external synergy theory, the financing service of business incubator, is an essentially integrated the various innovation entities in the region (Harwood, 2000; Kostopoulos et al., 2011). Effective financial flow between enterprises, business incubators, technology entrepreneurs, government, and financial intermediaries, promotes the effective circulation of funds within the innovation business ecosystem and ensures the efficient allocation of business resources in the region (Harwood, 2000; Fan et al., 2007; Pradhan et al., 2016). Thus, the financing services plays a significant role in business incubator and regional innovation performance.

Financial services provided by business incubators not only closely link the government, financial institutions and technology entrepreneurs (La et al., 2000), but also strengthen the synergy between the start-up enterprises and independent innovators in business incubators (Fan et al., 2007; Bruneel et al., 2012; Pradhan et al., 2016). In the face of increasingly complex and severe market competition, effective financial services of business incubators will allow innovators and start-up entrepreneurs to better exchange knowledge, to form multilateral cooperation for research and innovation activities (Harwood, 2000; Bruneel et al., 2012). This will allow technology entrepreneurs and start-up enterprises to improve the efficiency of new product development, reduce R&D costs, promptly solve problems, and eventually improve the regional innovation performance (Pradhan et al., 2016, Wang et al., 2020).

(3) Incubation Capacity of Business Incubators and regional innovation performance

In addition to transferring various types of resources to technology entrepreneurs and start-up enterprises (Qian et al., 2011; Markovitch et al., 2017), business incubators can also promote the flow of knowledge through enhanced social relationships between innovators and entrepreneurs (Ramesh, 2017; Lukeš et al., 2019), which is a key part

of the incubation capacities of business incubators (Marcotte, 2014). Fundamentally, the principal of knowledge sharing is a process meant to obtain experience from others. While referring to Razak et al., (2016) mentioned that knowledge sharing refers to preparation of task information, know-how to collaborate with others to facilitate people, problem solving, implement policies, or promote innovation. Recent to date, refer to Witherspoon et al. (2013) and Ramesh (2017) knowledge sharing is a process in knowledge management that used to create, harvesting, and sustaining business processes. The evolution of the knowledge sharing is trendy, according to the importance and used of knowledge sharing towards the business (Hackett and Dilts, 2004; Qian et al., 2011; Bruneel et al., 2012). Hence, knowledge sharing is the practices of exchange and disseminates the idea, experience, and knowledge with the others to ensure the knowledge continues, sustain and retain in the business (Chandra and Medrano, 2012).

Effective knowledge sharing was regarded as important facilitator for the development of technology entrepreneurs (Alavi and Leidner, 2001; Baldwin et al., 2010; Allameh et al., 2011; Filieri, and Alguezaui, 2014; Geisler and Wickramasinghe, 2015). Previous researchers highlighted the role of business incubators in developing networks between innovators and incubating businesses (Panahi rt al., 2013). For example, Ramesh (2017), pointed out that even if the business incubator managers cannot directly provide services, they can also facilitate social networks for R&D (Ramesh, 2017). This network is extremely important for the sharing of information and knowledge. Rubin et al. (2015) and Sindakis et al. (2015) also believed that the business incubators integrate various technological entrepreneurship and innovation resources in the region, serves SMEs, and enhances the overall innovation capacity in the region through better knowledge sharing (Rubin et al., 2015 and Sindakis et al., 2015).

In summary, the effective knowledge sharing in business incubators can (1) facilitate better utilization of newly acquired knowledge by technology entrepreneurs (Witherspoon et al., 2013); (2) strengthen cooperation and encourage mutual learning (Zhao et al, 2017); (3) facilitate effective decision making based on better knowledge acquired; and (4) enhance the innovation ability of individuals (Razak et al., 2016). As a result, the regional innovation capacity will benefit from better incubation capacity of business incubators (Rubin et al., 2015; Hillemane et al., 2019; Wang et al., 2020).

2.5.3 Communication Infrastructure and Regional Innovation Performance

(1) The Impact on Regional Innovation Performance

The underlying reasons for the communication and interaction of innovation activities are the subject of regional innovation system theory (Parida and Örtqvist, 2015; Li et al., 2016; Wang et al., 2020). Thus, this study focusses on one moderator: regional communication infrastructure. Regional communication infrastructure has been extensively studied as direct predictors of innovation: communication infrastructure as an information or knowledge exchange tool that influences business incubator development strategic access to new technologies (Chege and Wang, 2020; Díaz-Roldán and Ramos-Herrera, 2021). However, to our knowledge, no studies have, to date, examined whether or how regional communication infrastructure moderate the relationship between business incubator capacity and regional innovation performance for China (Zhou et al., 2003; Wang and Kafouros, 2009; Zeng et al., 2010; Du et al., 2019; Wang et al., 2020). Regional communication infrastructure increases firms' resources to innovate, but the uneven distribution of regional communication infrastructure development is particularly apparent in many emerging economies, such as China (Wang and Kafouros, 2009; Xu, 2010). The rapid development of communication technology (e.g., 5G) changes the range and the speed of access to technology and information (Zhao et al., 2020). It can also encourage deeper experimentation.

(2) The Moderation Role of Regional Communication Infrastructure

The extant literature has pointed out interdependencies between the infrastructure and the innovation activities of the respective regions (Rolland et al., 2018). Some studies believe innovation can be generally characterised as a basically uncertain process for solving problems, which mixes private with public resources (Bertello et al., 2020), such as knowledge, information and technology. Private resources come primarily from the enterprises themselves and associations of enterprises and scientific and professional organisations (Tether and Tajar, 2008). Public resources are drawn from institutions which conduct scientific and technical R&D, such as university (Khadaroo and Seetanah, 2010; Armanios et al., 2017). Thus, how can the most effective transmission of the most accurate resources become a key point of innovation (Bertello et al., 2020). Pavic et al. (2007) pointed out that the importance of communications

infrastructure stems from its role as one of the main tools employed in the information exchange activities of regional. Armanios et al. (2017) believed that getting high efficiency and effectiveness in organizations requires investment in communications infrastructures.

It is customary in the Knowledge Management (KM) literature suggesting that knowledge management is a management process using information technology to create, share and transfer, storage, transmission, and application knowledge (Alavi and Leidner, 2001; Acs et al., 2002; Chaminade and Vang, 2008; Bouncken and Aslam, 2019). Thus, it is reasonable that effective communication infrastructure facilitates the flow of information from the enterprises, associations of enterprises, and scientific and professional organisations (O'gorman and Kautonen, 2004; Klerkx and Leeuwis, 2008; Fu, 2012; Jiao, 2016), as well as from research institutions that conduct scientific and technical R&D, such as universities (Andersson et al., 1990; Acs et al., 2002; Markard, 2011). To this end, the effective flow of information and knowledge resources to where they are needed becomes one of the key enablers of business incubators' development.

In a similar vein, it is argued that communication infrastructures will influence the extent to which transfers of tangible resources from outside of business incubators (Rui and Yip, 2008; Fazey et al., 2013; Bouncken and Aslam, 2019; Zhao et al., 2020), as well as the basic finance and incubation capacity of business incubators (Klerkx and Leeuwis, 2008; Fu, 2012). Hence, investment in communication infrastructure will better allow the adaption and exploitation of key resources to benefit regional innovation.

2.6 Summary

This chapter has reviewed the published literature related to business incubators and regional innovation performance. There is still a gap in the literature regarding the density of business incubators and the capacities of business incubators. This study brings together different bodies of literature to study the role of density and capacities of business incubators at the regional level in the context of China. Furthermore, this study particularly considers the moderation role of communication infrastructure that moderate the impact of business incubators capacities on regional innovation performance.

Chapter 3. The Business Incubators and China's Innovation Development

3.1 Introduction

This chapter reviews literature relevant to business incubation and innovation development in the context of China. According to Aerts et al. (2007), the culture of entrepreneurship in general and the number of entrepreneurs in particular begin to develop in certain fields, business incubation is important because the two ideas influence each other. Aerts et al., (2007) argue that the lack of entrepreneurship at the same time is an obstacle to real incubators and determinants of change. On the one hand, a lack of entrepreneurship has a negative effect on the number of potential tenants (Montgomery, 2007; Bøllingtoft, 2012; Carvalho and Galina, 2015). On the other hand, existing potential tenants are really encouraged by business incubators to find and take advantage of opportunities, because they want to be successful and this can trigger overall entrepreneurial development (Parida and Örtqvist, 2015).

The literature provides many definitions of business incubation; over the years the focus has shifted somewhat from administrative facilities and services to actual business support. Hackett and Dilts (2004) present an overview of the development of the incubation literature and show that the focus has shifted from incubator development studies in the early eighties to the configuration of incubators and incubating development studies in the late eighties. The development of the research domain continued with the study of the effects of incubators - the incubation and theorizing studies of incubators in the nineties (Allen et al., 1991; Qian et al., 2012; Rubin et al., 2015).

3.2 The Role of the Business Incubators in Innovation

The business incubation program shows a different set of goals that reflect their own operating environment and stakeholders (Tamasy, 2007; Shepard, 2013). This is known by the incubator manger and is important for determining program goals and objectives (Aerts et al., 2007; Qian et al., 2011; Sentana et al., 2017; Lukeš et al., 2019). Each program will be determined by one or more objectives:

(1) National, regional or local economic development,

(2) Property or real estate,

(3) Regeneration of rural and urban industries,

(4) Small businesses and business creation,

(5) Technology transfer,
(6) Innovation and commercialization,
(7) Increasing the formation of new companies and spinouts,
(8) Creating new and sustainable jobs,
(9) Accelerating business growth / fast-track company development,
(10) Reducing the failure rate of new companies,
(11) Creating value for stakeholders,
(12) Empowerment / opportunities for certain groups of entrepreneurs,
(13) Development of an entrepreneurial / role model culture

Business incubation plans provide service assets for start-ups (Aerts et al., 2007; Qian et al., 2011; Marcotte, 2014; Sentana et al., 2017; Lukeš et al., 2019). The most common incubator services:
(1) Provide business support,
(2) Business incubation networks,
(3) Market guides
(4) Internet services
(5) Cancel financial management
(6) Obtain funds and guarantees
(7) Presentation skills
(8) Access to higher education resources
(9) Best partner consultants
(10) Venture capital links
(11) Any training programs required by start-ups
(12) Guidance to boards and mentors
(13) Determination of management Activities
(14) Technology transfer
(15) Assistance with regulatory compliance services.

Based on the above general services, the incubator provides common services such as email accounts, internet addresses, use of copiers, use of fax machines, telephones, use of meeting rooms and use of exhibition halls (Allen and McCluskey, 1991; Aerts et al., 2007; Qian et al., 2011; Marcotte, 2014; Sentana et al., 2017; Lukeš et al., 2019).

3.2.1 Value-Added and Enhance Innovation

After technology entrepreneurs are chosen, it is important to offer them various services and to create awareness of the importance of these services among them (Tötterman and Sten, 2005; Vanderstraeten and Matthyssens, 2012 Zhao et al., 2012). It is important for business incubators to market this set of services to their tenants as important because the technology entrepreneurs do not by definition value his interests; as observed by the (Lukeš et al., 2019), in their case, what companies' value most is not service but credibility because it is associated with business incubators (Bøllingtoft et al., 2005; Bruneel et al., 2012; Hong et al., 2019).

According to the following must be included regarding the typical business incubator function (Allen and McCluskey, 1991; Alavi and Leidner, 2001Rice, 2002; Carvalho and Galina, 2015). First, business incubator space, which is important when it comes to potential economies of scale (Bøllingtoft and Ulhøi, 2005). Second, various business support services (Grimaldi and Grandi, 2005; Albort-Morant and Ribeiro-Soriano, 2016). Four main areas are important. All of these functions are based on internal principles (Jin et al., 2018; Hong et al., 2019). However, this does not necessarily mean that facilities and services must be provided on their own (Lukeš et al., 2019). Using staff to provide services or through encouraging networking among tenants and by attracting external providers, various facilities and services can be expanded (Albort-Morant and Ribeiro-Soriano, 2016; Lukeš et al., 2019). Value-added intervention systems include:

(1) Entrepreneurship skills development training; creating new business ideas, training and advice on how to form a company and run a business.

(2) Business guidance, business plans, marketing, identifying suitable business partners, and general strategic assistance.

(4) Financial assistance; changing venture capitalist attitudes to start-ups through investment help tenants by providing small-scale seed capital funds.

(5) Technology and innovation; provide access to centres of excellence through more

traditional business activities or provide own professional resources or promotions.

(6) Expand the scope of services by leveraging staff to provide facilities or encouraging networking between tenants and charming external providers.

The success of a business incubator enhance innovation depends to a large extent on effective communication within the incubator and between the incubator and external resource or partner (Aernoudt, 2004; Shepard, 2013). Previous study indicated that business incubators provide a vital platform for innovation activities. Rice (2002) and Lukeš et al. (2019) recognizes that innovation activities is a co-production process and depends on the capacities of business incubators and entrepreneurs. Thus, the business incubators were perceived as a consultant or intermediary (Rice, 2002; Tötterman and Sten, 2005). The business incubators provide direct assistance as a consultant, and the business incubators acts as an intermediary to help through the network; linking entrepreneurs with other innovation elements (e.g., knowledge, technology and talents) (Hon et al., 2019; Wang et al., 2020).

3.2.2 Platform and Innovation Activate

Many authors suggested that the business incubators as the consumer of advance technology and stress the importance of take advantage of the advance technology by the business incubators to assistance technology entrepreneurs (Bøllingtoft and Ulhøi, 2005; Chandra and Medrano, 2012). In the short term, the new venture may improve the ability of technology entrepreneurs to deal with crises and problems in innovation process, and in the long term, the technology entrepreneurs may enhance their autonomy innovation ability (Hackett and Dilts, 2004). However, existing studies also mentioned the knowledge gap between business incubators and technology entrepreneurs, which often exists in many business incubators (Hillemane et al., 2019). The critical of this process depends on technology entrepreneurs' consciousness about their gaps in knowledge, capabilities, resources, and the awareness of the potential of business incubators to help fill those gaps, and the willingness of technology entrepreneurs to participate in innovation activities (Mian et al., 2016; Lamine et al., 2018).

The capital is essential for the innovation activities, especially for the business

incubators and technology entrepreneurs (Vedovello and Godinho, 2003; Barbero et al., 2012). Just as a financier should be able to manage the amount of funds among cash, stocks and real estate investment instruments to produce the best return while evading excessive risk, the business incubators must analysis the time allocation in various clients to produce the best return for the technology entrepreneurs (Brunee et al., 2012; Xiao and North, 2018). The business incubators are presented with a time financing portfolio that covers three parameters: which technology entrepreneurs inclines to produce the best results from the investment time business incubators; which form of interference is most suitable for each technology entrepreneurs (Lamine et al., 2018; Cassel and Anna, 2021). It takes more than just general knowledge about the general business status of a technology entrepreneurs to help make the right intervention decisions (Mian et al., 2016; Markovitch et al., 2017). This needs a comprehensive business plan that serves to guide the strategic development of the technology entrepreneurs concerned (Tötterman and Sten, 2004; Qian et al., 2011).

Without a comprehensive business plan that unites all business lines, there is no verifiable source of information on which to make strategic investment decisions (Barbero et al., 2012; Carvalho and Galina, 2015). Without a coherent strategy, the business incubators will rely on the opinions of others, a weak position to make important decisions (Scandizz, 2005). The business plan provides a road map that identifies the technology entrepreneurs' position and allows it to choose the path to growth (Barbero et al., 2012; Tola and Contini, 2015). The business plan also provides information that the business incubator needs to make an initial screening decision and helps prioritize the technology entrepreneurs for whom most of the time management must be devoted (Hanadi and Aruna, 2013; Hong et al., 2019; Cassel and Anna, 2021).

3.3 Incubation Principle and Strategies

Brunnel et al. (2012) and Sentana et al. (2017) argue that to achieve their goals, the business incubator implements various management policies in terms of entry and exit criteria for technology entrepreneurs. The list of criteria used to select technology entrepreneurs includes job creation and local ownership (Shepard, 2013; Tola and Contini, 2015). In addition, technology entrepreneurs' companies must be able to pay for their own operating costs, provide unique opportunities, become a new start-ups company with rapid growth potential, have clients who in some cases are required to

have a business plan, and have business liability insurance (Vanderstraeten and Matthyssens, 2012; Zhao et al., 2017). In terms of exit regulations, most incubators impose time limits on the technology entrepreneur's residence (Bruneel et al., 2012). Empirical evidence shows that the criteria used to select technology entrepreneurs vary according to the type of incubator and the number of vacancies available at the incubator facility (Wadhwa et al., 2017). For example, in recognizing technology entrepreneurs, public-sponsored incubators are more likely to consider the potential for job creation and local ownership (Rice, 2002).

Private company-sponsored incubators are generally more concerned with getting full occupancy. University-sponsored incubators are more open to tenants who are trying to commercialize technology developed at the university (Shepard, 2013; Sentana et al., 2017). Some university-sponsored incubators can even establish that tenant companies employ students as employees and faculty as consultants (Main, 1997; Grimaldi and Grandi, 2005). Technology incubators focus on companies involved in value-added activities such as creating, assembling, developing or researching technology intensive products or services (Hong et al., 2019). Entry criteria vary from one incubator to another. Some are very subjective and others require a severe pre-screening process for applicants or only an acceptable business plan (Croce et al., 2017; Sharma et al., 2019).

Croce et al. (2017) and Sharma et al. (2019) focuses on the problem of selectivity by citing five general techniques for increasing the selectivity of their business development programs:

(1) Screening potential tenants to choose the most suitable technology entrepreneurs.

(2) Monitor technology entrepreneurs to determine what measures the incubator may take to promote or assist growth.

(3) Segment the tenant inhabitants and choosing to work intensively with technology entrepreneurs who show the greatest growth potential.

(4) Develop a plan to allow tenants to make their own choices, and those technology entrepreneurs show the greatest potential for higher levels of intervention.

(5) Establish strict "trading obstacles" and choose companies with successful characteristics in their structure.

Acceptance criteria must be clearly defined, and transparent evaluation guidelines and procedures are applied. Scaramuzzi (2002) Vedovello and Godinho (2003), and Tamasy (2007) raises a number of points regarding admission criteria and procedures:
(1) Acceptance criteria must be clearly defined, and transparent evaluation guidelines and procedures are applied.

(2) Screening activities must be carried out using standard procedures and forms and managed by a team of professional evaluators.

(3) Evaluators generally include incubator managers and some team members, consultants, interns, academics, etc.

(4) Selection must be made in an ongoing effort to identify applicants' needs, while determining whether the services offered by the incubator can have 'value' for applicants.

(5) The screening process must be carried out according to criteria that are fully consistent with the goals of the incubator.

(6) Screening criteria generally include issues such as innovative business ideas / products; product eligibility and patent protection, market understanding and growth potential, financial plans, risks / opportunities involved in the project, applicant's professional and educational background, community benefits, ecological awareness.

(7) Screening must be done by considering the potential synergies between clients. The incubator must also avoid incubating companies that directly compete in the same market/ product, to avoid potential conflict situations.

Business incubators and incubate will agree with each other from the beginning about their goals. One or more of these goals will signal when to leave the incubator.

According to current research, the average duration of incubation is two to three years but ranges from 3 months and up. Some incubators include time, space, and employees considered as deciding to leave (similar to the criteria we use for our teenagers). In addition, some incubate needs to be released when failure is proven. Conditions for exit and follow-up are important for the incubator and incubator, because they allow for continuity in the development of the incubator, renewing its client base, and giving incubates a sense of additional urgency, thus regulating the steps for the incubator's activities (Lavrow & Sample, 2000). United Kingdom Business Incubation (2004) discusses exit strategies and argues that: business incubation is about 'direct support' rather than 'life support' and therefore the main goal is to move clients to the point where they no longer depend on services from the incubation environment or when incubation cannot again help them. Like selection policies, exit requirements and strategies must be consistent with the objectives of the incubation environment and take into account the types of clients supported. Exit requirements may or may not be formalized, but all incubation environments must discuss their exit expectations with the client at the time of entry and review and develop these expectations during the incubation period (Hackett & Dilts, 2004).

3.4 The Progress of Business Incubators

The development of business incubators is initiated to mid of the twentieth century during the increase of unemployment and recession in USA and Europe (Aerts et al., 2007). The beginning can be traced back to Western industrialized countries in the late 1970s and early 1980s (Bhabra-Remedios and Cornelius, 2003; Aerts et al., 2007). Faced with a rapid rise in unemployment resulting from the downfall of old industries, it was acknowledged in both the Europe and the USA that fresh strategies were required to help redevelop crisis sectors, regions and communities (CSES, 2002:4).

Business incubator concept was originated in United States in 1959 and after which this concept has gain significant growth in United States in mid 1980s (Aerts et al., 2007). Since then, this concept has become a global phenomenon (Apa et al., 2017). Cornelius and Bhabra (2003) investigated the development and history of business incubation in different literature and said that the beginning was in Batavia in 1959. The concept was developed jointly by governments in Europe and USA and research centers at academic institutions (Sam and Van, 2014). Hackett and Dilts (2004) investigated and traced the

formation of the first business incubator to 1959 in Batavia as Batavia Industrial Center as mentioned before. In the 1960s and 1970s incubation programmes refined slowly, and typically as government- sponsored responses to the need for urban economic recovery (Hackett and Dilts, 2004). In the 1980s and 1990s the rate of incubator dispersion increased significantly due to the development of legal system and its appreciation of business needs as well as the rebellion of biomedical research (Kearney, 2003). Mckee (1992) explained that business incubator concept was first generated in United States in 1959 when Batavia industrial center in Batavia, New York was opened. The concept of business incubators for the development of economy was developed in 1959 and it became popular in 1980s to grow the small businesses (Lalkaka 2002; Nelson and Nelson, 2002). The industrial incubators and shared office incubators began to grow in United States in 1970s in order to redevelop the historical buildings and use them for the better purpose and turn these vacant buildings to work communities and in order to create new jobs for the idle workers (Hackett and Dilts, 2004; Montgomery, 2007).

Industrial incubator is a term which is used to describe several short-term business sites (Allen and McCluskey, 1991). In early 1980s and 1990s, other types of incubators appeared such as business centres, science parks, and business incubators (Bruneel et al., 2012). These types of incubators were developed from two broad categories (Verma, 2004). One method was to renew older and empty buildings such as schools, factories and warehouses and lease these places for inexpensive rates. The strategy more emphasized on providing entrepreneurs with contact to space than on building new companies and providing them new operations, personals and markets for tenants (Rivera et al., 2009). Bøllingtoft and Ulhøi (2005) defined success as to rent out the space and ability of entrepreneurs to meet the monthly expenses. These types of incubators provide flexible space and services to tenant firms (Mian et al., 2012). These types of incubators generally have no selection criteria and with respect to business services and technology insides. Second strategy was to more conscious effort on building new companies it means that basic aims is to control resources to help new companies to grow further (Montgomery, 2007). In this strategy incubators requires the equity position in tenant companies, and to offer them space was still very important for the developing new firms (Aerts et al., 2007). In this strategy success was defined as the growth of tenant company and its ability to ultimately stand on its own (Bruneel

et al., 2012; Carvalho and Galina, 2015; Hong et al., 2019). Business incubators are examples of such type of incubators which are trying to build new companies (Lukeš et al., 2019).

Business incubators of early 1990s had highly selective entrance criteria which provided management services and emphasizes on building new companies in order to control and manage resources (Montgomery, 2007). The goal of these incubators was to increase economic development by encouraging innovation, employment, entrepreneurship, opportunities and growth and most of them were running by national and local authorities (Romanelli and Khessina, 2005; Tamasy, 2007; Rubin, 2015). Allen and McCluskey (1991) explained that in the mid of 1990s the new type of incubators which were specialized in some specific industry and focusing on specific industry sector, or specific type of technologies which were appeared because of arrival of internet. This type of industry focus incubators is highly focused on technology and mainly recognized by the universities and private sector organizations (Allen and McCluskey, 1991). In late 1990s, as a result of dot.com era the incubators without walls or virtual incubators were formed (Montgomery, 2007). These types of incubators were mainly virtual and funded by venture capital companies, or by large consultancies firms which provides large range of technological, advisory and other type of services to tenant firms (Uzzi, 1996; Qian et al. 2011).

Lalkaka (2003) sums up the evolution of incubation concepts as follows: The first-generation incubator in the 1980s was essentially affordable space and shared facilities to carefully selected entrepreneurial groups (Lalkaka, 2003). In the 1990s the need was recognized for supplementing the workspace with counselling, skills enhancement and networking services to access professional support and seed capital for tenants within the facilities and affiliates outside (Allen et al., 1991). This has led to the ‘second generation’ incubator. Starting in 1998, a new incubation model emerged in parallel (Grimaldi and Grandi, 2005). This is intended to mobilize start-ups and provide a convergence of support, towards creating growth-potential, technology-based ventures (Hackett and Dilts, 2004).

In the context of China, the development of the business incubators reflects the characteristics of innovation performance and entrepreneurship in China has largely

become an innovation drive (Hong et al., 2019). In 2017, more than half of the incubators in China were engaged in the electronic information industry, nearly 15% in high-end manufacturing, 8% in biomedicine and medical devices, and 8% in cultural creativity (Hou et al., 2019).

In 2017, the total number of business incubators in China has reached 4063 (see Figure 2), 175000 small and medium-sized science and technology enterprises are incubated, 111000 graduated enterprises are accumulated (see Figure 3), 11000 high-tech enterprises are cultivated, accounting for 8.2% of the national high-tech enterprises. It has 307000 effective intellectual property rights, including 52000 invention patents, accounting for 2.5% of the total number of effective invention patents in China, and 21000 new invention patents granted, accounting for 5% of the total number of invention patents granted in China in the current year. Furthermore, the business incubators also help about 40000 enterprises obtain 1940 billion CNY venture capital.

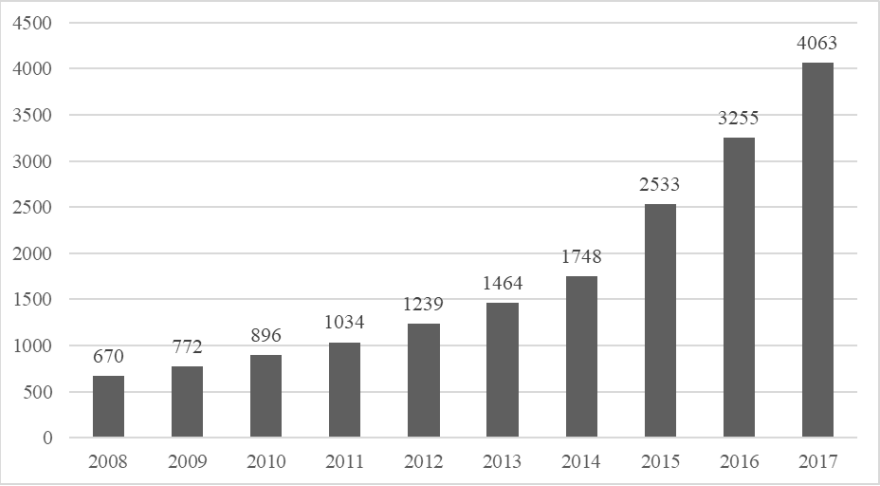

Figure 2 Number of Business Incubators in China

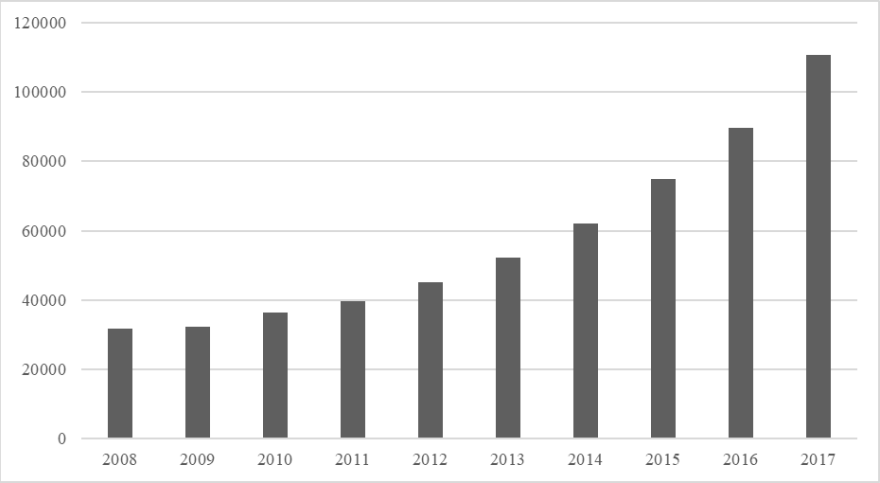

Figure 3 Accumulated Number of Graduated Start-ups

3.5 The Development of Innovation in China

Innovation and regional development literature suggested that China have become an important participant in the global knowledge economy (Niu et al., 2008; Valliere and Peterson, 2009; Bathelt and Zeng, 2014; Li et al., 2016; Kim and Shim, 2018; Wang et al., 2020; Conlé et al., 2021).

In the past 10 years, China's development model is transforming from one based on low cost, low value-added manufacturing activities to one increasingly reliant on the manufacturing of higher value-added, more sophisticated goods and also on knowledge generation (Zeng and Fang, 2014; Suder et al., 2015; Li et al., 2016; Liu and Lin, 2019, Qu et al., 2020). Meanwhile, the Chinese government regard business incubator and technology entrepreneurs as a new engine fuelling technology development and innovation performance growth (Hershberg et al., 2007; Wilson et al., 2009; Mok and Yue, 2013; Li et al., 2016; Wang et al., 2020). The development innovation proxied by the sustained and stable innovation input (e.g., R&D investment and regional intelligence) and output (e.g., patent and new product) exhibit that China may remain one of the world's fastest-growing innovation economies (Li et al., 2016; Wang et al., 2020; Conlé et al., 2021).

In the context of China, considerable variation in the extent to which business incubators have participated in the expansion of the regional innovation activities (Hong and Lu, 2016; Wang et al., 2019). Therefore, innovation activities in China are highly territorialised. Most innovation activities are concentrated in the eastern developed regions (Zhu and Tann, 2005; Zeng et al., 2010). Such uneven distribution is problematic, as innovation imbalances could entrench, if not exacerbate, already-pronounced disparities in wealth and economic development (Hong and Lu, 2016; Wang et al., 2020). The Chinese government has already noticed this question and has put forward the coordinated strategy of the regional innovation development (Mok and Yue, 2013; Wang et al., 2019).

Currently, China's business incubators development and government policies have provided a sufficient platform for entrepreneur and innovation activities. Such a

development necessitates, and even drives, the continuous development of China's innovation performance (Jin et al., 2015). Many authors suggested that regional innovation and entrepreneurship programmes implemented by Chinese provinces and municipalities as a critical facilitator for the growth of regional patenting activity (Zhao et al., 2017; Si et al., 2020). Existing literature has demonstrated that innovation in China's region has consistently played an important role in the advancement of knowledge through the use of experimental research (Sun et al., 2019).

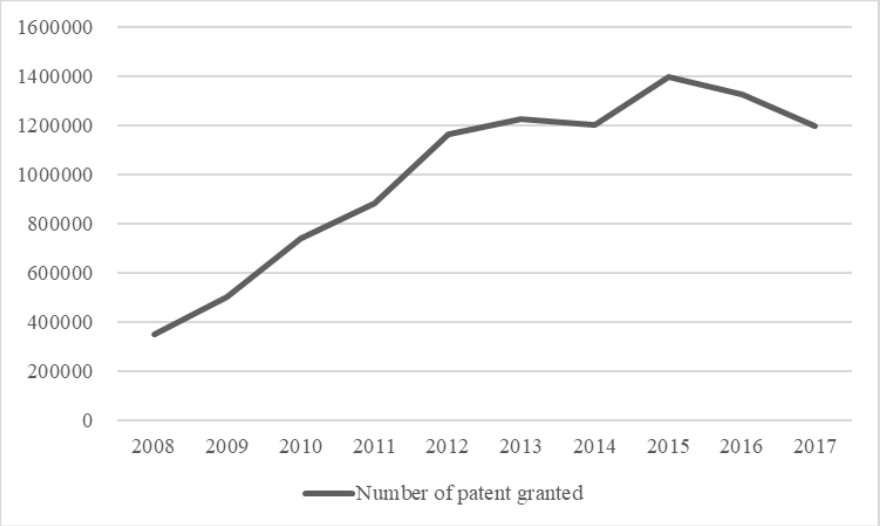

Figure 4 Number of Patent Granted

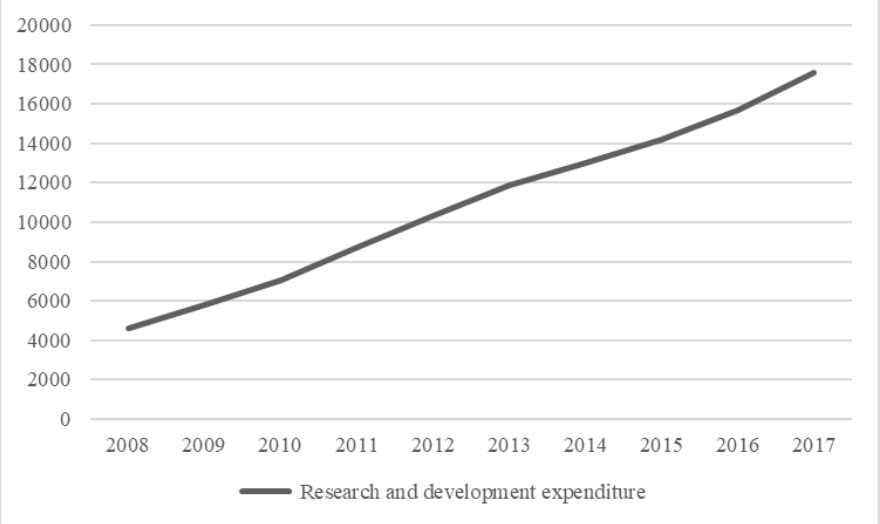

Figure 5 Research and Development Expenditure

Furthermore, the innovation performance is rapidly increasing in prominence due to new public policies (Qian et al., 2011). These policies provide a platform for improved links between business incubators with an emphasis on science and technology-based

innovation (Rui and Yip, 2008). As innovation performance develops, the number of granted patents nationally in China has risen significantly between 2008 and 2017, from 352406 to 1200828 (see Figure 4). Similarly, there has been a marked increase in research and development input in the local economy over the period, rising steadily from 4616.02 million CNY in 2008 to 17606.13 million CNY in 2017 (see Figure 5).

Furthermore, the Chinese government has attached great importance to innovation development, every stage in the innovation development has their own characteristic (see Table 2). In 1949, Chinese technology development was based on a traditional system due to limited scientists and research institutes. In 1953, the total expenditures related to S&T was 56 million yuan which was 0.26% of the total budget. For the regional innovation system, China adopted the gradualist method. In the 1980s, the Chinese government implemented the first reforms in the regional innovation system (Zhao et al., 2020). The main objectives were to re-establish the government research departments to improve efficacy and promote collaboration between industry (Xu, 2018). The expected outcome achieved through technology transfer between sectors for innovative product development (Xu, 2018). Based on the characteristics of this method, scholars consider it as Science and Technology strategy with the main purpose being to divide the institution (Fan et al., 2018; Wang et al., 2019). The motive of this division was to identify factors that were affecting the government initiative about collaboration between various sectors (Li, 2009; Siu, 2018). These major reforms aimed to enhance the interaction and strengthen ties among the academic institution and industry (Fu, 2008; Li, 2016). This emphasis focused on rebuilding the infrastructure by increasing investment and enhancing Research and Development activities (Liu and Nijkamp, 2019; Lin et al., 2020).

Table 2 Development Stage of China's Innovation System

Stage	Characteristics
1st stage 1949 - 1978	Central planned economy with focus on military related technologies. Less emphasis on interaction between university and industry.
2nd stage 1979 - 1985	Early economic reforms and S&T related reforms
3rd stage 1986 - 1992	Focus on technology transformation. Focus on improvement of relationship between producers and user of knowledge especially all stakeholder's university and industry for innovation. R&D funding for public sector reforms.

Stage	Characteristics
	Initiative of new programs related to enhancement of high-technology industry
4th stage 1993 - 1998	Restructuring of S&T system. Encourage university experts/ researchers to establish their own high-tech firms or work in it.
5th stage 1999 - 2005	Improve the Regional Innovation System (RIS). Strengthen the RIS Accelerate the transformation of S&T achievements. Facilitate interactions between innovation actors
6th stage 2006 - Now	Develop the RIS and link with industry. Independent innovation through National Incubation Centre.

Since 1978, the Chinese government announced its eight-year national plan (1978-1985) based on 'basic research' known as the "National Science and Technology Program" (MOST, 2018). Another purpose of this plan was to restore R&D facilities (Li, 2009; Liu and Nijkamp, 2019). National Science and Technology Commission started working. By the end of 1979, the Chinese Academy of Sciences (CAS) established 120 laboratories, and the strength of exports increased to 24,000 (MOST, 2018). At the same time, the Chinese government increased funding for R&D activities by 1.5% (MOST, 2018). This S&T system transformed into a "Bureaucratic, professional" model where scientific experts are the leader of research laboratories to promote S&T (Li, 2009; Liu and Nijkamp, 2019; Lin et al., 2020). The Chinese central government shifted its focus from S&T toward economic growth by building and merging research and product relationship in their 4th Five Year Plan, focusing on eight fields where new technologies were one of the main fields of focus (MOST, 2018). In the 5th Five Year Plan (1985-1991), the government also shifted its focus on government laboratories reform due to the technology market and linkage of R&D with other sectors to enhance industrial development and efficacy (MOST, 2018).

These reforms encouraged the government laboratories to have self-reliance to become part of the technology market (Liu and Nijkamp, 2019). In 1983, the government took the initiative to support basic research. It established National Science Foundation in 1986 and introduced a bidding system in place of the assignment approach (MOST, 2018). These reforms brought initial success, especially in the industrial sector through the technology push and market pull mechanism (MOST, 2018). The push approach

brings economic growth through government research laboratories, and the pull approach helps to reduce the reliance on government funding (MOST, 2018).

In 1999, the Chinese government realized that the technology-based market approach could not achieve the desired results (MOST, 2018). Even after two decades of reforms in government policies, government research laboratories and universities still heavily rely on government funding (about 47.5% of university funding from the government) (MOST, 2018). The main reason for the failure of the technology-based market approach was due to the incapability of government laboratories to put up with the dynamic market and increased industry reliance on full developed technology due to their limited capabilities (Wang and Kafouros, 2009). In addition, the government laboratories had immature technology or solution, which made the industries unable to apply it into their existing product line (Wang et al., 2019).

Therefore, the inability of government research laboratories to develop effective technologies resulted in the industry's failure from the perspective of technology application (MOST, 2018). Before the 1990s, the Chinese industries had more opportunities to develop and promote their business due to less competition in the market (Liu and Nijkamp, 2019; Lin et al., 2020). These increased opportunities led to reduced pressure on adopting and implementing new technology (Sun, 2002).

Due to the lack of efficacy in the technology-based market approach, the government did reforms in 1987 to merge both government research laboratories with industries (Xu, 2010). These reforms aimed to control research institutes R&D activities through industry and easily integrate industrial production system (Fu, 2008; Zhang et al., 2009). In 1987, government reforms merged only government research laboratories with the industry (MOST, 2018). Wang and Kafouros (2009) mentioned the reason for the failure of this strategy; lack of capabilities of the industry to handle R&D activities and cultural difference between them and under the direct supervision of the respective ministry. These policies merged both laboratories and industry. In reality, the industry was partially controlling the government research laboratories and handled independent financial matters (Wang et al., 2016; Xu, 2018). In 1987, the Chinese government started the "863 Program" to promote technologies (Xu, 2018; Wang et al., 2019). This program was based on a bidding system instead of an assignment of the project (Zhao

et al., 2020). In this project, the government asked the public to submit proposals and then upon successful acceptance of proposals, the government assigned project funding (Wang et al., 2019). This approach enwalled the fair competition for innovation compared to previously mentioned approaches (Chan and Lau, 2005; Fan et al., 2007; Chen et al., 2014; Du et al., 2019; Ding et al., 2021).

In 1988, the Chinese central government initiated a new "Torch Program". The purpose of this was to promote entrepreneurship and high-tech spinoffs industries (China torch statistics yearbook, 2018). The successful cases of high-tech spinoffs are the Legend group of the Chinese Academy of Sciences (CAS) (China torch statistics yearbook, 2018). The structure of the Chinese spinoffs industry is comparatively different from western countries, where the industry is independent of the parent organization. In China, parent organization handles human resources and funding of its spinoff's firms (China torch statistics yearbook, 2018). This approach is more likely as the business incubators model where generation and commercialization of new knowledge (or technology) are generated, and commercialisation is done from universities to industry (Pradhan et al., 2016; Rolland et al., 2018). In this approach, a low level of risk is involved especially financial risk (Bi et al., 2016). In this case, the industry gets long-term support from the universities and government (Sam et al., 2014; Chen et al., 2014). Chinese government reforms in the regional innovation system were based on a gradual process (MOST, 2018). These reforms were based on the continuous change in their policies which goes in hand with the institutional-learning-based approach to get desired outcome/ results on the basis of the previous set of action (Wang et al., 2016; Zhao et al., 2020) that is:

(1) Market oriented.
(2) Enhance the regional innovation performance.
(3) Enhance the development of business incubators.

3.6 The Development of Communication Infrastructure

3.6.1 The Overview of Communication Infrastructure

In the last two decades, communication infrastructure has transformed the world, communication infrastructure is a technology with special and far-reaching properties (Parida and Örtqvist, 2015; Rippa and Secundo, 2019). As a so-called general-purpose

technology (Hacklin et al., 2005; Buyya et al., 2009), it has three basic characteristics: First, it is pervasive, i.e., it spreads to all sectors (Fowler, 2002). Second, it improves over time and hence keeps lowering the costs for users (Olsson, 2005). Third, it spawns innovation, i.e., it facilitates research outcome, knowledge and new technology transferring and sharing (Van et al., 2009). Therefore, communication infrastructure has been acknowledged as a major contributor in innovation performance development, (Lechman and Marszk, 2015; Baron et al., 2016). Much has been written that communication infrastructure is a diverse set of technological tools and resources used to create, store, retrieve, sort, filter, distribute and share knowledge seamlessly and manage knowledge information (Kostopoulos et al., 2011; Parida and Örtqvist, 2015). Therefore, the communication infrastructure substantial efficiency the knowledge transferring and expansion (Bolívar-Ramos et al., 2012; Elia et al., 2020). Meanwhile, Communication infrastructure has always been perceived as a great opportunity for emerging economies, such as China (Xu, 2010; Hou et al., 2019).

Communication infrastructure is an influential enabler of development because its unique characteristics dramatically improve communication and the exchange of information to strengthen and create new economic and social networks (Sein and Harindranath, 2004; Rippa and Secundo, 2019). Communication infrastructure is pervasive and cross-cutting, communication infrastructure fosters the dissemination of knowledge, and communication infrastructure is global, impervious to geographical boundaries (Gichoya, 2005; Luo and Bu, 2016). Communication infrastructures reduce transaction costs because of its digital and virtual nature, communication infrastructure streamlines value system and supply chains and makes many business processes more effective (Carlsson, 2006; Tarafdar et al., 2012). The increase in efficiency and subsequent reduction of costs brought about by communication infrastructure is leading to the creation of new products (Andersson and Karlsson, 2006), services and distribution channels within traditional industries, as well as innovative business models and whole new industries (Christensen et al., 2012; Chege and Wang, 2020). There is increasing evidence that business incubators benefit substantially from the development of communication infrastructure (Özdemir and Şehitoğlu, 2013). It increases efficiency, promotes innovation, reduces transaction costs, facilitates networking among stakeholders and allows technology entrepreneurs to participate in broader markets (Chan and Lau, 2005; Carayannis et al., 2006).

With this in mind, this study argues that communication infrastructure is necessary to fully realise the benefits of business incubators for regional innovation performance (Meyer-Stamer, 2002; Hacklin et al., 2005; Carlsson, 2006). The advent of communication infrastructure has offered business incubators access to virtual resources, information and knowledge (Saavedra et al., 2020). Instances of such opportunities include e-business (Li et al., 2016), internet-of-things services (Yunis et al., 2018), virtual offices, effective customer relationship management (Chan and Lau, 2005; Lai et al., 2017), efficient supply-chain management (Papadonikolaki, 2020), continuous communication with internal and external stakeholders, and better access, management, and controlling of resources (Stone et al., 2017; Du et al., 2019). Still another example is that communication infrastructure enables the testing of different situations and decision-making scenarios, learning (Rafailidi, 2007), generating of effective business plans, accessing databases, and enhancing communication and social networking (Tötterman amd Sten, 2005; Carlsson, 2006). As these opportunities increase, strong and dynamic corporate entrepreneurship is also needed to seize the benefits of communication infrastructure by integrating them into organizational strategies and creating the right corporate culture for communication infrastructure adoption, use, and innovation diffusion (Freeman and Soete, 2009; Yunis, 2018).

For business incubators, the communication infrastructure is considered to be one of the most important factors in the success of incubators, technology entrepreneurs and innovation (Barba-Sánchez and Jiménez-Zarco, 2007; Blyde and Molina, 2015; Bertello et al., 2020). The existing study indicated that business incubators support technology entrepreneurs to achieve their business objectives (Fan et al., 2018; Papadonikolaki, 2020). Entrepreneurship is a dynamic process that requires links or relationships not only among individuals but also among a variety of institutions (Alzaghal and Mukhtar, 2007; Gawer and Cusumano; 2014). Through networking, the technology entrepreneurs have access to more opportunities and will have a greater chance of solving the problems expeditiously, which may give technology entrepreneurs the chance to succeed in technology entrepreneurs (Hisrich and Smilor, 1988).

Furthermore, communication infrastructure enables entrepreneurs to evaluate with

other entrepreneurs (Chen et al., 2015; Elia et al., 2020), get inspiration, develop common ideas and assess the performance of their business (Christensen et al., 2012; Dias et al., 2020), and it can also strongly promote performance through innovation for commercialization and internationalization (Carayannis et al., 2006; Xu, 2101), inspiration, idea development (Crupi, et al., 2020), business development and assessment, knowledge sharing (Markard, 2011), skill acquisition, identification of core competencies, increased market share, and scientific research (Elfring and Hulsink, 2003;Hackett and Dilts, 2014; Qiu et al., 2017; Rakshit et al., 2021). With this in mind, considers communication infrastructure to be one of the most important elements of the business incubator operation (Koh, 2006; Klerkx and Leeuwis, 2008; Parida et al., 2012).

3.6.2 Communication Infrastructure in China

Digitalization and communication infrastructure are growing phenomenon in China (Fan et al., 2018). Communication infrastructure provides many business opportunities in various areas, including cloud technology, enterprise services, e-commerce, e-finance, mobile components and embedded software, big data, and app-based communication infrastructure platforms (Chen et al., 2014). At the core of the Chinese government 12th Five-year plan, the communication infrastructure sector corresponds to the biggest single market in the world (MOST, 2018).

Following the studies on developing internet technologies for artificial intelligence (AI), internet of things (IoT), big data, cloud, and mobiles are new engines for growth; the many authors stressed that the communication infrastructure and the digital economy underpin the country economic development (Blyde and Molina, 2015; Shih and Aaboen, 2019). Chinese communication infrastructure companies have been growing enormously and became more influential because the private and state sectors are financing them with needed capital both inside and outside the country (Khadaroo and Seetanah, 2010). Furthermore, the communication infrastructure became an integral part of innovation since the entrepreneurs create new business applications and technologies that support and bring innovation into the day-to-day activities and routine work (Klerkx and Leeuwis, 2008). Ministry of Industry and Information Technology (MIIT) is responsible for regulating wire signals, the internet broadcasting and communication system, software and electronics products (MIIT, 2018).

In 2006, China announced the 2006-2020 National Informatization Development Strategy, which focused on the role of informatization in industrialization (MOST, 2018). The strategy is characterized to achieve an increase in productivity, ensure sustainable development, low environmental pollution, high economic efficiency, and low consumption of materials (Stek and van, 2016; Fan et al., 2018). Moreover, the strategy is the plan to boost local companies and make them global champions by bringing indigenous innovative core technologies rather than imitating and introducing them from abroad (Fu, 2008). Additionally, the strategy focuses on establishing a world-leading, safe, and reliable information system (Khadaroo and Seetanah, 2010). Therefore, there are opportunities for local companies to have information and innovative technologies (Khadaroo and Seetanah, 2010). The technologies bring forth new ideas and know-how that may enhance the capabilities of the business entities to introduce more sophisticated, diversified, and complex products (Li et al., 2016). That may, in turn, lead to the overall sophistication of the economy (Lin et al., 2020). China also operates five-year plans (Liu et al., 2019). The latest five-year plan mainly focuses on e-logistic, e-commerce, traceability of agricultural products, epidemic surveillance, smart healthcare, and smart transportation system (Zhou et al., 2003; Zhang et al., 2009; Wang et al., 2019).

In 2016, the communication infrastructure exports accounted for 26.49% of total exports (MIIT, 2018), the portion of communication infrastructure imports estimates 23.75% for total imports, and in 2017 the mobile cellular subscriptions accounted for 1.47 billion (MIIT, 2018). Moreover, China's GDP growth is 6.9% in 2017, which is quite useful for such a huge economy. The Chinese annual growth of the big data market is 30% (MIIT, 2018).

3.7 Summary

This chapter has reviewed the published literature related to the development of business incubators and China's innovation performance. This study using the quantitative framework to collect secondary data on the business incubators and regional innovation performance in the context of China. The methodological approach contributes to the literature by analysing the impact of density and capacities of business on regional innovation performance. The next chapter details the research hypothesis

and the methodologies used to collect and analyse the data used in this study.

Chapter 4. Conceptual Framework and Hypotheses

4.1 Introduction

The purpose of this thesis, which is exploratory in nature, is to provide empirical evidence of the role of density and capacities of business incubators in innovation performance development in the context of an emerging economy. This thesis contributes to the literature on business incubators, regional innovation system, and organizational ecology by employing quantitative methodologies to understand the relative importance of density and capacities of business incubators in regional innovation performance. This thesis examines the impact of the development of business incubators density on innovation performance in provincial and geographical areas in China and the basic, financial and incubation capacities of business incubators to facilitate the innovation performance with the moderation factor-- communication infrastructure. This chapter briefly introduces the conceptual framework and proposes six hypotheses.

4.2 Conceptual Framework

4.2.1 Regional Innovation System Framework

Concerning the description of "innovation" as well as the circumference of the innovation system, the perception of "system" gets more important (Cook et al., 1998: 1564; Iammarino, 2005: 499). "Decomposing of factors or segments, which jointly prerequisite and restrain with each and other, so that works together, with logically defined functions" (Fleck, 1993). Following Carlsson et al. (2002), a system basically lies in the three main aspects, namely elements, the association between elements and characteristics. Systems are used as systematic tools. In innovation studies, it's theoretical instead of operational, which serves as an analytical framework for examining the connections between variables (Cooke and Memedovic, 2003). The elements in this study mainly including regional innovation performance, density and capacities of business incubators and communication infrastructure.

In evolutionary economics research, evaluating the association between business incubation, innovation, knowledge transfer, and development has become the new goal. Some critical features connected with the knowledge transfer (or sharing) process and the amalgamation of innovation productive systems, such as the knowledge production argument (Griliches, 1990), regional intelligence (Sleuwaegen and Boiardi, 2014), and communication infrastructure (Allameh et al., 2011; Geisler and Wickramasinghe, 2015)

is a strong direct and indirect driver of regional innovation. The innovation system literature generally utilized either in academic or policy/ strategy contexts in the 1980s (Balzat & Hanusch, 2004, Sharif, 2006). It was formulated to investigate economic growth, considering innovation and learning when neoclassical economic contemplation was insufficient (Griliches, 1990; Lundvall, 2007; Geisler and Wickramasinghe, 2015).

By the end of the 1980's the regional innovation system has been presented and still a novel technique for the research of innovation. It first appeared in Freeman's work on technological infrastructure in 1982 was referred to as a system of innovation (Freeman, 1987). ln 1987, the system of innovation was first used in Freeman's study on "technology policy and economic performance in Japan" in the form of publication (Freeman, 1987). Freeman (1987, 2004), Lundvall (2007) and Nelson (1993) contributions can be identified as the three main pillars of this tradition (Fagerberg and Sapprasert, 2011). The main blast in the last three decades about innovation was proposed by these three researchers (Urionaet al., 2012). In order to find the further appropriate angles: regional (Malerba et al., 1999; Geels, 2004; Iammarino, 2005: 499), geographical area (Cooke et al., 1998), and national (Niosi and Bellon, 1994; Acs et al., 2002; Carlsson, 2006). Meanwhile, the determination of a suitable approach to implement the innovation system is a big challenge. The policymakers encouraged the development of this practice (Acs et al., 2002; Godin, 2009) and diversification of perceptions.

The innovation system is composed of interconnected elements functioning collectively to attain an objective, which is innovation (Geels, 2004). The innovation system integrates all feature components, social factors, economic factors, political factors, and organizational factors on the formation, use, and allocation of novelty/innovation (Charles Edquist, 1997; Acs et al., 2002). As reported by Carlsson et al. (2002), these elements are sometimes actors; sometimes associations and their association are the correlations amid them, presenting how the performance of all actors influences the whole system. Furthermore, each element possesses characteristics and qualities so as they classified to like capacities (Freeman, 2004; Carlsson, 2006). Innovation system has evolved broadly recognized into two reasons in innovation research studies, First, since it departs away from the predictable linear approach and second, research &

development to describe the transformations during innovation amid the countries (Radosevic, 1998). Although, this approach also has some weaknesses like other approaches. The weaknesses are associated with the system structure and its capabilities (Cooke and Memedovic, 2003; Lundvall, 2007). When analyzing the system, these weaknesses are also created problems either in physical/conceptual and the problem of system frontiers and an institutional variety of innovation system (Radosevic, 1998). According to (Carlsson et al., 2002; Lundvall, 2007), the deficiencies related to the level of analysis can be handled by identifying components or actors, their crucial association, and assessment of the performance of the innovation system.

4.2.2 Density of Business Incubators and Regional Innovation Performance

Although the business incubators in a cluster co-locate in a geographical area and may or may not have business dealings or interactions in other aspects (Wallsten, 2001; Aharonson et al., 2007). However, geographic proximity is seen as the core for the business incubators if they benefit from clusters in productivity, knowledge transfer and innovation (Rubin et al., 2015). Many authors suggested that knowledge and resource transfer not just between firms, but also between the business incubators in geographical areas (or province) (Filieri and Alguezaui, 2014; Rubin et al., 2015; Mian et al., 2016). The benefits of the spatial concentration of business incubators include lower operation and knowledge transaction costs, a higher concentration of incubation resource (e.g., mentors and venture capital), and closeness to the academic institution or university, which have been known as the agglomeration economies (Shepard, 2013). These agglomeration benefits have been considered the drivers of the business incubators density increasing in certain geographical areas (or province) (Qian et al., 2011; Filieri and Alguezaui, 2014; Rubin et al., 2015; Mian et al., 2016).

The latest research on organizational ecology and density dependence goes beyond this analysis, highlighting the mutualism and competition role of business incubators under different density development levels (Deligianni et al., 2019; Cavallo et al., 2020). The high density of business incubators in certain areas does not necessarily imply an increase in regional innovation performance development (Ellison et al., 2010). In other words, it has been recognised that not only mutualism associated with the development of innovation performance, but the competition also has an impact on regional innovation performance (Baldwin et al., 2010). However, there is still not enough study

about the impact of business incubators with different density development levels on regional innovation performance. This study provides new empirical evidence on this field.

4.2.3 Capacities of Business Incubators and Regional Innovation Performance

Previous research has shown that psychological capital is a higher-level concept: individual resources, self-efficacy, optimism and so on are the key basic resources to manage and adjust other resources (Luthans et al., 2007). Some empirical studies pointed out that the basic services provided by the business incubators have a positive effect on people's psychological capital (Luthans, 2007; Margaça et al., 2020). Therefore, establishing business incubators provides a space for regional innovation or entrepreneurial talents and provides entrepreneurs with a collision of ideas, actively promoting a strong entrepreneurial atmosphere and then enhancing the regional entrepreneurs' psychological capital (Cowell et al., 2018). Tang and Jiang (2007) pointed out that business incubators can further enhance the self-confidence and optimism of innovation by building a stable innovation platform and a solid basic service system. At the same time, the relaxed entrepreneurial atmosphere in business incubators helps entrepreneurs to ease their frustration when facing difficulties, thereby improving resilience psychological capital (Baldwin et al., 2010; Cowell et al., 2018). Therefore, the basic capacities of business incubators will promote the gradual accumulation of entrepreneurs' psychological capital, which can significantly improve the performance of start-up technology companies, and thus enhance the overall performance of innovation (Hou et al., 2019). The basic services of the business incubators provided a high-quality innovation space for regional entrepreneurs (Grimaldi et al., 2005; Sentana et al., 2017). In this space, both entrepreneurs and employees can better commit themselves to innovation research and development, gradually strengthen their innovative psychological capital, and then commit innovate the formation of a regional innovation atmosphere and promote the development of regional innovation (Cohen and Winn, 2007).

The synergy effect believes that the combination and common operation of the various entities in the system can create more value (Hansen, 2000). The goal of corporate business incubators financing services is to provide economic support for enterprises, especially for the innovation activity of start-ups (Lamine et al., 2018). Besides business

incubators investment found, the government is also continuously enhancing the financing support of innovative enterprises (Lukeš et al., 2019). Financial institutions such as banks have also increased the intensity of loans to high-quality enterprises (Maples-Keller et al., 2017). Therefore, from the perspective of external synergy, the financing service of business incubators is essentially integrated with the various innovation entities in the region (Sentana et al., 2017). Regional innovation factors flow between enterprises, business incubators, government, and financial intermediaries, promote the effective circulation of funds within the innovation system, and efficiently allocate resources such as funds, talents and information in the region (Sun et al., 2019). Therefore, the effectiveness of financing services plays a significant role in regional external synergy and regional innovation.

Previous knowledge sharing literature suggested that effective knowledge transfer is an important manner to facilitate progress and regional innovation performance (Alavi and Leidner, 2001; Chaminade and Vang, 2008; Afzal et al., 2013; Jiao et al., 2016; Bouncken and Aslam, 2019). The existing study has also proven that incubation promote knowledge transfer (Aerts et al., 2007; Fazey et al., 2013; Wang et al., 2020). In addition to directly transferring various types of resources to incubating enterprises, the business incubators can also indirectly promote the flow of knowledge by establishing social relationships (Lalkaka, 2003; Sofouli and Vonortas, 2007; Lesakova, 2012). Previous researchers also highlighted the role of business incubators in developing networks between incubating businesses (Lalkaka, 2003). Hansen (2000) pointed out that even if the business incubators managers cannot directly provide services, they can also connect the enterprises with other participants, form a social network for R&D results. This network is significant for the transfer of information and knowledge (Soetanto and Jack, 2013). Bubou and Okrigwe (2011) also believed that the business incubators integrate various technological entrepreneurship and innovation resources in the region, serve start-ups, and enhance the region's overall innovation capacity through knowledge transfer.

4.2.4 The Role of Communication Infrastructure

Few studies have included the role of communication infrastructure on regional innovation performance. The extant literature suggested that innovation can be generally characterised as a basically uncertain process for solving problems, which

mixes private with public resources (Allameh et al., 2011), such as talent, capital, and technology. Private resources come primarily from the enterprises themselves and associations of enterprises and scientific and professional organisations (Nelson and Nelson, 2002). Public resources are drawn from institutions which conduct scientific and technical R&D, such as university (Armanios et al., 2017). Meanwhile, there is considerable literature suggesting that the private resources base of companies in a region is supplemented by the public resources of research institutes located in the region (Baldwin et al., 2010). To this end, how can the most effective transmission of the most accurate resources become a key point of innovation. Pavic et al. (2007) pointed out that the importance of communications infrastructure stems from its role as one of the main tools employed in the information exchange activities of regional. Allameh et al. (2011) believed that getting high efficiency and effectiveness in organizations requires investment in communications infrastructure, such as the Internet, postal and telecom. In a similar vein, this would argue that the existing communications infrastructure (facilities and business) will influence the extent to which transfers of resources from outside of the business incubators (Durán and Ubeda, 2005; Rui and Yip, 2008), and influence the basic finance and incubation capacity of the business incubators (Nelson and Nelson, 2002). Hence, the emerging economies should invest in communications infrastructure and subsequently be able to adapt and exploit those assets to the benefit of their innovation performance.

4.2.5 The Conceptual Framework

The overview of the literature presented in Chapter 2 shows that despite previous literature have recognized the important role of business incubators development in promoting regional innovation performance. Most existing studies have not sufficiently explored the impact of density development of business incubators on regional innovation performance. To this end, further studies are needed to prove the findings in density development of business incubators and region innovation performance (Luthans et al., 2007; Jin et al., 2018; Hillemane et al., 2019; Lukeš et al., 2019). Hence, this study focus on the development of business incubators density affects innovation performance, intending to understand the role of business incubators with different density development levels on regional innovation performance in the context of an emerging economy. On the other side, from the previous literature on business incubators, it is possible to identify the importance of business incubators in support of

innovation development (Perez-Aleman, 2005; Uzzi, 1996; Whittington et al., 2009; Shepard, 2013; Sun et al., 2019). However, it is not completely clear how the capacities of business incubators affect regional innovation performance (Tamasy, 2007). Furthermore, there is still a need to examine how the communication infrastructure associates with regional innovation performance and how the communication infrastructure moderates the relations between capacities of business incubators and regional innovation performance (Maples-Keller et al., 2017).

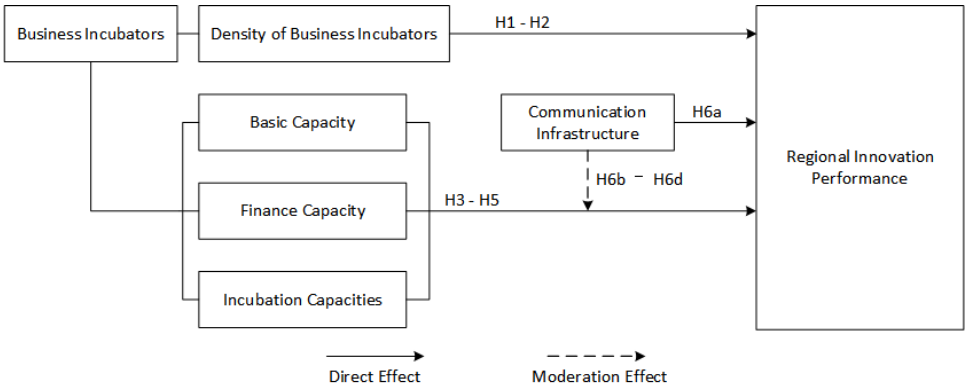

Figure 6 The Conceptual Framework

Therefore, the purpose of this thesis is to provide empirical evidence of the role of business incubators density and capacities on regional innovation performance in the context of China. There are three main aspects of the impact of business incubators on regional innovation performance that will be studied: the density of business incubators, the capacities (basic, finance and incubation capacities) of business incubators and the moderation role of communication infrastructure (see Figure 6). All of them contribute to the argument that business incubators affect and bridge the gap in the innovation literature.

4.3 Hypotheses Development

The business incubators are regarded as important homes to small technology entrepreneurs to provide important platforms for knowledge sharing and innovation activities and to promote the growth of innovation and technology entrepreneurship (Dahlstrand, 2007; Lamine et al., 2018; Rippa and Secundo, 2019; Wang et al., 2020). Emerging literature suggests that business incubators provide important complements to mainstream innovation (Jin et al., 2018; Hillemane et al., 2019; Matos et al., 2020).

They are attracting scientists and venture capitalists, while making them important homes for talents to advance science, technology, and innovation development of nations (Finegold et al., 2004; Dahlstrand, 2007; Mian et al., 2016; Lukeš et al. 2019; Xiao, North 2018).

4.3.1 Density of Business Incubators and regional innovation performance

The nature of the relationship between the business incubators and innovation is not clear cut, as there are both positive and negative effects (Aerts et al., 2007; Bubou and Okrigwe, 2011; Cavallo et al., 2020). On the one hand, the increase in the density of the business incubators facilitate its own population's position and legitimacy and create a mutualism system (Hong et al., 2019). Therefore, sufficient population's position and legitimacy to enhance the business incubators resource acquisition and thus promote the intention of many start-up firms to undertake R&D activities in the business incubator, especially for those business incubators in emerging economies (Barbero et al., 2012; Hou et al., 2019). Regarding the effect of mutualism, the effect may be realised through various channels (Bøllingtoft, 2012; Gawer and Cusumano, 2014). First, the start-up firms may learn knowledge or technologies through imitation (such as reverse engineering) from the cases provided by the business incubators (Cui et al., 2016). Second, the start-up firms may benefit from labour market turnover whereby skilled entrepreneurship mentors from other affiliates migrate to the business incubators carrying with them valuable knowledge and experience (Gawer and Cusumano, 2014). Third, there may be a 'demonstration effect' whereby products and technologies developed in start-up firms from other business incubators are observed by indigenous start-up firms and adapted by their own R&D efforts (Freeman and Audia, 2006; Hanadi and Aruna, 2013). Fourth, knowledge spillovers may be apparent either horizontally from the business incubators (Shepard, 2013; Ramesh, 2017; Sentana et al., 2017). In the emerging economy context of China, this study expects the positive effect to dominate with the increase in the density of the business incubators in the region to lead to more regional innovation performance.

On the other hand, with the business incubator increasing, competition for limited resources will erode their ability to acquire resources and thus reduce the support for start-up firms in the business incubators (Grimaldi and Grandi, 2005; Gawer and Cusumano, 2014). Start-up firms may not pursue innovation if they believe that they

will be unable to access sufficient and robust incubation resource to differentiate their products or lower R&D costs and that the competition between the business incubators denies them to profit from their R&D efforts (Hackett and Dilts, 2004; Bubou and Okrigwe, 2011; Bøllingtoft, 2012, Cowell et al., 2018). Meanwhile, the business incubator active in a highly competitive environment may have neither sufficient resources nor the time to support start-up firms to conduct R&D (Cohen and Winn, 2007; Dahlstrand, 2007; Qian et al., 2011; Filieri and Alguezaui, 2014), and thus their abilities to assimilate and apply the incubation resource acquired from outside may be limited (Sentana et al., 2017). Furthermore, the lack of sufficient and robust legal systems to protect intellectual property rights undermine the mutualism effect of many business incubators to support their incubating enterprises to undertake R&D activities, especially when the business incubators facing highly competitive pressures (Wallsten, 2001; Tamasy, 2007; Shepard, 2013; Rubin et al., 2015). The business incubators may well be more reluctant to transfer their acquired incubation resources, talents and technologies to other business incubators in the region if they operate in competitive markets because of concerns about their incubating enterprises losing intellectual property but would be more willing to do so if there was little competition at the region (Pavic et al., 2007; Li et al., 2012; Lamine et al., 2018). We would expect the negative effect to dominate and greater business incubators density in the region to reduce the innovation performance. This study thus hypothesises:

H1. The initial increase of business incubators density will facilitate the development of China's regional innovation performance

H2. The high density of business incubators will negatively affect China's regional innovation performance.

4.3.2 Capacities of Business Incubators and regional innovation performance

(1) Basic Service Capacity of Business Incubator

Psychological capital theory suggests (Cavus and Gokcen, 2015; Margaça et al., 2020) that individuals' performances are functions of psychological capitals which are influenced by factors such as self-efficacy, hope, optimism, and resilience (Clapp-Smith et al., 2007; Herbert, 2011). Self-efficacy is one's belief on his/her ability to succeed in accomplishing a task (Luthans et al., 2007). Hope is a positive motivational state that

is based on an interactive effect of a derived sense of successful pathways (planning to meet goals) and agency (goal-directed energy) (Chandra et al., 2012; Zhao et al., 2017). Optimism is an attribution style that explains positive events in terms of personal, permanent causes (Luthans, 2007), such as abilities, and negative events in terms of external and situation-specific causes, such as luck (Luthans et al., 2007; Zhao et al., 2017). Resilience is the salient willpower and capacity to rebound or bounce back from adversity, conflict, and failure or even positive and challenging events (Nelson and Nelson, 2002; Luthans, 2007; Marcotte, 2014). The synergy of these factors can directly or indirectly affect the behavioural performance of individuals and organizations to which individuals belong (Pavic et al., 2007; Lai and Lin, 2015).

Previous research has gained evidence that adequate services provided by business incubators can potentially enhance the synergy of psychological factors and the psychological capital of entrepreneurs which can affect the performance of the entrepreneurs in business incubators, and subsequently affect regional innovation performance (Grimaldi and Grandi, 2005; Allameh and Zare, 2011; Carayannis et al., 2016; Cavallo et al., 2020).For instance, Vanderstraeten and Matthyssens (2012) pointed out that business incubators could further enhance the self-confidence and optimism of innovation by building a stable innovation platform and a solid basic service system. Therefore, effective business incubators can actively promote the creation of strong entrepreneurial atmospheres and enhance the innovators and entrepreneurs' psychological capital. Wadhwa et al. (2017) and Kiani et al. (2019) revealed that people who worked in business incubators would continue to improve their entrepreneurial self-efficacy, which had a direct positive impact on the innovation performance for start-up technology companies.

The establishment of business incubators provide not only physical innovation spaces for regional innovators or entrepreneurial talents, but also opportunities for the development of inspirational new ideas (Vanderstraeten and Matthyssens, 2012; Wadhwa et al., 2017). In business incubators, both entrepreneurs and innovators can better commit themselves to research and development activities, gradually strengthen their innovative ideas, and commit to continuous innovation (Ramesh, 2017; Lamine et al., 2018). Therefore, the continuous improvement of basic services of business incubators can promote the accumulation of innovation capabilities (Marcotte, 2014;

Mian et al., 2016), which can significantly improve the performance of technology entrepreneurs and start-up technology companies, and thus enhance the overall performance of the regional innovation. Therefore, this study hypotheses:

H3. The basic service capacity of business incubator is positively related to the regional innovation performance.

(2) Financial Capacity of Business Incubator

The concept of synergy effect originally refers to the potential ability of individual organizations or groups to be more successful or productive as a result of a merger (Barbero et al., 2012; Carayannis et al., 2016; Armanios et al., 2017). This concept has been applied not only to business incubators, but also to regional innovation studies (Cui et al., 2016). Bruneel et al. (2012) suggested the financial investments received by incubating enterprises usually come from multiple entities such as financial institutions, government and enterprises. Similarly, Bubou and Okrigwe (2011) argue that financial investments are not immediately available for incubating enterprises without stable financing channels, and that regional innovative performance is unlikely to benefit from business incubators. Luckily, the finance capacities of business incubators can integrate various funding channels and create sustainable funding structures (Cohen et al., 2007; Chandra et al., 2012). The higher degree of finance capacity is thus likely to be directly associated with better innovation performance (Rafailidis et al., 2017; Wang et al., 2020).

Indeed, it has been suggested that the finance capacities of business incubators not only integrate external financing channels, but also strengthen the internal synergy of incubating enterprises (Chandra et al., 2012). For instance, Bruneel et al. (2012) and Rafailidis et al. (2017) notes the potential importance of internal synergy for incubating enterprises. With secured financial backing, incubating enterprises has sufficient capital to acquire advanced technology or hire technical experts specialized in product research and development. This will improve the efficiency of new product development, reduce R&D costs and eventually boost the regional innovation performance (Bruneel et al, 2012; Kostopoulos et al., 2011; Hanadi and Aruna, 2013; Rafailidis et al., 2017). Therefore, this study hypothesises:

H4. The financial capacity of business incubator is positively related to the regional innovation performance.

(3) Incubation Capacity of Business Incubator

In general, many authors suggested that great occupancy and graduate rate for start-ups and technology entrepreneurs caused by better knowledge transformation and management of business incubators (Wallsten, 2001; Witherspoon et al., 2013; Parida and Örtqvist, 2015; Ramesh, 2017; Sun et al., 2019). Wallsten et al. (2001) and Wadhwa et al. (2017) argued that knowledge transferring is a process in knowledge management to create, harvest, and sustain business processes. Zhao et al. (2017) further suggest that knowledge sharing is to do with the preparation of task information and know-how to facilitate problem-solving, implement policies, or promote innovation. In general, knowledge sharing is the practice of exchanging and disseminating ideas, experience, and knowledge with one another to ensure knowledge continues, sustains and retains in businesses (Whittington et al., 2009).

Effective knowledge sharing was regarded as an important facilitator for the successful development of technology entrepreneurs (Wallsten, 2001; Panahi et al., 2013; Rubin et al., 2014; Sun et al., 2019; Rush et al., 2021). Previous researchers highlighted the role of business incubators in developing networks between innovators and incubating businesses. For example, Sun et al. (2019) and Rush et al. (2021) pointed out that even if the business incubator managers cannot directly provide services, they can also facilitate social networks for R&D. This network is extremely important for the sharing of information and knowledge (Hong et al., 2019). Mian et al. (2016) also believed that the business incubator integrates various technology entrepreneurship and innovation resources in the region, serves SMEs, and enhances the overall innovation capacity in the region through better knowledge sharing.

In summary, the effective knowledge sharing in business incubators can (1) facilitate better utilization of newly acquired knowledge by technology entrepreneurs (Cabrera et al., 2006); (2) strengthen cooperation and encourage mutual learning (Carayannis et al., 2016); (3) facilitate effective decision making based on better knowledge acquired; and (4) enhance the innovation ability of individuals (Allameh and Zare, 2012). As a result, the regional innovation performance will benefit from the better incubation

capacity of business incubators. Therefore, this study thus hypothesises:

H5. The incubation capacity of business incubator is positively related to the regional innovation performance.

4.3.3 Communication Infrastructure and regional innovation performance

Geisler and Wickramasinghe (2015) define knowledge management as a series of activities which include identifying, collecting, storing, and transmission of knowledge. The most important basis for knowledge management is the adequate communication infrastructure (e.g., ICT facilities) (Alavi and Leidner, 2001; Geisler and Wickramasinghe, 2015). Sindakis et al. (2015) advocates that regional communication infrastructure development policy with the purpose of improving innovation can be conducive to stimulate the efficiency of knowledge management and technical exchange in local industrial sectors (Evers et al., 2010; Armanios et al., 2017). Others also found that regional intelligence is a strong driver of regional innovation and that communication infrastructure is the main tool for gaining and disseminating intelligence (Alavi and Leidner, 2001; Aharonson et al., 2007; Allameh and Zare, 2011). Therefore, this study expects that higher investment in communication infrastructure can lead to better regional innovation performance. Therefore,

H6a. Regional communication infrastructure is positively related to the regional innovation performance.

4.3.4 The Moderation Role of Communication Infrastructure

This study expects a positive moderating effect of communication infrastructure on the relaionship between business incubators basic capacities and regional innovation performance. Evers et al. (2010) point out that the importance of communications infrastructure stems from its role as one of the main tools employed in the information exchange activities of business incubators. Effective communication enhances mutual understanding between business incubators (Gawer and Cusumano, 2014; Geisler and Wickramasinghe, 2015). The presence of communication infrastructure thus acts as a spur to business incubators who are keen to observe, learn from, and emulate the superior competences of their rivals (Grimaldi et al., 2005; Li et al., 2012; Jin et al., 2018). For instance, the management and service standards adopted by superior

incubators in China have helped other business incubators to learn some advanced experiences and develop capacities (Sindakis et al., 2015; Mian et al., 2016; Wadhwa et al., 2017). A higher presence of communication infrastructure is thus likely to be associated with better basic capacities of business incubators (Wadhwa et al., 2017; Sun et al., 2019). Therefore,

H6b. Regional communication infrastructure positively moderates the relationship between business incubators' basic capacity and the regional innovation performance.

In a similar vein, this study argues that the communication infrastructure has positive moderating effects on the relationship between finance capacity and incubation capacity of business incubators and the regional innovation performance. The impact of the communication infrastructure on financial capacities of business incubators is much evident (Vanderstraeten and Matthyssens, 2012; Sun et al., 2019). The rapid development of communication technologies shortens the business lead times and transaction delays which enhances the development of the capital market (Panahi et al., 2013; Mian et al., 2016; Ray et al., 2017; Hong et al., 2019). Communication infrastructure improves the capital supply, efficiency of capital allocation (Freeman et al., 2006). A better communication infrastructure is thus likely to be directly associated with better financial capacities of firms (Pavic et al., 2007; Rui and Yip, 2008; Parida and Örtqvist, 2015). Furthermore, the facilitating role of communication infrastructure will enable business incubators to make better use of various assets and to provide better support (Freeman et al., 2006; Aharonson et al., 2007; Wang et al., 2020). The start-up enterprises which grow in incubators thus have a better chance to get better services or support from business incubators, which as a result, improves the incubation success rate and the regional innovation performance. Therefore,

H6c. Regional communication infrastructure positively moderates the relationship between business incubators' finance capacity and the regional innovation performance.

As regards the moderating effect of communication infrastructure on the capacities of business incubator, this study would expect the positive effect to dominate. Rui and Yip (2008) pointed out that the importance of communications infrastructure stems from its role as one of the main tools employed in the information exchange activities of

business incubator, effective communication enhanced mutual understanding between business incubator (Markovitch et al., 2017). The very presence of communication infrastructure thus acts as a spur to business incubator who are forced to observe, learn from, and emulate the superior competences of their rivals, and so match their performance (Alavi and Leidner, 2001; Bubou and Okrigwe, 2011; Vanderstraeten and Matthyssens, 2012; Markovitch et al., 2017). For instance, the technological, quality standards and financial standards adopted by superior incubator in China have helped other business incubator to learn some advanced experience and promote capacities development (Allameh and Zare, 2011; Wadhwa et al., 2017). A higher presence of communication infrastructure investment in any region is thus likely to be directly associated with better incubation capacities of business incubator (Rui and Yip, 2008; Whittington et al., 2009). This study thus hypothesises:

H6d. Regional communication infrastructure positively moderates the relationship between business incubators' incubation capacity and the regional innovation performance.

4.4 Summary

This chapter described the conceptual framework and hypotheses based on existing literature related to the business incubators and regional innovation performance. Many authors suggested that business incubators in the advanced economies are constantly developing to guide healthy innovation performance development; thus the concern to innovation performance has also increased in the context of emerging economies, such as China (Jin et al., 2018; Sun et al., 2019). The previous studies indicate that a few types of research have dedicated to exploring the regional innovation performance affected by the density and capacities of business incubators. Therefore, there are heightened study gaps in this field of study, particularly in China. Therefore, the study seeks to contribute to the innovation and entrepreneurship literature by analysing the role of density and capacities of business incubators in China's regional innovation performance development.

Chapter 5 Research Methodology

5.1 Introduction

This chapter has explained the research methods used for this study, focusing in particular on the research philosophy, choice of methodology and secondary data collection. The thesis adopts a positivist approach using a quantitative methodology. For the analysis, secondary data were collected from reliable sources, including "China Torch Statistics Yearbook", "China Statistical Yearbook on Science and Technology" and "China Statistics Yearbook". GMM estimation is the main technique used for secondary data analysis.

This study considers the impact of business incubators on regional innovation in the context of China. Since China is a fast-developing emerging economy that has had many business incubators with entrepreneurship and innovation-oriented policies after reform and opening, which may have promoted the development of regional innovation performance (Cui et al., 2016). But few studies have examined how business incubators affect regional innovation performance through their capacities (Hong et al., 2019). Meanwhile, the density of business incubators in China presents an interesting situation since the emergence of entrepreneurship in the region with uneven distribution for the development of business incubators has not been deeply studied in the innovation literature (Li et al., 2012; Jin et al., 2018). It is important to study the economic and social conditions that are necessary to further developing the business incubator in order to inform public policies relative to innovation promotion (Rui and Yip, 2008; Qian et al., 2011).

5.2 Research Philosophy

5.2.1 Research Philosophy

Research philosophy relates to the development of knowledge and the nature of that knowledge (Crotty 1998: 24). Johnson and Clark (2006) note that the research philosophy is a belief about the ways in which data about a phenomenon should be collected, analysed, and used. In essence, addressing research philosophy in the study

involves being aware and formulating hypotheses and viewpoints (Saunders et al., 2012: 127). The identification of the research philosophy is positioned at the outer layer of the research onion (Saunders et al., 2012: 128; Collis and Hussey, 2014). Accordingly, it is the first topic to be clarified in the research methodology chapter. Following the previous research, the research philosophy has many branches related to a wide range of disciplines (Saunders et al., 2012: 127). Within the scope of business studies (e.g., business incubators and innovation performance). In particular, as it is illustrated in Table 3, there are four main research philosophies: Pragmatism, Positivism, Realism and Interpretivism (Saunders et al., 2012: 128).

Table 3 Research Philosophies

	Pragmatism	**Positivism**	**Realism**	**Interpretivism**
Approach	Deductive/ Inductive	Deductive	Inductive	Inductive
Ontology	Objective/ Subjective	Objective	Subjective	Subjective
Axiology	Value-Free/ Biased	Value-Free	Biased	Biased
Strategy	Qualitative/ Quantitative	Quantitative	Qualitative	Qualitative
Data collection	Mixed/ multiple level quantitative (or qualitative) data	Highly structure and large samples quantitative (or qualitative) data	The quantitative (or qualitative) data collection method must fit the subject matter	Small samples qualitative data with in-depth investigations

The positivist approach is commonly used to test a theory. Mukherji and Albon (2014) argued that in order to understand a phenomenon, we need to observe events in a systematic way and then work out the underlying theory that causes the event to occur. Positivist designs look for general patterns based on an objective view of reality (Bhattacherjee, 2012). This approach also helps define cause and effect relationships among variables. In order to understand the impact of business incubators on regional innovation performance, we have to observe events in an objective way and then work out the underlying theory that causes the event to occur. Thus, the positivism design was chosen for this thesis for the following reason:

1. Positivist designs facilitate coverage of a wide range of situations by representing a wider sample and are easy to replicate in order to arrive at a general conclusion, this study uses the 10-year panel dataset covering 31 provinces and autonomous in China. Furthermore, a lack of restriction on the replication of a study leads to the production of more acceptable generalisations. In contrast, according to Remenyi et al. (1998), it is difficult to generalise using an interpretive approach.

2. Positivist results are more likely to be expressed quantitatively, while interpretive results are usually expressed qualitatively (Kielmann et al., 2011). The explanatory and dependent variable of this thesis -- business incubators (density and capacities) and regional innovation performance uses numerical data and quantitative methods to address the research questions, the positivist approach is better suited to this study.

3. The positivist paradigm is more economical than the interpretive approach when time and resources are limited. This study had a limited time frame, so is better suited to a positivist approach.

4. The positivist approach aims to make statistical comparisons (Kielmann et al., 2011), this thesis makes an analysis through the econometric method of the generalized method of moments (GMM) model, which contributes to the depth of analysis of this thesis.

5.2.2 Research Strategy and Design

The research strategy chosen to best fulfil the objectives is the experimental research strategy since establishing the existence of a cause-and-effect relationship between the variables (Hargreaves et al., 2008; Fischer and Jasny, 2017). The extant literature has identified the purpose of the experimental research strategy is to establish the existence of a cause-and-effect relationship between the variables (Baum and Mezias, 1992; Cooke et al., 1997). To test the hypothesis in this study, an experiment manipulates one variable while a second variable is measured, and other variables are controlled

(Brandstätter, 2019). In which case, it is reasonable to suppose that the experimental research strategy gives a more robust view of the relationship among the variables.

Specifically, in the emerging economies' regional innovation performance studies, the econometric approach has been trying to combine business incubators with innovation growth. For the assessment of the association between business incubator development and innovation performance growth; Jin et al., (2020) and Wang et al., (2020) demonstrated a review of empirical research articles for the last two decades; selected variables about the innovation performance growth integrate the development of the business incubators, R&D investment, and infrastructure development. The dynamic approaches could be found in knowledge production function (Griliches, 1979) and GMM models (Arellano and Bond, 1991; Blundell and Bond, 2000) and the empirical exercise is closely related to the dynamic approaches.

Research design is the plan, structure and strategy of investigation to obtain answers to research questions (Avey et al., 2006; Baron et al., 2016). A plan or strategy to conduct our research process is named research design (Griliches, 1979). Formulating a strategy and its implementation for higher outcomes, synchronizing the current strategic knowledge and issues with operational strategic issues, accommodating emerging issues are mainly kept in mind while deciding about the design of research (Grimaldi and Grandi, 2005; Freeman and Soete, 2009; Fu, 2012). This study aims at evaluating the impact of the business incubators and their capacities on regional innovation performance. Research designs tell us about the type of study, study time period and about nature of the study. The research paradigm and method assumed for this study is interpretive and pragmatic in nature (Gawer and Cusumano, 2014). This study employs the quantitative research approach, which is mono methods study (Hackett and Dilts, 2004).

The current study employed an explanatory mono-method research design in which findings were based on first collecting the quantitative data and then measurement and analysis of data via the regression model, and thereby, ensuring this study can effectively address the research gaps (see Table 4) (Hannan et al., 1995; Iammarino and

McCann, 2006; Hargreaves et al., 2008). The explanatory design assists in investigating the instrument for measuring the effect of each capacity of business incubators on regional innovation performance and the moderation role of communication infrastructure among them (Kearney, 2003).

Table 4 Sequential Explanatory Research Design

Steps	Design
First Step Chapter 2, 3 and 4	**Development the quantitative strand** • Find gaps in research • Identify the theoretical framework • Development of the concept model • Identify the quantitative sample • State quantitative research hypotheses
Second Step Chapter 5	**Design the quantitative research strand** • Determine the quantitative approach • Identify the source of secondary data • Collect the secondary data with ethic approvement • Identify the dependent, independent and control variables • Identify regression method
Third Step Chapter 6 and 7	**Testing and discussing hypotheses** • Identify the regression model • Discuss the quantitative sample by descriptive statistics • Test hypotheses via GMM method to answer each research.
Fourth Step Chapter 8	**Interpret the research result** • Summarise the quantitative results • Discuss the main finding • Discuss the contribution and implication • Summarise the limitation and limitation and recommendation for further study

The objective of explanatory research is to develop a hypothesis for a problem that has not been explored yet or no previous studies refer to (Khadaroo and Seetanah, 2010). Meanwhile, the explanatory research is conducted for the issue that was not well investigated before, demands priorities generates the panel data and choosing a better-researched model (Klerkx and Leeuwis, 2008). Thus, this study enriched the literature on the areas of the business incubator and regional innovation in emerging economies,

which focuses on explaining the aspects of business incubators' density and capacities in regional innovation performance (Minelli et al., 2013). Its initial phase is to collect the quantitative data first through the statistics yearbook and then it focuses on developing the GMM model to explain the relationship between the previous paragraph's identified business incubators and regional innovation performance (Naude et al., 2009; Peterson et al., 2011; Li et al, 2016). Based on correlation analysis and by identifying how strong the regional innovation performance with these capacities, and communication infrastructure, making the further explanation of how the communication infrastructure moderates the relationship between capacities of business and regional innovation performance (Grimaldi and Grandi, 2005; Chandra et al., 2012; Hanadi and Aruna, 2013; Carvalho and Galina, 2015; Cui et al., 2016; Cowell et al., 2018; Hong et al., 2019). The figure in Appendix V maps out the specific design of this study.

5.3 Choice of Method

The choice of research methodology is closely related to the choice of research philosophy. Kielmann et al. (2011) observed that the positivist approach usually has quantitative characteristics, while the interpretive approach is more qualitative. Quantitative methods deal with data to measure what people think, while qualitative research focuses on why people make choices, and what and how they choose. The quantitative method is appropriate since the subject of the business incubator and their capacities and regional innovation performance is objective and can be better explored and understood when being led by data and observations in order to enrich the literature on regional innovation system theory (Iammarino and McCann, 2006; Li et al., 2016; Zhao et al., 2017; Wang et al., 2020).

Qualitative research provides a deeper knowledge and understanding of the phenomena (business incubators and regional innovation performance) being researched (Gramatikov et al., 2010). In this thesis, quantitative research reveals more important facts about the data, for instance, the relationship between business incubators and regional innovation performance. In quantitative research, researchers gather, organise and analyse data using an appropriate method. In this quantitative study, researchers use secondary data from the statistics yearbook issued by the Ministry of Science and

Technology (MOST) and the National Bureau of Statistics of China. This study examines the impact of business incubators (density and capacities) on regional innovation performance and the moderation role of communication infrastructure. The variables selected to analyse these objectives are based on the literature review and are quantifiable and measurable. Moreover, hypotheses are developed and tested using a quantitative approach. In addition, most previous published research on these topics has been based on quantitative research. This study also adopts a quantitative methodology to examine the stated objectives.

5.4 Data Collection and Estimation Methodology

5.4.1 Data Collection

The panel data in this study representing 31 provincial administrative unit over the period 2008-2017. First, the literature survey was conducted during February 2019-June 2019, then the topic was justified in July 2019 and after that pilot study was conducted from July 2019 to September 2019, though the pilot study the research model were sufficient then further the data collection about the density and capacities business incubator and regional innovation performance was started which was completed in November 2019 and then the data analysis was conducted and results were written until January 2020.

This study uses China as the main data sets to analyse the relationship between business incubator capacities on regional innovation. China as the fastest developing emerging economy has experienced substantial development of business incubators in recent years (MOST, 2018). Moreover, China is a vast country with many provinces and municipalities to allow cross-region analysis (Colombo and Delmastro, 2002; Child and Rodrigues, 2005; Li et al., 2016). More importantly, the Chinese government has been an enthusiastic supporter of business incubators in its indigenous innovation policy inaugurated in 2006 (Li, 2009; Ning et al., 2016). This ensures more relevant data will be available. In this study, secondary data refers to the data that is gathered by a secondary party. Common sources of secondary data for business incubators and innovation studies include statements, data collected by government agencies (e.g., statistics yearbook), organisational documents, and the data that was collected for other research objectives (precautions see Table 5).

Table 5 Precautions of Secondary Data

Precautions	Actions
Reliable agency	The secondary data in this study were collected from official database and statistics yearbooks that issued by government (e.g., National Bureau of Statistics).
Suitability for the purpose of an enquiry	The aim of this study is to investigate the impact of business incubators on the regional innovation performance, statistics yearbooks offer appropriate, accurate and serial data.
Adequacy and accuracy to avoid the impact of bias	As an authoritative source, statistics yearbooks and databases from the National Bureau of Statistics is a work known to be reliable, because their authority or authenticity is widely recognized by experts in the field.
Method of collecting the data used	In this study, secondary data collection is concerned with business incubators and regional innovation performance. We collected data available from statistics yearbooks by visiting the websites.

In order to fulfil the objectives and accuracy of this study, secondary data were drawn from valid and reliable official sources (see Table 6). Specifically, the innovation and R&D data are drawn from the China Statistics Yearbook on Science and Technology, compiled by the Ministry of Science and Technology and the National Bureau of Statistics of the People's Republic of China. The data for business incubator capacities are assembled from the China Torch Statistical Yearbook, compiled by the Torch High Technology Industry Development Centre from the Ministry of Science and Technology of the People's Republic of China. The authors then calculate the innovation index and business incubator capacity index based on the compiled data set. Furthermore, data were also collected on the infrastructure, industrial structure, economic development, labour, international trade, and foreign direct investment (FDI) from the China Statistics Yearbook and China Economic and Social Development Yearbook, compiled by the National Bureau of Statistics.

Table 6 Details of Secondary Data Source

Data	Source of data	Issued by
Regional innovation performance	China Torch Statistics Yearbook	Ministry of Science and Technology of the People´s Republic of China

Data	Source of data	Issued by
Density of business incubators	China Torch Statistics Yearbook	Ministry of Science and Technology of the People´s Republic of China
Basic capacity of business incubators	China Torch Statistics Yearbook	Ministry of Science and Technology of the People´s Republic of China
Financial capacity of business incubators	China Torch Statistics Yearbook	Ministry of Science and Technology of the People´s Republic of China
Incubation capacity of business incubators	China Torch Statistics Yearbook	Ministry of Science and Technology of the People´s Republic of China
Regional Communication infrastructure	China Statistical Yearbook on Science and Technology	Ministry of Science and Technology of the People´s Republic of China
Regional Research intensity	China Statistics Yearbook, China Statistical Yearbook on Science and Technology	National Bureau of Statistics of China, Ministry of Science and Technology of the People´s Republic of China
Regional Education level	China Statistics Yearbook	National Bureau of Statistics of China
Size of the business incubators	China Torch Statistics Yearbook	Ministry of Science and Technology of the People´s Republic of China
Age of the business incubators	China Torch Statistics Yearbook	Ministry of Science and Technology of the People´s Republic of China
GDP growth rate	China Statistics Yearbook	National Bureau of Statistics of China
FDI	China Statistics Yearbook	National Bureau of Statistics of China
Industry structure	China Statistics Yearbook	National Bureau of Statistics of China
GDP per capita	China Statistics Yearbook	National Bureau of Statistics of China
Labour	China Statistics Yearbook	National Bureau of Statistics of China
International trade	China Statistics Yearbook	National Bureau of Statistics of China

This study calculated the score of regional innovation performance and business incubator capacities using the entropy method, which is a kind of objective weighting methods of quantitative analysis (Furman et al., 2002; Pavic et al., 2007). Entropy is

the measure of uncertainty. This method overcomes measuring and calculating errors caused by manmade factors (Greve, 2002). Therefore, it makes the gauging process more efficient, accurate and reliable (Furman et al., 2002; Grimaldi and Grandi, 2005).

5.4.2 Estimation Methodology

This study mainly used a GMM method for several reasons. First, it was used to control for the endogeneity problem (Hillier et al., 2011). Many innovation and incubators studies face endogeneity problems, Ignoring the endogeneity issue may cause a bias in the estimated coefficient of density and capacities of business incubators (Pindado and Requejo, 2015). An endogeneity issue may arise when there is a relationship between the explanatory variables and the error term. Wooldridge (2010) found three factors that may create endogeneity problems: omitted variables, measurement errors and causality. Omitted variables may correlate with explanatory variables. For instance, some regions may have more business incubators than others due to economic development and growth opportunities, which may create omitted variable bias. Measurement errors may occur in any dependent or explanatory variables. Furthermore, causality issues may arise when a dependent variable and at least one explanatory variable are determined simultaneously. For instance, the business incubators may lead to better regional innovation performance, but a region with better innovation performance is also likely to have more business incubators.

Second, the endogeneity problem can also be controlled by an IV approach. However, in order to apply this approach, the researcher must find external instruments, which are sometimes very difficult to obtain, from both theoretical and empirical points of view. In this regard, Liu et al. (2015) and Pindado et al. (2014) have pointed out that external instruments may not be readily available and finding them is extremely complex. On the other hand, GMM uses lags of variables as instruments for estimations and therefore provides efficient estimations. Regional innovation performance follows the path-dependent hypothesis (Garcia-Quevedo et al., 2014), and the cumulativeness of innovation activities implies that the current year's innovation performance follows that of the previous year. Therefore, the use of lagged values of dependent variables as instruments may produce biased results. However, GMM estimations control for lagged values of the dependent variable (David et al., 2006).

Third, both heteroscedasticity and auto-correlation problems can be addressed by GMM estimations. Heteroscedasticity may arise because different countries in the sample have different characteristics, thus residuals are unlikely to be constant across observations. Auto-correlation may arise as a result of using the lag of the dependent variable for the hypothesis test. These problems cannot be controlled by OLS. Moreover, Baum et al. (2003) observed that, in the presence of heteroscedasticity, IV estimations provide inconsistent estimations of standard errors. However, GMM provides more consistent estimations than two-stage least squares (2SLS) in the presence of heteroscedasticity and auto-correlation (David et al., 2006).

Fourth, Hansen (1982) suggests that GMM estimations provide a general framework within which to take into account issues of statistical inference, as they encompass many estimators of interest to econometrics. Meanwhile, Worrall (2008) stated that, within a single framework, GMM nests several estimations, such as OLS, 2SLS and IV. Moreover, as GMM estimations use richer sets of instruments than IV estimators, they provide a higher level of efficiency estimation (Arellano and Bond, 1991).

Previous literature suggests that the Sargan test is more appropriate for the difference-GMM estimator and under the assumption of homoskedasticity and no serial correlation (in levels) of the idiosyncratic error term, while the system-GMM estimator should consult the Hansen test (Roodman, 2009). In this study, we used the system-GMM estimator and thus the Hansen test should take precedence over the Sargan test. Therefore, the Hansen statistic of overidentifying restrictions was used to test the validity of the instruments. The Hansen test is based on the assumption that model parameters are identified via a priori restrictions on the coefficients and tests the validity of over-identifying restrictions. We thus use the Hansen test to ensure the validity of the instruments. GMM estimation uses multiple lags, which implies that the model is over-identified. Lagged levels t-1, t-3 and t-4 were used as instruments for the equations, and one lag as an instrument for the level equation. In order to choose the best possible instruments, the trade-off between the exogeneity and strength of each instrument was considered, following Keasey et al. (2015). Furthermore, the Hansen test results show that the instruments are valid in the models. The rule of thumb is that the number of instruments should not be higher than the number of observations. In this case, the test

results show that the number of instruments is far lower than the number of observations. Both results provide confidence that the instruments used are strong enough for GMM estimation.

5.5 Variables and Data

This thesis has chosen China as the empirical setting for study the impact of business incubator on the regional innovation performance. The definition of each variable is provided in Table 8.

5.7.1 The Dependent Variable

The theme of this study is to explore the impact of density and capacities of the business incubator on regional innovation performance. Therefore, the dependent variable for both empirical regression analysis is regional innovation performance ($INN_{i,t}$) as measured by the natural log of the average regional innovation score. This study referring to the "Innovation scorecard of EU Member States", set up three indexes of regional innovation performance (1st level). Then, following Tao (2016) and Zhao and Han (2019) set up three level indexes from the perspective of input and output to calculate the comprehensive evaluation score of regional innovation performance (see Table 7).

Table 7 Evaluation System for Regional Innovation Performance

1st Indices	2nd Indices	3rd Indices
Regional innovation performance	Innovation input	Number of R&D projects
		R&D staff of full-time equivalent
		R&D outlay
	Innovation output	Patent application
		Patent authorizations
		Transaction amount of technology market

In this evaluation system, evaluation of innovation input includes the number of R&D projects, R&D staff of full-time equivalent (person/ year) and R&D outlay (billion CNY). Previous studies have considered the innovation process at the firm (e.g., Lin et al., 2020), sector (e.g., Li, 2011), and regional (e.g., Fu, 2008; Liu and Nijkamp, 2019) levels, and have typically measured the R&D inputs (RDI) using the R&D intensity which included the number of R&D projects, R&D staff of full-time equivalent and

R&D outlay. In a similar vein, this study following this system to carry out the research.

On the other side, evaluation of innovation output includes the number of patent applications, number of patent authorizations, and transaction amount of technology market (billion CNY). Not all innovations are patented, but patent counts are the favoured measure used in most previous research because they provide a more accurate indication of innovation performance than alternative measures such as "new product" sales (Acs et al., 2002; Williams et al., 2011; Hong and Su, 2013; Wang and Lin, 2013). This is because "new products" are often loosely defined and can be potentially over-recorded by firms to gain subsidies in many countries such as China (Li, 2016). Furthermore, the process of patent registration means that data are publicly available and of guaranteed quality, and the patent documents typically provide useful technological and organizational details (Griliches, 1990). Patent data are often available in longitudinal series and, last but not least, patent counts provide a homogeneous and meaningful indicator of innovation performance across countries (Malerba et al., 1997). Meanwhile, China was a major participant in the technology market over the period covered by this study, and it is important to control for this potential determinant of innovation performance (Li, 2016; Wang et al., 2016).

Furthermore, this study calculated score of regional innovation performance and each capability of incubators using the entropy method. There is a considerable literature suggesting that the method of entropy is a kind of objective weighting methods of quantitative analysis. Entropy is the measure of the uncertainty; this method overcomes measuring and calculating errors caused by manmade factors (Furman, 2002; Cheny, 2011). Therefore, it makes gauging process more quick, accurate and reliable.

Therefore, specific results are as follows:

Step 1: Convert raw measures X_{ij} into the standardized measures $|X_{ij}|$ by using equation (1) and (2). Furthermore, positive and negative indexes are processed differently, that's because the absolute terms of both positive and negative indexes have different meanings.

Positive indexes (equation 1):

$$X_{ij} = \frac{x_{ij} - \min\{x_{1j},\cdots,x_{nj}\}}{\max\{x_{1j},\cdots,x_{nj}\} - \min\{x_{1j},\cdots,x_{nj}\}} \quad \textbf{(1)}$$

Negative indexes (equation 2):

$$X_{ij} = \frac{\max\{x_{1j},\cdots,x_{nj}\} - x_{ij}}{\max\{x_{1j},\cdots,x_{nj}\} - \min\{x_{1j},\cdots,x_{nj}\}} \quad \textbf{(2)}$$

Steps 2: Calculation of subject weighting (e.g., subject *i* from objective *j*)for situations in which either all data are convertible into the standardized measures (X_{ij}=$|X_{ij}|$.) by using equation (3)

$$P_{ij} = \frac{X_{ij}}{\sum_{i=1}^{n} X_{ij}} \quad \text{i=1,}\cdots\text{,n; j=1,}\cdots\text{,m} \quad \textbf{(3)}$$

Steps 3: Calculation of objective entropy via equation (4 and 5)

$$e_j = -k\sum_{i=1}^{n} p_{ij}\, ln(p_{ij}) \quad \textbf{(4)}$$

$$k = \frac{1}{\ln(n)} \quad \textbf{(5)}$$

Steps 4: Calculation of objective entropy redundancy using equation (6)

$$d_j = 1 - e_j \quad \textbf{(6)}$$

Step 5: Calculation of objective weighting via equation (7)

$$p_{ij} = \frac{d_j}{\sum_{j=1}^{m} d_j} \quad \textbf{(7)}$$

Step 6: calculation the score of each objective using equation (8)

$$s_i = \sum_{j=1}^{m} w_j\, p_{ij} \quad \textbf{(8)}$$

5.7.2 The Explanatory Variables

The explanatory variable in Chapter 6 is the density of business incubators in the region. Following the theory of organisational ecology and density dependence (Hannan and Freeman, 1977; Hannan, 1986; Hannan and Freeman, 1987; Hannan and Freeman, 1989; Freeman and Audia, 2006; Aldrich and Ruef, 2006), the density of the regional organisation population change causes an organisational relationship in China's regions. In a similar vein, the density dependence theory believes that the density of organisational populations reflects the relationship between organisational populations. Barnett & Carroll (1987) using the organisation density for the first time to analyse the impact of inter-organizational dependence on individual organisation mortality. In the study of organisation ecology, Hannan & Freeman (1977) and Freeman (1982) believed

that the most effective way to measure organisation density is to count the number of organisations in the region. Hannan & Freeman (1987) used the number of existing unions to measure the impact of the current union density on the establishment rate of unions in the United States. Greve (2002) measured the regional bank density by counting the number of all banks and branches in the region when studying the influence of geographic factors on the development of the banking industry in Tokyo. Barnett & Carroll (1987) studied the reciprocal and competitive relationship in the early telecommunication industry in the United States and used the total number of telecommunication firms in the region to measure the density of local telecommunication firms. Zhang and Schoonhoven (2007) using the number of national technology development zones to evaluate the density of national technology development zones in the region, and then discussing the impact of density of China's national technology development zones on regional development. Therefore, this study considers the number of business incubators of each region to measure the density of business incubators.

The explanatory variables in Chapter 7 are the capacities of business incubators and regional communication infrastructure. This study measures three capacities of regional business incubators. Previous studies have considered the business incubator capacities by space, facilities, service team and resource. This study creates the evaluation system of business incubator capacities in terms of basic service capacity, financial capacity and incubation capacity, following the previous evaluation systems in the literature, to analyses the capacity scores of the business incubators in all the 31 provincial administrative regions in China (Iammarino, 2005; Li et al., 2016).

Specifically, basic service capacity is operationalized as the score of last year's (t) basic service capacity of business incubators (Vanderstraeten and Matthyssens, 2012; Lai and Lin, 2015). It includes the number of business incubators, the number of management practitioners and total incubation funds. Financial capacity is operationalized as the score of last year's (t) financial capacities of business incubators (Bruneel et al., 2012). It includes total venture capital investment and the number of incubators receiving funds. Incubation capacity is operationalized as the number of tenants and the accumulated number of graduated tenants in business incubators. Furthermore, following the previous literature (Del et al., 2010; Jiang et al., 2016), the regional

communication infrastructure construction intensity is operationalized as the proportion of communication infrastructure investment over regional GDP.

5.7.3 The Control Variables

(1) The Control Variables in Chapter 6

There are six control variables in the Chapter 6 analysis. First, many authors have highlighted that the R&D inputs have been a crucial source of advanced technology and innovation development (e.g., Li et al., 2016). The emphasis on advanced technology and innovation is rising in China; the investment in research and development of innovative products from the state and start-ups presented sustained high growth trends (Yang and Lin, 2012). It is important to control for this potential determinant of regional innovation performance (Li, et al. 2016). Thus, this study includes the proportion of R&D expenditures value over GDP in China's regions and expect this to be positively related to the region innovation performance.

Second, this study would expect the business incubator with high degree employee to have a stronger ability for mentoring the start-ups (Liu et al., 2014). Thus, strengthen the capacity of business starter and increase business starting and survival rate, which should also lead to better regional innovation performance (Kusnadi et al., 2015). This study using the ratio of the business incubator employees in the region who graduated from university or collage as a measure of education level of the business incubator employees.

Third, several authors have suggested that the newer business incubators may be more interested in innovation than existing business incubators (Qian et al., 2018; Xiao and North, 2018). Thus, this study considers the age of business incubators as the third control variable and expect those regions where the newer business incubators account for high proportions to exhibit higher levels of innovation performance.

Fourth, the size of the business incubators can reflect their competitiveness in China's regions (Lukeš et al., 2019). Larger business incubators are more competitive and can better mentoring the start-ups to conducting innovative activities (Xiao and North, 2018). Therefore, this study includes the size of the business incubators and using the total number of employees in the incubator to measure the size of the business

incubators.

Fifth, study have suggested that the level of regional economic development has an impact on the development potential of business incubators and regional demand of innovation (Fu, 2012; Li et al., 2016). Regions with a higher level of economic development can provide better infrastructure, financial support and other intermediary services for developing technology business incubators, such as consulting, accounting and legal services (Piperopoulos et al., 2018). Therefore, regional GDP growth rate was included to control for the development of business incubators and regional innovation performance

Sixth, foreign knowledge has been a crucial way of advanced technology for many emerging economies seeking to enhance their innovation performance (Yang and Lin, 2012). China acquired much foreign knowledge through FDI over the period covered by this study, and it is important to control for this potential determinant of innovation performance. Therefore, this study includes the FDI in China's regions and expect this to be positively related to the regional innovation performance.

(2) The Control Variables in Chapter 7

The analysis in Chapter 7 controls four variables that affect innovation performance in general. First, the regional GDP per capita is controlled, which might affect the development potential and regional demand for innovation (Fu, 2012; Li et al., 2016; Piperopoulos et al., 2018). This is because the innovation performance tends to be stronger in regions with faster economic growth. More funds and human resources tend to be available to business incubators in those regions. Furthermore, we would expect regions with higher economic status to have a stronger recognition of intellectual property rights and better infrastructure, leading to better innovation performance. Second, labour quality is a crucial source of advanced knowledge for many emerging economies seeking to improve their innovation capabilities (Li et al., 2016). Higher quality of labour is expected to be positively related to innovation performance. Therefore, this study controls the quality of labour, measured by years of education per capita. Third, previous studies have suggested that the industrial structure may affect innovation performance (Liu et al., 2014; Kusnadi et al., 2015). This study thus controls for the proportion of the service industry over the GDP in each region. Fourth, China

was a major participant in international trade over the period covered by this study. Involvement in international trade may affect innovation performance (Li et al., 2016). This study thus controls for the proportion of international trade value over GDP in each region.

5.7.4 Data Analysis

This thesis conducted econometric estimations in Chapters 6 and 7. The statistical models tested are also part of the statistical tools used for analysing knowledge production function (Lalkaka, 2003; Sofouli and Vonortas, 2007; Snijders, 2011; Lazega et al., 2012; Crossley et al., 2015; Lazega and Snijders, 2016).

In Chapter 6, the Knowledge Production Function (KPF) model was estimated to assess the impact of business incubators density on regional innovation performance. The dependent variable is regional innovation performance ($INN_{i,t}$) that identified the innovation performance from the perspective of input and output of innovation. The explanatory variable including the density of business incubators and its square term to investigate the importance of business incubators density in the region innovation performance in China. There are also 6 control variables presented in Chapter 4, controlling for features of the business incubators and regional economic alters.

In Chapter 7, another model is estimated. The research objective in this chapter is about the impact of the business incubators capacities on regional innovation performance. Similarly, the dependent variables were the regional innovation performance (INN) as well and it's consisted of the number of R&D projects, R&D staff of full-time equivalent and R&D outlay (as a proxy for innovation input); transaction amount of technology market, patent application and authorizations (as a proxy for innovation output). The explanatory variable including the basic, finance and incubation capacities of business incubation and regional communication infrastructure. The count nature of the explanatory variables implied that not strictly exogenous. In this case, the Generalized Method of Moments (GMM) model is appropriate if the network of each firm is also considered an attribute of it (Carrington et al., 2005; Roodman, 2020). Definition and detailed operationalization of each of the variables are provided in Table 8 and Table 9.

Table 8 Description of Key Variables

Variable	Acronym	Operationalization
Regional innovation	$INN_{i,t}$	Natural log of regional innovation performance score of regions i in year t.
Density of business incubators	$DBI_{i,t}$	Natural log of the business incubators number of regions i in year t.
Basic capacity	$BAS_{i,t}$	Natural log of the basic capacity score of regions i in year t.
Financial capacity	$FIN_{i,t}$	Natural log of the finance capacity score of regions i in year t.
Incubation capacity	$INC_{i,t}$	Natural log of the incubation capacity score of regions i in year t.
Communication infrastructure	$INF_{i,t}$	Natural log of communication infrastructure investment of regions i in year t
Research intensity	$RDI_{i,t}$	Natural log of R&D expenditure/GDP (percent) of regions i in year t.
Education level	$EDU_{i,t}$	Natural log of number of high degree employee in business incubators of regions i in year t.
Size of the business incubators	$BIS_{i,t}$	Natural log of the business incubators total employee of regions i in year t
Age of the business incubators	$AGE_{i,t}$	Natural log of the business incubators age of regions i in year t.
GDP growth rate	$GDP_{i,t}$	Natural log of GDP growth rate of regions i in year t.
Regional FDI	$FDI_{i,t}$	Natural log of FDI flow of regions i in year t.
Industry	$IND_{i,t}$	Natural log of proportion of service industry of regions i in year t.
GDP per capita	$ECO_{i,t}$	Natural log of GDP per capita of regions i in year t.
Labour	$LAB_{i,t}$	Natural log of years of education per capita of regions i in year t.
International trade	$INT_{i,t}$	Natural log of proportion of international trade of regions i in year t.

Table 9 The Definition of Variable

Variable name	Definition
Regional innovation	Regional innovation performance refers to the ability of all innovation entities in a region to produce new technologies and new products by inputting innovation elements, and it is directly reflected in the scale of innovation output (Lamine et al., 2018; Lukeš et al., 2019).
Density of business incubators	Density of business incubators is the number of business incubators in a region (Dahlstrand, 2007; Chandra et al., 2012).
Basic capacity	The basic capacity of business incubators in a region refers the incubation facilities and service system in a regional (Vanderstraeten and Matthyssens, 2012; Kiani et al., 2019).
Financial capacity	The financial capacity of business incubators is the ability of business incubators to provide funds or capital support for start-ups (Bruneel et al., 2012; Zhao et al., 2017)
Incubation capacity	Incubation capacity of business incubators is efficiency of business incubators.
Communication infrastructure	Communication infrastructure is unified communications and the integration of telecommunications facilities and digital equipment (Fu, 2008; Autant et al., 2013).
Research intensity	Regional Research intensity is the proportion of R&D expenditures value over GDP (Li et al., 2016).
Education level	Regional Education level is the percentage of people between the ages of 25 and 64 who have completed the HE (Liu et al., 2014).
Size of the business incubators	The scale of business incubators in a regional (Lukeš et al., 2019).
Age of the business incubators	The year of business incubators opened for business (Qian et al., 2018; Xiao and North, 2018)
GDP growth rate	Regional GDP growth rate is the change in the GDP of a region in comparison to an earlier period (Piperopoulos et al., 2018).
Regional FDI	The regional FDI is critical source for foreign knowledge (Yang and Lin, 2012).
Industry	Industry structure is the basic, underlying characteristics that shape the competitive strategy for a group of firms producing products
GDP per capita	Regional GDP per capita is GDP divided by its total population (Fu, 2012; Li et al., 2016).
Labour	regional labour is quality of labour in a region (Liu et al., 2014; Kusnadi et al., 2015).

Variable name	Definition
International trade	Regional International trade is the exchange of goods and services with foreign countries (Li et al., 2016).

5.6 Ethical Considerations and Limitation

5.6.1 Ethical Considerations

As mentioned above, this study using the data and information about business incubators in the context of China from secondary sources, for instance, the statistics yearbook (e.g., the data of business incubation and regional economic etc.), government document (e.g., the relative policy of business incubation etc.) and relative reports from the third party (e.g., the development and operation of the business incubators) to describe the business incubators and analyse in the different regions. In this case, the data and information of the business incubators in China's regions were already public. Furthermore, this study has passed Coventry University ethics review (Ethic Number: P99993). Following the Coventry University ethics profile, all data and information only stored on CU OneDrive with passcode protection.

5.6.2 Limitation

The limitation emerges from the empirical study nature of the research, which implies that it was possible to analyse only one factor (e.g., innovation performance) in one economy during the study. Furthermore, there is always a question about how generalisable results from empirical studies are. Many authors have suggested that there is still scoped to understand social, economic and country differences with respect to the role of the business incubators in the emerging economies regional innovation performance development. Future research should focus on this aspect.

5.7 Descriptive Statistic

5.7.1 Regional innovation performance

Figure 7 map out the spatial distribution of the dependent variable -- the regional innovation performance. China is marked by the uneven distribution of regional innovation performance between eastern coastal provinces, central provinces and western provinces. The better performance of innovation is mainly concentrated in the eastern coastal provinces (e.g., Jiangsu 59.52, Guangdong 44.16, Shanghai 39.81, Zhejiang 34.93 and Shandong 30.98), these patterns are consistent with the expectation

that developed regions have stronger innovation performance. However, the innovation performance in the central and western provinces is generally lower. This also reflects the potential issues in the economic transformation of China. When these figures are compared with the distribution of business incubators, the positive relationship between the distribution of business incubators and innovation performance becomes apparent. It is this that the econometric results explore further.

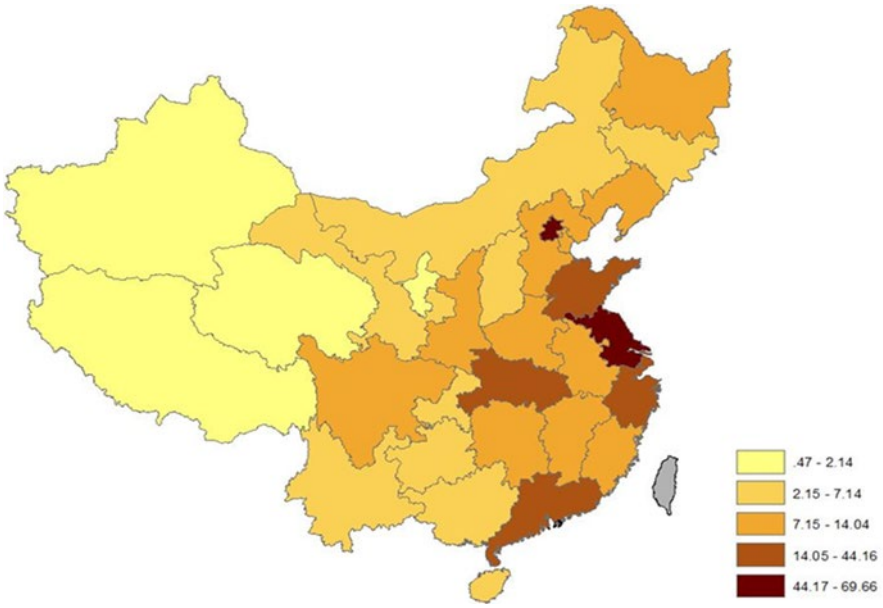

Figure 7 The Distribution of Regional Innovation Performance

5.7.2 Density of Business Incubators

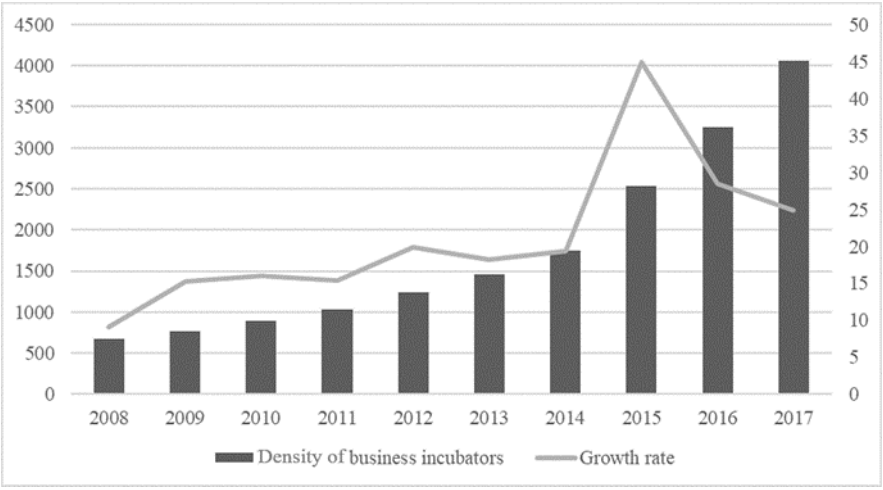

Figure 8 Density of Business Incubators and Growth Rate

In the past decade, the density of China's business incubators has increased significantly. Meanwhile, as business incubators' density evolves, each parameter has also shown a

steady growth trend. But, as the density of the business incubators continued to expand, competitive pressures among the business incubators have led to each parameter (e.g., such as revenue, the density of graduated start-ups and intellectual property rights) being decreased, particularly in the intellectual property rights, which directly affect the regional innovation performance.

To this end, from the perspectives of organizational ecology, the development of the business incubation in China's regions is consistent with population development trends. China therefore provides an appropriate context to explore the link between the development of the business incubators and innovation performance. The number of business incubators nationally in China has risen dramatically over the 2008–2017 period, from 670 in 2003 to over 4063 in 2017 (see Figure 9), but the growth has moderated. This national increase has not been mirrored uniformly across the Chinese regions, however, and more business incubators have been reported in several eastern provinces (e.g., Guangdong, Zhejiang and Jiangsu province)—see Figure 8.

5.9.3 Geographical Distribution of the Business Incubators

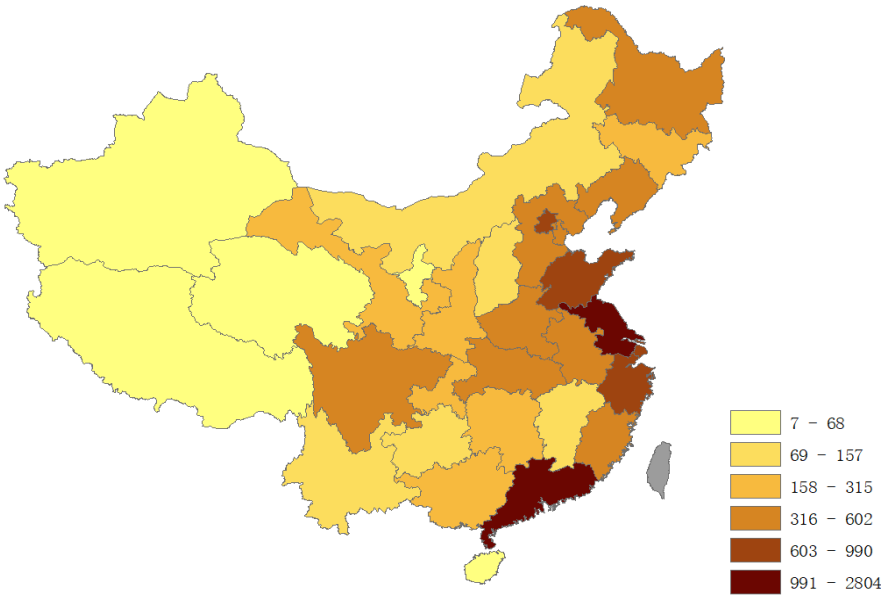

Figure 9 Geographical Distribution of the Business Incubators in China

Specifically, the density of business incubators in the eastern coastal areas are much higher than those in the central and western regions due to the great difference in economic development, technological resources and support from the local government. For instance, as the first innovative pilot province, the government in Jiangsu continues

to subsidize and support the business incubator to promoting the development of small and medium-sized technology start-ups. Thus, the density of business incubators in Jiangsu far exceeding any other province in China.

Furthermore, many business incubators gather in the coastal provinces and municipalities (see Figure 9) such as Shandong, Guangdong, Liaoning, Zhejiang, Fujian and Beijing. In the central region, Hubei Province boasts many colleges and universities, thereby providing many intellectual workers for the development of technology business incubators, thus spawning a lot of business incubators. Anhui is a famous science and education city with strong scientific research strength and innovation capability, thus providing a good technical environment and talents for developing technology business incubators. Though the business incubators in West China have progressed in recent years, its development is still far behind the eastern coastal region. In terms of quantity, Shaanxi has many high education institutions, and the number of the business incubators ranks first in the western region. They include optoelectronics, biomedicine, software, aviation technology, aerospace technology, electronic information, digital media, agricultural science and technology.

5.9.4 Density of Business Incubator and Innovation Performance

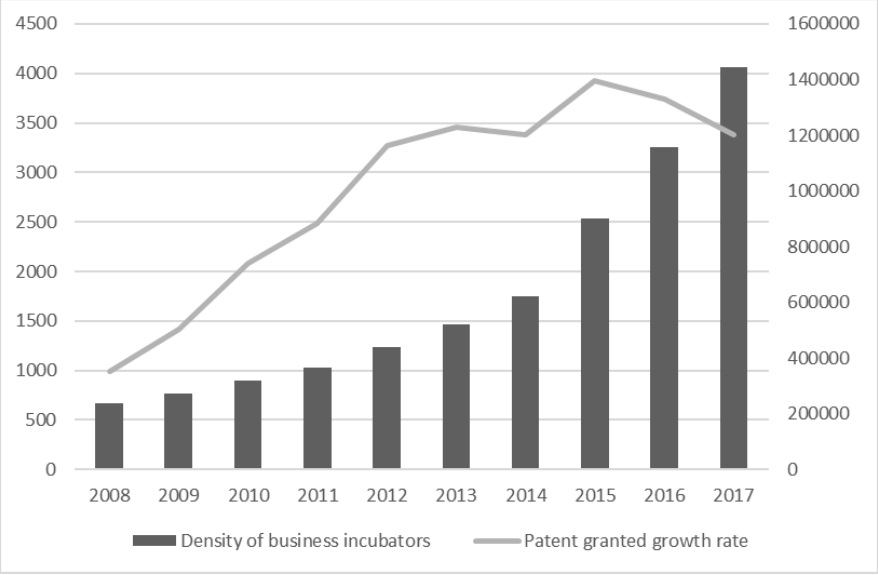

Figure 10 Density of Business Incubators and Patent Granted Growth Rate

The existing legislation requests that the start-up firms in the business incubators take intellectual property rights or patents as a graduation requirement. Therefore, the number of intellectual property rights owned by the business incubator can reflect the

effect of the incubator in cultivating the growth of start-ups and contributing to regional innovation performance. Figure 10 shows that business incubators' intellectual property rights are rising steadily from 2008 to 2015. Considering the growth of density and intellectual property rights of business incubators, the development of business incubators with the gradually increasing density improving their legitimacy, the business incubators show a mutual relationship in China's regions, which beneficial for the business incubators access technology resources and enhancing the financial capabilities to support the start-up firms R&D investment and innovation activities. Therefore, the intellectual property rights of China's business incubator have grown quickly from 2008 to 2015. However, the further rapid growth of the density of the business incubators has led over time to intense competition. Limited resources are restricting the R&D and innovation activities of the business incubators. Therefore, the intellectual property rights granted of China's business incubator has decreased between 2015 and 2017.

The uneven distribution of innovative activity is particularly apparent in many emerging economies, such as China. Due to the different density level of business incubators in different parts of China and the significant difference in growth rate. China therefore provides an appropriate context to explore the impact of business incubators development on regional innovation performance. Specifically, due to the high density and rapid growth of incubators in the eastern region, it is unknown whether the dependency among incubators has changed from reciprocal cooperation to competition, thus discouraging regional innovation performance. However, in the central and western regions, due to the low density of incubators and the relatively slow growth rate, it is also unknown whether the dependency among incubators in this region is still in the stage of reciprocal cooperation. Addressing them will facilitate the development of the business incubators and benefitting the regional innovation performance.

5.9.5 Geographical Distribution of the Business Incubators capacities

Figure 11 illustrate the distribution of the basic capacity of business incubators. It is clear that the basic capacity of business incubators in the eastern coastal province (e.g., Jiangsu, Shandong, Zhejiang, Shanghai and Guangdong). As an advanced region in China, the investment in business incubators in the eastern coastal province is

remarkable. For example, Jiangsu province has about 27000 entrepreneurial mentors, including 117 of whom are in the Torch Business Mentoring System of the Ministry of Science and Technology Torch Centre of China. The western region is an underdeveloped area of China, the basic capacity of business incubators in Qinghai, Ningxia, and Xinjiang provinces is less than 3.0, partially due to the lower levels of economic development, talent reservation and the lower investment in business incubators in those regions.

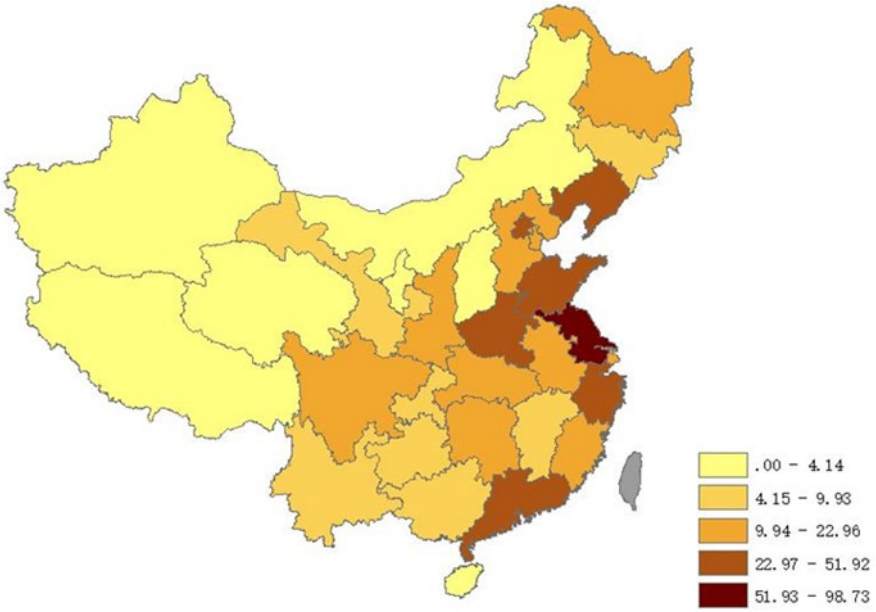

Figure 11The Distribution of Business Incubator Basic Capacity

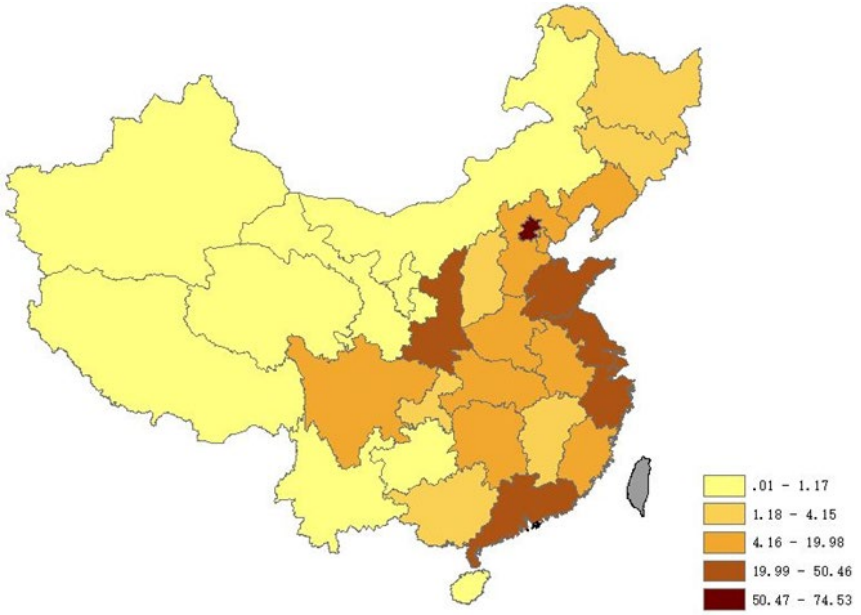

Figure 12 The Distribution of Business Incubator Finance Capacity

Figure 12 also provides information regarding the distribution of financial capacity of business incubators. Among 31 Provincial administrative units, Beijing takes first place,

followed by Jiangsu, Shanghai, Guangdong, and Zhejiang Meanwhile, it is worth noting that apart from Beijing with very high scores, the eastern coastal areas (e.g., Jiangsu, Shanghai, Guangdong, and Zhejiang) have similar scores in financial capacity, suggesting the more available financial support for business incubators in Beijing compared to all other regions.

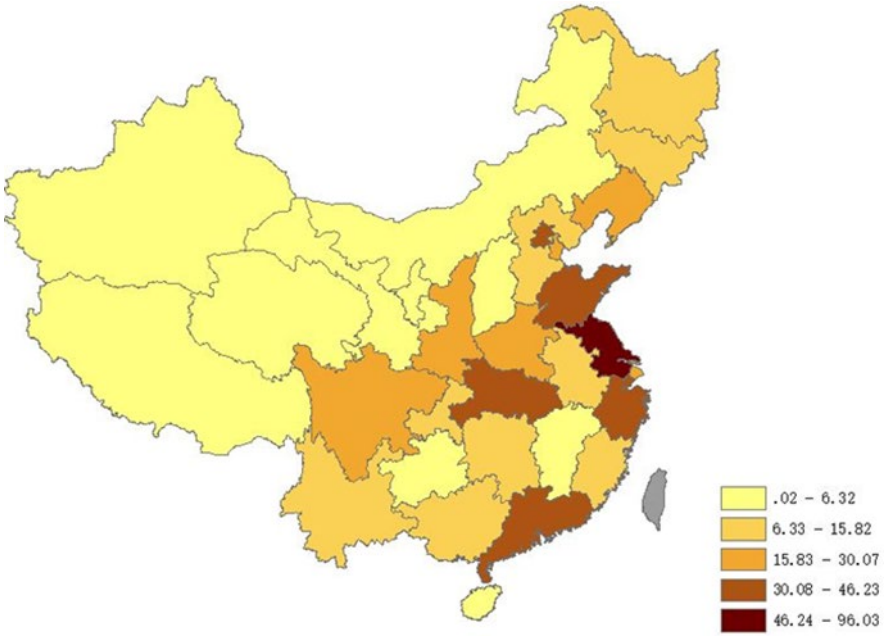

Figure 13 The Distribution of Business Incubator Incubation Capacity

Figure 13 suggested that the distribution of incubation capacity of business incubators in China present slightly different patterns with both basic and financial capacities. Jiangsu take first place, followed by Beijing, Zhejiang and other eastern coastal provinces. The incubation capacity of business incubators in Xinjiang, Qinghai, Ningxia, and other western regions is much lower. In summary, the statistics shows that factors such as levels of economic development and talent reservation are well related to the development of business incubators' capacities in terms of basic services, financial, and knowledge incubation.

5.9.6 Regional Communication Infrastructure

Figure 14 shows the distribution of communication infrastructure development intensity. There is little gap in communication infrastructure construction intensity between middle, western, and eastern coastal provinces. Many middle and western provinces have even better scores than some eastern coastal provinces, such as Guizhou, Tibet, and Shaanxi. However, the number and capacity of business incubators in these

regions are generally not high, and the innovation performance is also at a lower level than the eastern coastal provinces.

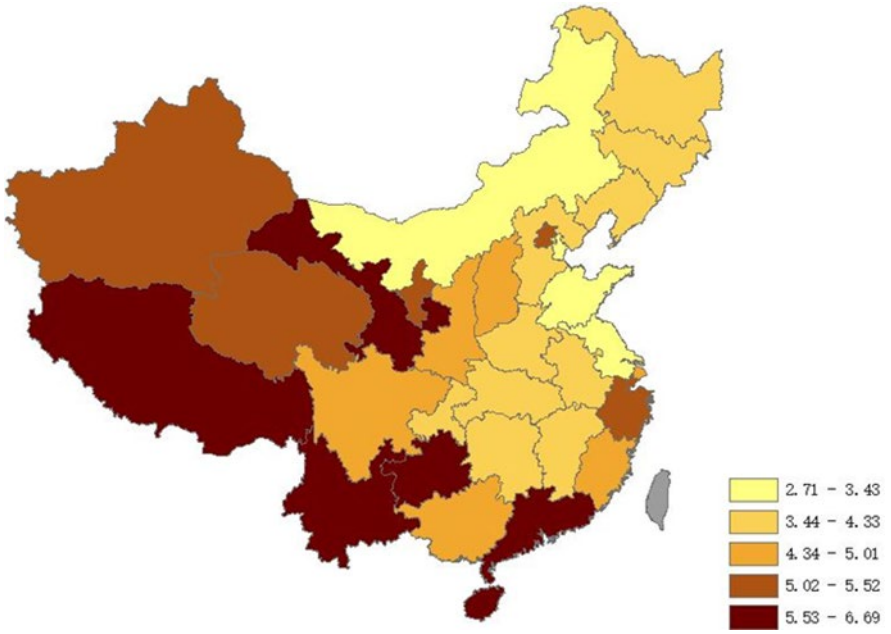

Figure 14 The Distribution of Communication Infrastructure in China

This phenomenon might be related to the policy orientation of China's reform and opening up policy, communication infrastructure construction in some less developed provinces, such as Guizhou, benefited from the more favourable development policies. However, such favourable policy might not directly assist the growth of business incubators and the regional innovation performance.

5.8 Summary

In summary, this chapter has described the methodology, research period, the process of the data collection and has briefly introduced the methods used through the study in the analysis of the data. Furthermore, the different methodologies of research in this study provide support for each hypothesis. Due to the analysis chapter (Chapter 6 and 7) being written in a journal article format; thus, each chapter will be presented the description of the data relevant for the analysis. An account of the methods used in each chapter will provide a specific explanation of them. Meanwhile, the different methodologies of empirical research will provide support for each hypothesis of this study. Each method will support the findings of the others, providing reliable results and robust conclusions.

Chapter 6. Density of Business Incubator and Regional Innovation Performance

6.1 Introduction

In the past two decades, there has been a significant increase in the density of incubators in the emerging economies and scholars from different perspectives have paid increasing attention to the emergence and growth of incubators. However, these studies have implicitly treated business incubators as if they are independent of one another, little theoretical or empirical work has been done to address the effects of business incubators density on regional innovation performance. Thus, the ecological theory is introduced into the research of the influencing factors of incubation performance, from the density dependence model and ecological perspective, this study tries to explore how the density of business incubator may affect regional innovation performance with the continued increase in incubators' population (see Figure 15). The results of this research may contribute to answering the practical question that whether the rapid increase in Chinese incubators has been successfully promoting the regional innovation performance.

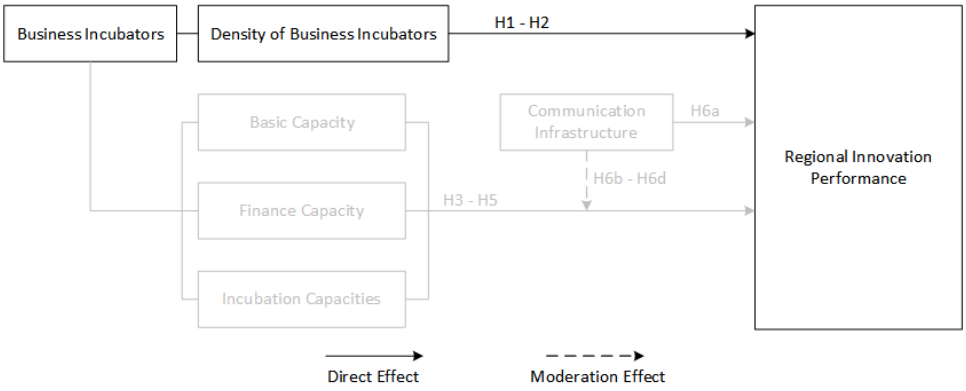

Figure 15 Analytical Framework of Chapter 6

As mentioned in Chapters 2 and 3, the concept of organisation ecological and density dependence followed in this study has two main elements: mutualism and competition. This chapter will investigate the impact of business incubators density development on regional innovation performance by focusing on location decisions at the regional level, since the business incubators are spatially concentrated.

6.2 Model Specification

The literature suggests that business incubation related R&D inputs result in the production of knowledge, which upon application leads to improvement in innovation

productivity in the business incubator sector. The basic structure of the Knowledge Production Function (KPF) is like a standard production function in which the output is knowledge produced in region i at year t. Therefore, this study bases our model on the KPF proposed by Griliches (1979):

$$INN_i = \alpha \times (RDI_i)^{\alpha} \quad \textbf{(9)}$$

Where,

$INN_i =$ The innovation performance in region i.

$RDI_i =$ The research and development inputs in region i.

Equation (9) shown the basic model assumes that innovation (the outcome of successful R&D expenditure) is a function of the resource inputs to the R&D process (Cohen and Levinthal, 1989). Existing research has identified input variables such as R&D input. This study keeps the knowledge production function simply and clearly, accounting for the main extension-research inputs to include the hypothesised and other control variables for this study. Therefore, this study using the general specification of Grimaldi and Grandi (2005), Ratinho and Henriques (2010), and Wang et al. (2020) that includes R&D expenditures, the number of the high degree employee, age and size of business incubators, GDP and FDI. This study introduces the dynamic effects of each provincial administrative unit of China in the empirical function (Equation 10).

$$INN_{i,t} = A \times (DBI)_{i,t}^{\alpha} \times (RDI)_{i,t}^{\beta} \times (EDU)_{i,t}^{\gamma} \times (BIS)_{i,t}^{\delta} \times (AGE)_{i,t}^{\varepsilon} \times (GDP)_{i,t}^{\eta} \times (FDI)_{i,t}^{\theta} \times Z_{i,t}^{\mu} \quad \textbf{(10)}$$

Where,

$DBI_{i,t}$ = Density of business incubators of region i in year t.

$EDU_{i,t}$ = Education level of business incubators employee of region i in year t.

$BIS_{i,t}$ = Size of the business incubators of region i in period t.

$AGE_{i,t}$ = Age of the business incubators of region i in period t.

$GDP_{i,t}$ = GDP growth rate from region i in period t.

$FDI_{i,t}$ = FDI from region i in period t.

$Z_{i,t}$ = vector of control variables for region i in period t.

$A, \alpha, \beta, \gamma, \delta, \varepsilon, \epsilon, \eta, \theta, \mu$ are the parameters to be estimated.

Increasing density of business incubators leading to the mutual interaction of more start-ups, stakeholders, and knowledge transfer, which may have led to the larger number of innovations produced in the regions. Furthermore, the model includes a non-linear term for the density of business incubators. This is included to capture the possible diminishing of regional innovation performance caused by the density of business incubators. Increasing density of business incubators leading to the mutual interaction of more stakeholders and knowledge transfer, which may have led to the larger number of innovations produced in the region. An increase in the density of business incubators can be beneficial to innovation production, but after a certain degree of provision, the marginal effect may diminish, such as when the density of business incubators exceeds the resource carrying capacity, the competition among the business incubators dominates rather than mutual interaction. It makes little sense to keep building business incubators without sufficient resource or capital to fill the demand.

$$log(INN_{i,t}) = a + \alpha \times log\,(DBI_{i,t}) + \beta \times log(2DBI_{i,t}) + \gamma \times log(RDI_{i,t}) + \delta \times log(EDU_{i,t}) + \varepsilon \times log(BIS_{i,t}) + \eta \times log(AGE_{i,t}) + \theta \times log\,(GDP_{i,t}) + \mu \times log(FDI_{i,t}) + \upsilon \times log(Z_{i,t}) + \phi_{i,t} \quad \textbf{(11)}$$

Where,
$log(2DBI)_{i,t}$ = quadratic of the density of business incubators of region i in period t.
$a = log\,(A)$ and $\phi_{i,t}$ is the independent and identically distributed error term.

The quadratic specification of the density of business incubators means that over-development in business incubators may be counter-productive and diminish the regional innovation performance. To test this hypothesis, the square term for the log of business incubators density was included in the model. This study takes logarithms of both sides of equation (11) to facilitate the computation of output elasticity for each innovation input.

6.3 Correlation Coefficient and Multicollinearity

Table 10 reports the descriptive statistics and pairwise correlations of the variables used. Most correlations are relatively low. This study also calculates the variance inflation factors (VIFs) and finds that all VIFs are below the acceptable level of 10 (Stine, 1995). The results thus indicate that multicollinearity is not a serious concern. To eliminate

any problems of multicollinearity and enhance the interpretation of interactions, this study centres the variables before generating any interaction terms (Stine, 1995).

Table 10 Correlation Coefficient and Multicollinearity Test

Var	**Mean**	**SD**	*INN*	*RDI*	*EDU*	*BIS*	*AGE*	*GDP*	*FDI*	*DBI*	**VIF**
INN	216	1.633	1								
RDI	1.12	0.296	0.633**	1							3.06
EDU	6.03	2.633	0.702	0.618	1						2.63
BIS	2.26	0.241	0.301*	0.535*	0.302	1					1.68
AGE	3.16	0.268	-0.211	-0.296	0.016	-0.423	1				2.99
GDP	5.36	2.052	0.366	0.661	0.229*	0.561	-0.416	1			3.63
FDI	2.22	0.433	0.671*	0.339*	0.436	0.023	-0.103	0.423	1		6.31
DBI	2.68	0.702	-0.696*	-0.723*	-0.602	-0.363	0.202	-0.726	-0.337	1	6.98

p-values in parentheses $p < 0.1^{*}$, $p < 0.05^{**}$, $p < 0.01^{***}$

6.4 Result

6.4.1 Density of Business in Provincial Region

The panel regression results for the complete sample of 31 provincial regions are reported in Table 11. The consistency of the GMM estimators requires valid instruments and also the absence of second-order serial correlation (Blundell and Bond, 2000). We used the lagged first differences of the dependent and explanatory variables from year 1–3 as instruments and also employed the Hansen test for over-identifying restriction and overall validity of instruments in the estimation process. The significant values of the Hansen test in models (1) to (3) support the view that the instrumental variables are uncorrelated to residuals. This emphasises the importance of including the interaction terms in models (2) to (3).

Table 11 GMM Results for Provincial Region

	(1)	(2)	(3)
INN	0.082***	0.092***	0.074***
	(0.51)	(0.46)	(0.35)
RDI	0.209**	0.129***	0.336***
	(0.96)	(1.51)	(0.68)
EDU	0.092**	0.831**	0.850**
	(1.23)	(1.98)	(1.66)
BIS	0.526	0.155	0.152
	(0.88)	(0.57)	(0.55)

AGE	0.601*	0.823	0.820
	(0.92)	(1.18)	(1.16)
GDP	0.386	0.505	0.460
	(0.09)	(0.34)	(0.31)
FDI	0.109**	0.309	-0.567
	(0.26)	(0.11)	(-0.20)
DBI		0.622***	
		(0.65)	
2DBI			-0.151***
			(-0.74)
AR(1)	0.061	0.174	0.205
AR(2)	0.368	0.957	0.895
Hansen	0.126	0.201	0.233
Observations	310	310	310
Number of regions	31	31	31

p-values in parentheses p < 0.1, p < 0.05 **, p < 0.01****

Model (1) serves as the baseline model and includes the control variable only. In models (1) to (3), the lagged value of the dependent variable $INN_{i,t}$ is highly significant as expected. This result suggests that regional innovation performance improvement is a gradual and accumulated process.

When the main predictor variables density of business incubators ($DBI_{i,t}$) are added in Model 2, the coefficient of the density of business incubators (0.129, p=0.002) is positive and significant in this model. Therefore, hypothesis 1 is supported, suggesting that the density of business incubators is positively associated with regional innovation performance.

Model 3 include the square term for the log of the density of business incubators ($2DBI_{i,t}$). The estimated coefficient of the square term for the log of the density of business incubators is (-0.151, p=0.007) negative and significant in model (3). Therefore, the result of the quadratic specification of the density of business incubators ($2DBI_{i,t}$) means that over-development in the business incubators may be counter-productive and diminish innovation performance. Therefore, hypothesis 2 is supported, suggesting that over-development of business incubators is negatively associated with regional innovation performance.

6.4.2 Density of Business Incubators in Geographic Region

The regression result for geographic regional division is reported in Table 12. Previous studies pointed out that the consistency of the GMM estimators requires valid instruments and also the absence of second-order serial correlation (Blundell & Bond, 2000). This research using the lagged first differences of the dependent and explanatory variables between year 1 and 3 as instruments, and also employ the Sargan test for over-identifying restriction and overall validity of the instruments in the estimation process. As shown in Table 13, the reported Sargan test is significant in model (1) when only the control variables and OFDI are considered. Meanwhile, the significant values of the Sargan test between models (2) to (4) support the view that the instrumental variables are uncorrelated to residuals. Furthermore, the Arellano–Bond tests in the model (1) to (4) show that the 1st order AR (1) and not the 2nd order AR (2), error terms are serially corrected.

Table 12 GMM Results for Geographic Region

	(1)	(2) Eastern	(3) Central	(4) Western
INN	0.217***	0.128***	0.064***	0.177**
	(0.61)	(0.89)	(0.30)	(1.13)
RDI	0.023**	0.117**	0.344*	0.235**
	(1.02)	(1.23)	(0.75)	(0.65)
EDU	0.102**	0.174**	0.128**	0.729*
	(0.93)	(2.22)	(1.50)	(1.06)
BIS	0.605**	0.443***	0.866**	0.775**
	(1.61)	(4.28)	(2.18)	(2.44)
AGE	0.131	0.239**	0.208	0.222
	(1.86)	(2.22)	(0.94)	(1.21)
GDP	0.241*	0.824**	0.607	0.648
	(0.81)	(2.72)	(1.34)	(1.57)
FDI	0.101	0.188	0.283	-0.289
	(0.08)	(0.31)	(-0.33)	(-0.38)
DBI		1.455**	0.691**	0.482**
		(2.63)	(0.29)	(0.83)
2DBI		-0.017**	-0.161	-0.112
		(-0.19)	(-0.87)	(-0.28)
AR(1)	0.081	0.052	0.051	0.039
AR(2)	0.560	0.901	0.289	0.316
Hansen	0.127	0.241	0.223	0.176

Observations	310	310	310	310
Number of regions	31	31	31	31

p-values in parentheses $p < 0.1^{*}$, $p < 0.05^{**}$, $p < 0.01^{***}$

Based on the baseline model (1), the main predictor variables density of business incubators is added in the model (2) - (4). The lagged value of the dependent variable $INN_{i,t}$ in this study is highly significant as the excepted. This result further conformed that innovation performance improvement is a gradual and accumulated process in the provincial and geographic regions.

In models (2) - (4), the lagged value of the dependent variable $INN_{i,t}$ is highly significant as expected, as too is the $DBI_{i,t}$ variable. The estimated elasticity of innovation concerning the density of business incubators is between the range of 0.2 - 0.6 in the model (2) to (4), which suggesting the 1% increase in the density of business incubators could lead to an increase in the regional innovation performance around 0.2% - 0.6% when other condition unchanged.

Furthermore, in models (2) - (4), we also considered the square term for the log of the density of business incubators ($2DBI_{i,t}$). In model (2), the coefficient between square term for the log of the density of business incubators ($2DBI_{i,t}$) and regional innovation performance is negative and significantly as expected. However, in the model (2) and (3) coefficient among the square term for the log of the density of business incubators ($2DBI_{i,t}$) and regional innovation performance is negative but statistically insignificant. This appears to be primarily because the business incubators distribute unevenly in the geographic region (largely concentrated in eastern, but few in central and western areas), and the density of business incubators in the central and western areas have not yet reached a significantly adverse level for regional innovation performance. From the perspective of geographical distribution, the business incubators have been concentrated in the eastern region. Meanwhile, it is clear that the density of business incubators in the central and western regions is less than eastern region. The same distribution of innovative performance illustrates these patterns are consistent with the expectation that the region with the initial growth in the density of business incubators have stronger innovation performance.

6.4.3 Robustness Check

The above empirical analysis proved the relationship between the business incubators and regional innovation performance. In this section, our study conducted robustness checks to confirm the consistency of the above results. In this section, this study employed 2SLS as an alternative estimation method with 31 provinces over the period of 2008-2017 to test the robustness of our main findings. To test for the impact of business incubators on the regional innovation performance using 2SLS, we have to identify a valid instrumental variable. Following standard practice (Gujarati, 2012), one instrument variable that was used is the GDP growth rate in a region. A valid instrument should be correlated with the suspected endogenous variable while simultaneously being orthogonal to the error term. GDP gives information about the size of the economy and how an economy is performing, an increase in GDP is interpreted as a sign that the economy is doing well. In general, the development of business incubators in economically developed regions is more activity. Therefore, this study posits that the regional GDP growth rate is an appropriate instrument variable.

Following the result of 2SLS in Table 13, the estimation also confirms the strength of our model. Durbin score and Wu-Hausman tests are used to determine the endogeneity, with the null hypothesis that all the variables are exogenous, so our model has a significant score that rejects the null hypothesis and accepts the alternative hypothesis of endogeneity. The minimum eigenvalue or F- statistics of the first stage regression are much greater than the critical value and statistically significant at the 1% level. Thus, the null hypothesis of weak instruments is rejected. The initial growth of business incubator density is positively associated with regional innovation performance, but this relation is reversed when the density of business incubators further developing in a region. Furthermore, the coefficient of the GDP growth rate is positive and also expresses the principal role of the economic base in the development of business incubators and regional innovation activities. In short, these empirical results unravel the interactive relationship between regional green innovation performance. Our robustness test has confirmed the consistency of the above empirical results, the results of 2SLS conform to our primary findings and indicate the reliability of our findings for theoretical and practical implications.

Table 13 Robustness Checks

Variable	GMM		2SLS	
INN	0.092***	0.074***	0.128***	0.142***
	(0.46)	(0.35)	(0.62)	(0.58)
RDI	0.129***	0.336***	1.102***	1.109***
	(1.51)	(0.68)	(0.38)	(0.30)
EDU	0.831**	0.850**	0.703*	0.622*
	(1.98)	(1.66)	(0.79)	(0.91)
BIS	0.155	0.152	0.198	0.202
	(0.57)	(0.55)	(0.63)	(0.81)
AGE	0.823	0.820	0.104	0.241
	(1.18)	(1.16)	(1.32)	(1.03)
GDP	0.505	0.460	0.218*	0.116
	(0.34)	(0.31)	(3.16)	(2.82)
FDI	0.309	-0.567	0.267	0.376
	(0.11)	(-0.20)	(0.81)	(0.76)
DBI	0.622***		0.141***	
	(0.65)		(1.19)	
2DBI		-0.151***		-0.190**
		(-0.74)		(-0.95)
Observations	310	310	310	310
Number of regions	31	31	31	31
R--squared	\	\	0.696	0.632
Durbin Score (Tests of endogeneity)	\	\	5.932**	5.239**
Wu–Hausman	\	\	5.763**	5.172**
Min. eigenvalue (First-stage regression summary statistics)	\	\	23.621***	22.823***
AR(1)	0.174	0.205	\	\
AR(2)	0.957	0.895	\	\
Hansen J Statistics	0.201	0.233	\	\

*t statistics in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$*

6.5 Discussion

This chapter offers a robust result for the research question to consider the impact of business incubators density development on regional innovation performance. This chapter provided in-depth analysis to develop a quantitative model (KPF) that included constructs identified from the literature and guided from previous studies. The analysis

conducted an exploratory analysis that established a solid statistical model (11). The quantitative analysis serves as a foundation to provide strong statistical evidence to generalise the qualitative analysis findings. To study the relationship between the density of business incubators and regional innovation performance, quantitative data was collected regarding the business incubators and regional innovation performance in 31 provinces and 3 geographic regions (eastern, central, and western) of China. Then, before the regression analysis, this study calculates VIF correlation analysis among those variables. This study gets some ideas of the correlation of the variables and finds there is no multicollinearity among those variables. This has reached a basis for the next regression analysis. The following provides a discussion of the findings obtained from the quantitative analysis.

This chapter detects a nonlinear impact of business incubators density on regional innovation performance, which is different from the previous linear impact. Specifically, in line with the organizational ecology and density dependence perspectives, the current density level of business incubators significantly facilitates the regional innovation performance, but this impact inverse when the density further increases. The discussion and empirical identification of double-threshold values contribute to the literature on the impact of business incubators. Considering the rapid development of business incubators in the region of emerging economies (such as China), the research gap is theoretically meaningful and practically important for studies like ours to address.

At the provincial level, the results suggest a positive and highly significant relationship between the density of business incubators and regional innovation performance. This result is consistent across several estimations, when without reckoning further growth of business incubator density in the region. However, when the density of business incubators further grows, it may not deliver actual value to the regional innovation performance. Our result suggested that the great density of business incubators in the region is likely to occur growing competition. This aligns with the organizational ecology and density dependence perspective that the growing competition may not encourage innovation activities in the region.

From the perspective of geographic areas, the current density level business incubators positively impact innovation performance in eastern, central, and western areas in

China. However, when the density of business incubators further increases, the impact of business incubator density on innovation performance in the eastern area showing negatively, but insignificant in central and western areas. In line with the mutualism and competition perspective, our result suggested that there is both positive and negative effect of business incubators density development upon regional innovation performance. Although it is expected that mutualism relations between business incubators and regional innovation performance dominate at the current stage, but with further development of density of business incubators competition deters business incubators get benefiting from the external resource then contributing to regional innovation performance. Particularly in large emerging economies with within-country uneven geographical distribution of business incubators such as China.

6.6 Summary

In summary, arising from the unclear conclusion density development of business incubators in emerging economies is the lack of theoretical development regarding the role of density growth of business incubators on regional innovation performance, particularly apparent in many emerging economies with uneven distribution of business incubators and innovation activates, such as China. Therefore, this chapter empirical demonstrates the contribution in considering the double-edged of business incubators density development effects on the regional innovation performance and highlight our contribution to the business incubators and regional innovation studies.

Chapter 7. Capacities of Business Incubators and Regional Innovation Performance

7.1 Introduction

In the context of China, the development of business incubators has increased dramatically since 2010. Business incubator figures published by the China torch statistics yearbook, for example, show that the number of business incubators in China increased nearly dozens of times between 2007 and 2017 (Ministry of Science and Technology, 2018). Zhang and Stough (2013), Jiang et al. (2016), Xiao and North (2018) suggested that the fast development of business incubators accounted for indigenous innovation policy inaugurated, advocated for mass entrepreneurship and innovation and regard them as a new engine fuelling China economic growth. They also found that industry structure, labour supply and global trade also contributed to the surge of the business incubator (Zhang and Stough, 2013; Jiang et al., 2016; Xiao and North, 2018). Despite this growing interest in China's regional innovation systems, few studies have yet considered the effects of the business incubator on regional innovation performance through incubator capacities and how business incubator interacts with communication infrastructure.

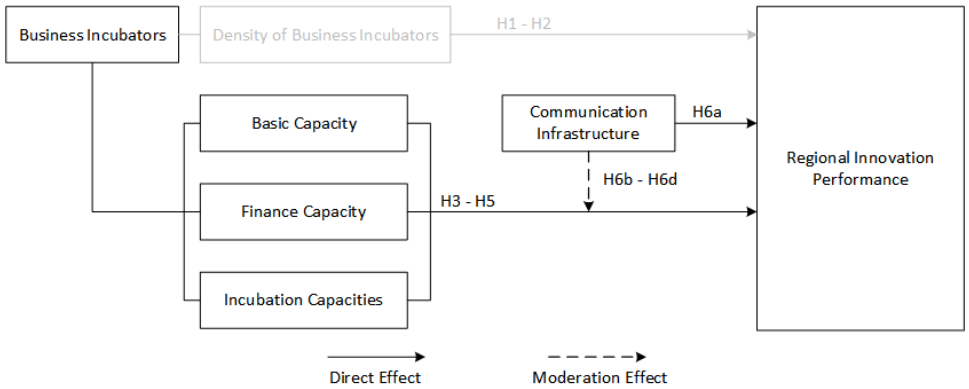

Figure 16 Analytical Framework of Chapter 7

As mentioned in Chapter 2 and 4, the capacities of business incubators followed in this study has three main elements: basic, finance and incubation capacities. In this chapter, this study analysed the effect of business incubators capacities on innovation performance at the provincial region level, and further consider the moderation role of communication infrastructure in the region (see Figure 16). This chapter presents descriptive statistics of the key subjects mentioned above. Additionally, the Generalized Method of Moments (GMM) tests were conducted to identify the correlation between regional innovation performance and the variables of interest: the basic, finance and

incubation capacities of business incubators and communication infrastructure in the region.

7.2 Model Specification

In order to select a suitable model to estimate our dynamic panel data model, it is now important to discuss some possible techniques. This study considers data from 2008 to 2017 in China (T=10) with the business incubators and innovation performance in 31 provincial regions (N=31). Thus, our panel data have small T and large N properties. The dynamic effect model is considered to be a suitable technique in our case. Meanwhile, because it is difficult to select the appropriate instrumental variables in general economic statistics research, the Generalized Method of Moments (GMM) exhibits advantages. GMM can use lagged dependent variable as an instrumental variable to further control estimation. Therefore, the GMM model is one of the best choices. The panel data GMM model technique is used to control for endogeneity and individual heterogeneity (Hillier et al., 2011). Furthermore, as a difference GMM model has a problem with weak instruments in the estimation (Alonso-Borrego and Arellano, 1999), thus, system GMM model is more efficient than difference GMM model (Blundell and Bond, 2000). In line with prior studies of regional innovation performance, this study uses the system GMM model proposed by Arellano and Bond (1991) and Blundell and Bond (2000)

Literature suggests that quantitative analysis should consider problems of endogeneity (Blundell and Bond, 2000; Liu et al., 2014). Endogeneity means that the explanatory variable is related to the residual, endogeneity could lead to estimation bias and often difficult to find the roots of bias (Blundell and Bond, 2000). This thesis faces the challenge of endogenous variables. Some explanatory variables in the model are endogenous, which may create a problem of endogeneity. For example, the capacities of business incubators may also impact the R&D intensity, as a greater capacity of business may encourage start-ups to commence more R&D activities (Pindado et al., 2015). This endogeneity problem can be addressed by an IV approach, such as 2SLS or GMM estimation. In general, external instruments are used for IV estimation, while internal instruments (lag of explanatory variables) are used for GMM estimation. The IV approach provides consistent estimation under the assumption that valid instruments exist (Cameron and Trivedi, 2010). However, it is very complex, if not impossible, to

find valid external instruments (Pindado et al., 2014). In addition, GMM embeds all other instrumental methods as special cases (Hiller et al., 2011).

In line with prior studies of regional innovation performance, this study uses system-GMM model proposed by Arellano and Bond (1991) and Blundell and Bond (2000):

$$y_{i,t} = \gamma_o + \sum_{j=1}^{n} \varphi_{t,j}\, y_{i,t-j} + \sum_{k=1}^{n} \delta_{t,k}\, x_{i,t-k} + \gamma_{i,t} + u_{i,t} \quad (i=1,\cdots,N;\ t=1,2,\cdots,T) \quad \textbf{(12)}$$

Where i refers to region, j, k refers to the lag, γ_0 refers to constant, γ_i refers to individual effects, and $u_{i,t}$ refers to residuals.

This basic model gives a way of avoiding endogenous problems. Here, this study augments the basic model as follows to include our hypothesised variables and other control variables.

$$lnInn_{i,t} = \alpha_0 + \alpha_1\, log\, INN_{i,t-1} + \alpha_2\, log\, BAS_{i,t} + \alpha_3\, log\, FIN_{i,t} + \alpha_4\, log\, InINC_{i,t} + \alpha_5\, log\, INF_{i,t} + \beta_1\, log\, IND_{i,t} + \beta_2\, log\, ECO_{i,t} + \beta_3\, log\, LAB_{i,t} + \beta_4\, log\, INT_{i,t} + \varepsilon_{i,t} \quad \textbf{(13)}$$

Where

$INN_{i,t}$ = innovation performance of region i in period t.

$BAS_{i,t}$ = basic capacity of business incubators of region i in period t.

$FIN_{i,t}$ = financial capacity of business incubators of region i in period t.

$INC_{i,t}$ = incubation capacity of business incubators of region i in period t.

$INF_{i,t}$ = proportion of communication infrastructure investment of region i in period t.

$IND_{i,t}$ = proportion of services industry of region i in period t.

$ECO_{i,t}$ = GDP per capita of region i in period t.

$LAB_{i,t}$ = years of education per capita of region i in period t.

$INT_{i,t}$ = proportion of international trade of region i in period t.

Meanwhile, in the equation (13), α_0 is the constant, α_1 is the lag of regression coefficient of dependent variable, α_2 to α_5 are the lags of regression coefficients of each independent variable; β_1 to β_4 are the lags of regression coefficients of each control variable; $\varepsilon_{i,t}$ is the random disturbance term.

7.3 Correlation Coefficient and Multicollinearity

Table 14 provides means, standard deviations, and the correlation matrix for all the variables. The mean number of regional innovation performance over the period is 2.12. The average score of basic service capacity of business incubators is 2.30. The average score of financial capacity of business incubators is 1.64. The average score of incubation capacity of business incubators is 2.34. This study used standardized values for the interaction terms (involving *Bas*, *Fin*, *Inc* and *Inf*) to avoid possible biases arising from high correlations with the main effects (Belsley, 1984).

Table 14 Correlation Coefficient and Multicollinearity

Var	**Mean**	**SD**	*INN*	*IND*	*LAB*	*ECO*	*FOR*	*BAS*	*FIN*	*INC*	*INF*	**VIF**
INN	2.12	1.302	1									4.36
IND	3.75	0.194	0.334**	1								4.03
LAB	2.16	0.147	0.490*	0.648	1							3.69
ECO	2.36	0.049	0.479**	0.605*	0.810*	1						4.21
FOR	2.89	0.956	0.739***	0.466	0.543	0.549	1					4.76
BAS	2.30	1.303	0.766***	0.076	0.187	0.226	0.526	1				2.07
FIN	1.64	1.731	0.844*	0.334	0.479	0.513*	0.609	0.750	1			4.91
INC	2.34	1.435	0.847**	0.113	0.353	0.387	0.599	0.861	0.827	1		2.88
INF	1.42	0.512	-0.059**	0.014	-0.371*	-0.479	0.041	0.122**	-0.117	0.108**	1	3.36

p-values in parentheses $p < 0.1^{*}$, $p < 0.05^{**}$, $p < 0.01^{***}$

Most of the correlations between the explanatory variables are small, so multicollinearity is not a serious concern. The correlations between basic capacity and communication infrastructure are +0.122, and the correlation between financial capacity and communication infrastructure is +0.167. This figure appears to confirm our contention that the highest capacities of business incubators are located in those with relatively advanced communication infrastructure regions.

7.4 Result

The regression results are reported in Table 15. This study uses the lagged first differences of the dependent and explanatory variables from year 1–4 as instruments and employs the *Hansen* test for the over-identifying restriction and the overall validity of the instruments in the estimation process.

Table 15 GMM Regression Results

	(1)	(2)	(3)	(4)	(5)
INN	0.351***	0.228*	0.952***	0.886***	0.944***
	(0.000)	(1.93)	(8.60)	(5.37)	(9.04)
IND	-1.968***	0.922***	0.054	0.055	0.079
	(0.000)	(2.99)	(0.26)	(0.26)	(0.70)
LAB	3.391***	-0.242	1.08	0.406	0.311
	(0.000)	(-0.32)	(1.08)	(1.08)	(0.90)
ECO	-0.219	-1.032*	0.349	0.349	-0.455
	(0.572)	(-1.94)	(0.71)	(0.71)	(-1.21)
FOR	0.609***	-0.035	0.016	0.016	-0.028
	(0.000)	(0.43)	(0.28)	(0.28)	(-0.50)
BAS		0.170***	0.048**	0.015**	0.056**
		(2.23)	(1.20)	(0.11)	(1.51)
FIN		0.206***	0.088*	0.014**	0.063*
		(3.66)	(2.00)	(0.36)	(1.37)
INC		0.317***	0.044**	0.129*	0.069***
		(4.92)	(0.61)	(0.55)	(0.005)
INF		0.148***	0.037*	0.133*	0.061*
		(1.72)	(0.53)	(0.43)	(1.13)
BAS_INF			0.298**		
			(0.92)		
FIN_INF				0.018	
				(0.30)	
INC_INF					0.101**
					(0.23)
AR (1)	0.021	0.167	0.015	0.067	0.029
AR (2)	0.266	0.476	0.117	0.292	0.126
Hansen	0.106	0.247	0.229	0.165	0.239
Observations	310	310	210	310	310
Number of regions	31	31	31	31	31

*p-values in parentheses ($p < 0.1$ *, $p < 0.05$ **, $p < 0.01$ ***)*

The insignificant values of the *Hansen* test in models (2), (3), (4) and (5) support the view that the instrumental variables are valid. The reported regional innovation performance is however significant in model (1) and (2) when only the control variables and business incubator capacities are considered. Moreover, the Arellano–Bond tests in

all models indicate that the first-order AR (1), and not the second-order AR (2), error terms are serially corrected. This further support the use of GMM for the estimation in models (2) - (5). We therefore focus the discussion on models (2) - (5).

7.4.1 Capacities of Business Incubators and Regional Innovation Performance

In models (2), the lagged value of the dependent variable $INN_{i,t}$ is significant as expected, so as business incubator capacity variables. This result suggests that the regional innovation performance improvement is a gradual and accumulated process. In this sense, during the formulation of innovation principles and polices, the government should consider the dynamic development process of the innovation capacities in different regions, as well as the long-term development of innovation performance.

Furthermore, all four hypothesised variables and their direct effects on innovation performance are highly significant in models (2). In particular, the incubation capacity has the strongest effect, where the estimated coefficient is 0.170. Hypothesis 5 is thus supported. Therefore, it is reasonable to argue that business incubators provide important social network for start-ups and technology entrepreneurs and promotes knowledge transfer between enterprises. Meanwhile, business incubators as knowledge sharing platforms not only encourage mutual learning within incubators, but also knowledge exchange with external knowledge sources, such as the universities and research institutions, and promote tacit knowledge transfer between various entities in the innovation ecosystem. This has subsequently promoted the transformation of technological achievements and the enhancement of regional innovation performance.

Moreover, the impacts of basic service capacity and financial capacity of business incubators are relatively smaller, but still significant (the estimated coefficients are 0.206 and 0.317, respectively). Hence, hypotheses 3 and 4 are supported. The smaller effect on regional innovation performance, however, reflects the fact that assets availability (e.g., spaces and talent) and financial support is not as important as the knowledge transfer opportunities provided by business incubators. One of the reasons could be that not all start-ups and technology entrepreneurs in business incubators are seeking tangible or intangible assets. It is knowledge exchange that will enable better

innovation activities of technology entrepreneurs.

7.4.2 Communication Infrastructure and Regional Innovation Performance

The estimated coefficient of communication infrastructure is 0.148. The significant effect suggesting that high quality communication infrastructure construction is a necessary antecedent for the better innovation performance. Hypothesis 6a is thus supported. In models (3) - (5), this study considered the three interaction terms one at a time. In model (3) coefficient of the interaction term between basic service capacity of business incubators and communication infrastructure is positive and significant (+0.298, $p< 0.01$). This supports hypothesis 6b that the communication infrastructure positively moderates the relationship between basic service capacity of business incubators and regional innovation performance. In model (4) the coefficient of the interaction term between financial capacity of business incubators and the communication infrastructure is statistically insignificant. Furthermore, its introduction has little effect on the size and statistical significance of the direct effect coefficients.

Thus, it appears that the effects on innovation performance of financial capacity of business incubators and communication infrastructure are additive, but that the hypothesised 6c moderating effect of the communication infrastructure on the relationship between financial capacity of business incubators and the regional innovation performance is not supported. Finally, model (5) carries out the regression with the interaction term between incubation capacity of business incubators and the communication infrastructure included. The coefficient of the interaction term is positive and statistically significant (+0.101, $p< 0.05$); thus, hypothesis 6d is supported. The above result shows the positive impact of business incubators' incubation capacity on the regional innovation performance is enhanced in regions where communication infrastructures are more developed, presumably because communication infrastructure assisted the spill over effects (e.g., knowledge transfer) and transformation of innovation results in those regions.

7.5 Discussion

Business incubators as important homes to technology entrepreneurs have developed dramatically in recent years, especially in emerging economies, such as China thanks to the vast investment from the government and the industry. Despite the ongoing

literature that has investigated the beneficial impact of investment activity on innovation performance in emerging economies (e.g., Fu, 2008), little is known about the effects of the development of business incubators on regional innovation performance, particularly in the context of emerging economies. The panel data analysis presented in this paper considers the effects of business incubator capacities on the regional innovation performance in 31 Chinese provinces over a ten-year period (2008–2017). The results suggest that the capacities of business incubators have a significant impact on regional innovation performance. Furthermore, this study identifies the communication infrastructure as an important moderator of the relationship between business incubator capacities and innovation performance. This result echoes recent calls for more attention to the communication infrastructure construction on business incubators in China.

This study provides a more profound examination of the effects of business incubators capacities on regional innovation performance as well as its interplay with an important moderation variable such as communication infrastructure. Although business incubators are usually considered to have an impact on innovation performance. Different from previous studies, this thesis further divided business incubators' capacities into three aspects: basic, finance, and incubation capacities. This thesis puts forward that business incubators facilitated regional innovation performance through their capacities. This study has found that incubation capacity is the most important capacity for business incubators contributed to the regional innovation performance, it is a trigger to knowledge management and transformation of the start-ups into its innovation processes, the final outcome being the success of innovation and thus promote the innovation performance development where the business incubators were located. The following ones were finance and basic capacities, and both capacities offer funding and services for innovation activities in the region. In the geography areas, although different regions in China have exhibited different levels of business incubator capacities (middle and western regions are generally weaker than eastern/coastal regions), the positive influence of business incubator capacities on the regional innovation performance is quite stable across regions. From this vein, both the western region and the middle region should consider more on how to mobilize the business incubators within the national innovation momentum in order to advance the development of regional innovation.

In examining the communication infrastructure and regional innovation performance, this thesis has looked at the direct and moderation role. Our results suggest that communication infrastructure enhances regional innovation performance in the context of China. We suggest that this variation might be due to communication infrastructure stimulate the efficiency of knowledge management and transformation in the region. Furthermore, our findings shed light on the moderation role of communication infrastructure in the relation between capacities of business incubators and regional innovation performance. In this moderation path, this study has found that communication infrastructure enhances the impact of each business incubators capacity on the regional innovation performance. Therefore, communication infrastructure acts as a significant moderation role between capacities of business incubators and regional innovation performance. This is a contribution to the innovation literature.

In summary, the findings of this study suggest that the development of business incubators may bring more benefits beyond just providing additional entrepreneurial opportunities. In this sense, attention is deserved from policymakers to consider the impacts on innovation performance when designing policies to promote business incubators. It is important to realise that the development of business incubator capacities may in turn facilitate technological development beyond the boundary of business incubators to the regional level. This recommendation, however, is tempered by the condition that certain levels of pre-existing regional communication infrastructure in the region can harness the benefits of business incubators. As the communication infrastructures of many regions in China (as is the case in most other emerging economies) are still far behind those of most developed countries (National Bureau of Statistics PRC, 2018), steady investment and development of the communication infrastructure will be necessary to establish a healthy regional innovation system.

7.6 Summary

In this chapter, the empirical analysis presented in this thesis considers the effects of three capacities of business incubators on innovation performance in 31 Chinese regions (province) over a ten-year period (2008–2017) and finds that each capacity of business incubators has a very significant impact on the innovation performance in the

region. Meanwhile, the empirical study in this chapter also identifies that communication infrastructure moderates the impact between the capacities of business incubators and regional innovation performance. This result echoes recent calls for more attention to be given to the effects of communication infrastructure construction on business incubators and innovation performance development in China. This result highlights our contribution to the business incubation and regional innovation system field.

Chapter 8 Conclusion

8.1 Introduction

The questions address the four aspects of the impact of business incubators on regional innovation performance: the business incubation density and its variations in the region, the capacities of business incubators, the communication infrastructure in China's region and its moderation role, which crucial for business incubators and regional innovation development. Each question was addressed in a separate analytical chapter.

This study discussed the impact of business incubators density with different development levels on regional innovation performance (Chapter 6) regarding the first research question. Using the quantitative analysis, this study shows that the development of business incubators density in local economics significantly impacts regional innovation performance, which is crucial for regional innovation performance development. Based on these results, this study concluded that the initial growth of business incubators density in the region significantly facilitates the regional innovation performance. Still, this impact is inverse when the density further increases.

The other three research question was addressed in Chapter 7. To study the relationship between business incubators capacities and regional innovation performance. This study tests the basic, finance and incubation capacity of business incubators to identify the effect of business incubators on regional innovation performance. Furthermore, this study also considers the capacities of business incubators and regional innovation performance interactions simultaneously. The results show that basic, finance and incubation capacity positively affect the regional innovation performance. The effect is significant, although each capacity affects regional innovation performance differently. Meanwhile, as an important tool for sharing and transferring knowledge and resource, the communication infrastructure positively related to regional innovation performance. It also positively moderated the relationship between capacities of business and regional innovation performance in the context of China.

Consequently, this study presented evidence that supports the main argument of this research, i.e., that both density and capacities of business incubators, communication infrastructure and its moderation effect between capacities of business incubators and regional innovation performance. The final chapter brings together the results of the

previous discussion to draw conclusions about regional innovation performance development and provides a general view of the topics covered in this research. The main findings present in section 2. In section 3, this study stresses the contribution of this thesis. This study also provides some practical implications and policy recommendations in section 4. The final section in this chapter points out the limitation and further study points emerging from the results.

8.2 Main Findings

Many authors from different perspectives have paid increasing attention to the development of incubators (Wiggins et al., 2003; Grimaldi and Grandi, 2005; Aerts et al., 2007; Somsuk et al., 2012; Alzaghal and Mukhtar, 2017). However, these studies have implicitly treated the business incubators as individuals, and few theoretical or empirical work has been done to address the effects of density development of business incubators on regional innovation performance (Wang et al., 2016; Xu, 2018; Wang et al., 2020). Thus, the organisation ecological theory and density dependence theory is introduced into the research of the influencing factors of incubation performance; from the density dependence model and ecological perspective, we try to explore how the density development of business incubators may affect regional innovation performance, the results of this research may contribute to answering the practical question that "How the rapid growth of business incubators density affect regional innovation performance development?"

This study revealed that business incubators play a more critical role in innovation development around the emerging economies. It focused on the greater importance of density development of business incubators in the region; basic, finance and incubation capacities of business incubators; and communication infrastructure in fostering regional innovation performance. Consequently, a positive relationship is found that initial growth of business incubators density in the region significantly facilitates the regional innovation performance, but this impact inverse when the density further increases. Thus, the hypotheses (H1-H2) were supported. From the perspective of geographic areas, the impact of density development of business incubators has the great regional difference the initial growth of business incubators density positively impacts innovation performance in eastern, central and western areas in China. But, when the density of business incubator further increases, the impact of business

incubator density on innovation performance in the eastern area showing negatively and insignificant in central and western areas.

Business incubators create value by combining the innovative spirit with the resources that are typically available to new businesses. It is widely recognized that technology-based entrepreneurial companies are the main creators of regional innovation performance development, and such enterprises require sufficient business incubation services. These incubators provide a comprehensive set of services and environments through their capacities that are suitable for supporting entrepreneurial skills and helping entrepreneurs develop their ideas, skills, and expertise. As a field of research, the capacities of business incubators have become a research hotspot for regional innovation performance development. The result of this study contributes to answering the practical question that "How the capacities of business incubators affect regional innovation performance?". Furthermore, the communication infrastructure is considered as the main pillar of innovation development in the region, and they have a pivotal role in knowledge sharing and transferring critical resource for research and development. Meanwhile, the business incubators not only acquire valuable innovation assets through communication infrastructure in the region but also subsequently be able to adapt and exploit those assets to the benefit of their regional innovation performance. Therefore, this study also examined the direct and moderating effects of communication infrastructure in regional innovation performance development. The result of this study contributes to answering the practical questions that "does the communication infrastructure positively associate with regional innovation performance? " and "how the communication infrastructure moderate the impact of business incubators capacities on regional innovation performance?"

In this study, the strong relationship was found among the basic, finance, and incubation capacities of business incubators and regional innovation performance. Thus, the hypotheses (H3-H5) constructed were supported. The communication infrastructure is also considering within this study. The result exhibited that the significant positive impact of communication infrastructure on regional innovation performance and it's also positively moderated the relationship between each capacity of business incubators and regional innovation performance. Therefore, the hypotheses (H6a-H6d) were supported. To this end, the capacities of business solve the many challenges of

innovative entrepreneurs, such as the lack of technical skills, working space, venture capital, and support systems. The sufficient communication infrastructure ensures the sharing and transferring of knowledge and resources among the business incubators in the region. In this situation, business incubators can play an essential role in the regional innovation performance growth and development of entrepreneurship. In the context of China, the government has taken several initiatives to support innovation and entrepreneurship by establishing institutions, such as the National Business Incubation and the "mass entrepreneurship and innovation" policy for innovation, which does many jobs in handling start-ups and regional innovation performance development.

8.3 Contribution

8.3.1 Theoretical Contribution

This thesis aimed to analyse the effects of business incubators on regional innovation performance by exploring and identify the density level and capacities of business incubators between 2008 and 2017. The initial growth of business incubators density in the region significantly facilitates the regional innovation performance, as mutualistic benefits strengthened communication between business incubators and extract knowledge and technology from sources. On the other side, with the further development of business incubators density, the competition has replaced the mutualistic relation, and competition is reducing the business incubators extraction the knowledge, which has a negative effect on regional innovation performance. Meanwhile, this empirical analysis also presented in this thesis considers the effect of business incubators capacities on regional innovation performance and finds that each capacity of business incubators has very significant impact on regional innovation performance. This thesis also identifies a moderation factor, the communication infrastructure that positively moderate the impact of capacities of business incubators on regional innovation performance.

Table 16 Gaps in Literature and Contributions

Gaps in Literature	Research Question	Research Objective	Contribution
There is no unanimous conclusion about whether business incubators are conducive to regional innovation	RQ 1	OBJ 1	This thesis adds insights to the literature on regional innovation and business incubators by simultaneously studying the mutualism and competition relationship between

Gaps in Literature	Research Question	Research Objective	Contribution
performance when its density further develops in the region			business incubators and regional innovation performance
There is still lack of investigation on the impact of business incubators capacities on regional innovation performance	RQ 2	OBJ 2	This study contributes to the business incubators and regional innovation study by providing a better understanding of the specific mechanisms by which business incubators' three capacities influence regional innovation performance
Not many studies have investigated the effort made in communication infrastructure on regional innovation performance in the context of China	RQ 3	OBJ 3	This study enriches the literature on regional innovation by demonstrating how the communication infrastructure influences regional innovation performance in the context of China
There is lack of investigation on the moderation role of communication infrastructure on the capacities of business incubators and regional innovation performance	RQ 4	OBJ 4	This study enriches the research on business incubators and regional innovation by identifying a moderating role of the communication infrastructure between capacities of business incubators and regional innovation performance

In general, this thesis integrates the literature on business incubators and regional innovation performance and proves the important relationship between business incubators and regional innovation performance. The contribution to the theory of the doctoral thesis is coming from the validated conceptual model that enables the assessment of the effects of business incubators density development and capacities on innovation performance at the regional level in the context of China. Furthermore, this study covers the gaps of multidisciplinary studies on a conceptual model that clearly states the relation among the density and capacities of business incubators, communication infrastructure and regional innovation performance (see Table 16). The final discussion of each contribution that corresponds with the objective for this thesis is addressed in the following points.

- **This thesis adds insights to the literature on regional innovation and business incubators by simultaneously studying the mutualism and competition relationship between business incubators and regional innovation performance.**

In Chapter 6, the thesis has considered the variables of the density of business

incubators to evaluate the development of business incubators density and innovation performance at a regional level. Following the previous study, this thesis implements econometric models (KPF) to generalise the effect of business incubators density on the regional innovation performance (Qian et al., 2011; Filieri and Alguezaui, 2014; Rubin et al., 2015; Mian et al., 2016). The results have shown that the impact of business incubators on regional innovation performance has changed from positive to negative with density development. This characteristic may help the Chinese government to make a more reasonable development strategy for the business incubators. Therefore, this study enriches our understanding of how business incubators density development affects regional innovation performance. This analysis also enables us to bring the organisational ecology and density dependence theory more explicitly and appropriately into regional innovation study and enhances our understanding of business incubators' mutualism and competition role under different density development levels, jointly shaping the business incubators and regional innovation study.

Most previous studies based on the organisational ecology and density dependence theory were conducted at the firm or organisation level (Peterson et al., 2011; Cavus and Gokcen, 2015). However, these studies did not consider the role of macro factors, such as geographic distribution of business incubators density, as important contingencies that affect regional innovation marginal benefits of business incubators. On the other hand, regional innovation studies based on econometric models tended to focus on the formation of business incubators clusters in the region, based on business incubators spatial proximity as the transaction of knowledge and technology (Wallsten, 2001; Aharonson et al., 2007; Rubin et al., 2015). Extending the application of organisational ecology and density dependence theory, this study complements previous studies by systematically examining the mutualism and competition relation of business incubators, and it helps to understand the boundary between business incubators mutualism and competition. Therefore, this study goes beyond a simplified application of organisational ecology and density dependence theory to innovation study and gain important insights by broadening the organisational ecology and density dependence theory beyond the boundary of the individual organisation.

- **This study contributes to the business incubators and regional innovation**

study by providing a better understanding of the specific mechanisms by which business incubators' three capacities influence regional innovation performance.

In Chapter 7, based on regional innovation system theory, this thesis further investigates the influential mechanism of business incubators on regional innovation performance, which is developing a quantitative model that analyses the effects of each capacity of business incubators on regional innovation performance. The finding of this study contributes to a better understanding of how regional innovation performance is affected by business incubators through their capacities. Our perspective considered how the business incubators capacities (basic, finance and incubation) driving the innovation activities to contribute to regional innovation performance. The conceptual model developed in Chapter 4 identifies each type of capacity of business incubators linked to the innovation activities and use of resources. First, our conceptual model considered the characteristics of the basic capacity of business incubators. The assessment also considers the basic capacities of business incubators that have promoted the accumulation of entrepreneurs' psychological capital, which facilitate the innovation performance in where the business incubators were located. Second, our study covered the financial capacities of business incubators, the model assessed how the financial capacity of business incubators provided economic support for innovation activities. Finally, this thesis also assessed how the incubation capacity of business incubators facilitated knowledge transfer to support innovation activities in the region. The result of the above assessment is positive and significant. In line with regional innovation system theory, as the participant in the local network, the activities of business incubators contributed to the regional innovation performance development.

The process enabled us to assess what type of capacity of business incubators were contributed to regional innovation performance and better understand the mechanism of business incubators on regional innovation performance in the context of China. Our findings indicate that the capacities of business incubators are a critical way of business incubators contribute to regional innovation performance. We have obtained more in-deep insights in terms of the relationship between the capacities of business incubators and regional innovation through focusing on the interrelationship between these factors.

- **This study enriches the literature on regional innovation by demonstrating how the communication infrastructure influences regional innovation performance in the context of China.**

Our quantitative model proved empirical evidence to identify the effect of communication infrastructure on regional innovation performance in the context of emerging economies. This thesis achieved evaluating adequate variables and constructed the use through the exploratory GMM regression analysis. Meanwhile, our regression model also passed all the validity tests, ensuring that the reliable result successfully measures the effect of communication infrastructure in the regional innovation performance development. Generally, the quantitative analysis proved that communication infrastructure positively affected regional innovation performance. Furthermore, sufficient communication infrastructure can facilitate knowledge transfer (or sharing) during the business incubators. The result also showcased the research on the impact of communication infrastructure is particularly relevant in the context of emerging economies, such as China, because of the potential higher value-added of knowledge sharing activities in emerging economies.

Moreover, the quantitative analysis conducted an empirical assessment of the communication infrastructure that promoted interaction between the business incubators and other external entities in the region. The traditional regional innovation systems theory highlights the interactions between various actors and institutions in the local network. This paper further indicates that the development of communication infrastructures can facilitate the synergy between multiple entities in regional innovation ecosystems. Thus, this thesis enriches the literature of innovation and regional development.

- **This study enriches the research on business incubators and regional innovation by identifying a moderating role of the communication infrastructure between capacities of business incubators and regional innovation performance.**

Empirically, previous studies on the impact of business incubators upon regional innovation performance were unable to fully capture the impact of communication

infrastructures (Fu and Xiong, 2011). Thus, the role of the communication infrastructure remains unclear. Our empirical result provides some evidence to verify the positive moderating effects of communication infrastructure development on business incubator capacities and regional innovation performance. The critical contribution to the regional innovation study from the research was the clarify the moderation effect of communication infrastructure on capacities of business incubators and regional innovation performance.

The model statistically proved that one of the business incubators behaviours is to hire skilled human capital with scientific knowledge to mentor start-ups activities. Under this category, the business incubators unidirectionally generate knowledge internally and seek to develop new products through innovation activities. On the other side, the business incubator backed start-up R&D projects with money and provided a knowledge stream from the network. Business incubators on this process would further create new knowledge through the development of patents. This process is supported by using communication infrastructure to gather sufficient resources from the external networks. The quantitative analysis has proven that incoming knowledge and resources through communication infrastructure enhance the impact of each capacity of business incubators on regional innovation performance. Thus, this thesis successfully supported the literature to group the communication infrastructure and business incubators capacities into formative constructs that could be used in equation modelling. Therefore, the findings of this paper further add to the literature of regional innovation by conceptualizing the moderating effect of communication infrastructures and their roles in knowledge incubation activities of business incubators.

8.3.2 Practical Contributions

(1) For Business Incubators

The result of this study suggested that business incubators play a more critical role in regional innovation performance development in emerging economies. First, this thesis pointed out that how density development influence business incubators contributed to regional innovation performance. These include selecting the business incubator's geographical location and generally not advisable to set up new business incubators in the region with existing high density. Accessing enough innovation and incubation resources has become difficult because of fierce competition from the business

incubators further concentration in the region. Second, this thesis emphasises the importance of basic, financial and incubation for regional innovation performance development, which explained the influential mechanism of business incubators on regional innovation performance.

These insights are integrated into a framework that clarified the pathway for business incubators driving regional innovation performance. These insights are crucial to business incubators because they can concentrate the resources and time necessary on further develop the core competence for innovation. Finally, it informs that communication infrastructure is able to enhance the capacities of business incubators influence regional innovation performance. This thesis suggested that communication infrastructure facilitate identifying business incubators obtaining intelligence, funding and gaining insights on the local network.

(2) For Policymaker

The present study suggests that in order to promote the development of regional innovation performance, governments in emerging economies should focus on business incubation and government regulations for business incubation development because, without government regulations, the overgrown of business incubators in the region won't be contributed to innovation performance. It is widely accepted that no country has unlimited resources and capabilities to sustain innovation development. Likewise, incubators also needed support to contribute to regional innovation performance. This thesis provides empirical evidence that communication infrastructure contributes to regional innovation performance and positively moderation the relationship between the capacities of business and regional innovation performance. Therefore, the development of communication infrastructure would be improving the capacities of business incubators and further facilitate the regional innovation performance in emerging economies.

Moreover, our findings indicate that regional communication infrastructure investment may be essential to facilitate the capacities of business incubators and regional innovation performance. After decades of reform and opening, communication infrastructure investment and construction attract more attention and regulations of the government. And the government has made some favourable policies to stimulate

communication infrastructure investment. Nevertheless, excessively enjoys the preferential treatments may cause unpleasant effects of communication infrastructures such as excessive investment and repeated construction. These may affect the efficiency and quality of knowledge retrieval by business incubators. This must be tempered by the realization that excessive preferential policies may also affect business incubators capacities and regional innovation performance, which will have a counterbalancing negative impact on innovation.

8.4 Limitation and Further Study

This study is not without limitations which deserve better future works. First, this study used aggregate business incubator data, and did not differentiate the type of business incubator. Future research may develop more fine-grained data to evaluate the development of different business incubator on the innovation performance of different regions. Second, this study cannot distinguish state-owned and non-state-owned business incubator due to the limited data availability. For instance, state-owned business incubator may have more support from the government, but non-state-owned business incubator may have more flexibility in operation. Therefore, future studies might wish to examine the roles of different ownership characteristics of business incubator in promoting regional innovation. Third, this study used the panel data of regional innovation to measure regional innovation performance. Future studies might employ longitudinal designs or survey questionnaires that go beyond archival input-output scores to capture empirical evidence of the channels through which business incubator would influence on regional innovation performance. Finally, this study used China as the main research context. Although China forms a good example of emerging economies, different emerging economies may have different policy and business environments for business incubator. Such differences may alter the relationship between business incubator capacities and the regional innovation performance. Future research may extend our study to a multi-country context involving other emerging economies and even developed countries.

8.5 Summary

This chapter discussed the finding and contribution of this research in line with the research objectives, hypotheses, and questions. This study has verified the statistical assumption and associated calculation. This study integrated the use of empirical

simulation values and reach reliable data. The results are consistent with the theoretical results. Furthermore, based on our result, this study also took some useful conclusions for the related theoretical and practical problems of business incubators and regional innovation performance development in emerging economies, and thus fill the blank of the research in the regional innovation area.

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Appendix 1

Regression Result

Density of business incubators and regional innovation performance

```
Favoring speed over space. To switch, type or click on mata: mata set matafavor space, perm.

Dynamic panel-data estimation, one-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =       310
Time variable : year                            Number of groups   =        31
Number of instruments = 22                      Obs per group: min =         1
F(0, 30)      =         .                                      avg =      5.53
Prob > F      =         .                                      max =         6
------------------------------------------------------------------------------
             |               Robust
         inn | Coefficient  std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
         INN |
             |   .0924902    .202868     0.46   0.002    -.3218216     .506802
             |
         RDI |
             |   .1286911   .0852676     1.51   0.142    -.0454486    .3028308
             |
         EDU |
             |   .8312368   .4195781     1.98   0.057     -.025656     1.68813
             |
         BIS |
             |   .1553172   .2719118     0.57   0.572    -.4000008    .7106351
             |
         AGE |
             |    .823613   .6966434     1.18   0.246    -.5991226    2.246349
             |
         GDP |
             |   .5046134   1.482886     0.34   0.736     -3.53307    2.523843
             |
         FDI |
             |   .3087187    2.79957     0.11   0.913    -6.026204    5.408766
             |
         BDI |
             |   .1295596   .1989962     0.65   0.002    -.2768448    .5359639
             |
        year |
        2012 |  -1.015946   5.318449    -0.19   0.850    -11.87767    9.845775
        2013 |  -.7455818   5.288367    -0.14   0.889    -11.54587     10.0547
        2014 |  -1.206425    5.30369    -0.23   0.822    -12.03801    9.625155
        2015 |  -1.251445   5.373577    -0.23   0.817    -12.22575    9.722862
        2016 |  -1.244209    5.40306    -0.23   0.819    -12.27873    9.790311
        2017 |  -1.261546   5.472626    -0.23   0.819    -12.43814    9.915047
------------------------------------------------------------------------------
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -1.36  Pr > z =  0.174
Arellano-Bond test for AR(2) in first differences: z =   0.05  Pr > z =  0.957
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(7)    =  18.59  Prob > chi2 =  0.110
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(7)    =   8.37  Prob > chi2 =  0.201
  (Robust, but weakened by many instruments.)
```

```
Favoring speed over space. To switch, type or click on mata: mata set matafavor space, perm.

Dynamic panel-data estimation, one-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =       310
Time variable : year                            Number of groups   =        31
Number of instruments = 21                      Obs per group: min =         1
F(0, 30)      =         .                                      avg =      5.53
Prob > F      =         .                                      max =         6
------------------------------------------------------------------------------
             |               Robust
         inn | Coefficient  std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
         INN |
             |   .0736604   .2085297     0.35   0.006     -.352214    .4995349
             |
         RDI |
             |  -.3364791   .4971949    -0.68   0.204    -1.351887    .6789284
             |
         EDU |
             |   .8504826   .4293161     1.98   0.057    -.0262979    1.727263
             |
         BIS |
             |   .1518078   .2780862     0.55   0.589    -.4161201    .7197356
             |
         AGE |
             |   .8203022   .7091086     1.16   0.256    -.6278908    2.268495
             |
         GDP |
             |   .4603226   1.505641     0.31   0.762    -3.535253    2.614608
             |
         FDI |
             |  -.5678684   2.892133    -0.20   0.846    -6.474391    5.338655
             |
        2DBI |
             |   .1510783   .2051671     0.74   0.007    -.2679287    .5700853
             |
        year |
        2012 |  -.5406574   5.523325    -0.10   0.923    -11.82079    10.73948
        2013 |  -.2649678   5.496364    -0.05   0.962    -11.49004    10.96011
        2014 |    -.73512   5.509832    -0.13   0.895     -11.9877    10.51746
        2015 |  -.7752095   5.580203    -0.14   0.890     -12.1715    10.62109
        2016 |  -.7610448   5.611016    -0.14   0.893    -12.22027    10.69818
        2017 |   -.769652   5.680063    -0.14   0.893    -12.36989    10.83058
------------------------------------------------------------------------------
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -1.27  Pr > z =  0.205
Arellano-Bond test for AR(2) in first differences: z =   0.13  Pr > z =  0.895
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(6)    =  16.89  Prob > chi2 =  0.160
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(6)    =   8.07  Prob > chi2 =  0.233
  (Robust, but weakened by many instruments.)
```

```
Favoring speed over space. To switch, type or click on mata: mata set matafavor space, perm.

Dynamic panel-data estimation, one-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =       310
Time variable : year                            Number of groups   =        31
Number of instruments = 14                      Obs per group: min =         1
F(0, 30)      =         .                                      avg =      5.53
Prob > F      =         .                                      max =         6
------------------------------------------------------------------------------
             |               Robust
         inn | Coefficient  std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
         INN |
             |   .1282281   .1439183     0.89   0.008    -.1656923    .4221484
             |
         RDI |
             |   .1173223   .0950556     1.23   0.027    -.0768072    .3114518
             |
         EDU |
             |   .1736225   .0780574     2.22   0.034     .014208    .3330371
             |
         BIS |
             |   .4426661   .1034205     4.28   0.000     .2314532    .6538789
             |
         AGE |
             |   .2390415   .1075766     2.22   0.034     .0193407    .4587423
             |
         GDP |
             |   .8242377   .3029176     2.72   0.011     .2055974    1.442878
             |
         FDI |
             |   .1877222   .6152356     0.31   0.762    -1.068757    1.444201
             |
         DBI |
             |   1.455232   .5530758     2.63   0.013     2.584763    .3257005
             |
        2DBI |
             |  -.0168226    .090577    -0.19   0.086    -.1681602    .2018055
        year |
        2012 |  -.0535901    5.03978    -0.01   0.992    -10.34619    10.23901
        2013 |   .2344878    5.03779     0.05   0.963    -10.05405    10.52303
        2014 |  -.2903281   5.049867    -0.06   0.955    -10.60353    10.02288
        2015 |  -.3536199   5.111903    -0.07   0.945    -10.79352    10.08628
        2016 |  -.2959263   5.111938    -0.06   0.954     -10.7359    10.14404
        2017 |  -.3256605   5.174214    -0.06   0.950    -10.89281    10.24149

------------------------------------------------------------------------------
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -1.94  Pr > z =  0.052
Arellano-Bond test for AR(2) in first differences: z =  -0.12  Pr > z =  0.901
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(5)    =  11.63  Prob > chi2 =  0.140
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(5)    =   5.66  Prob > chi2 =  0.241
  (Robust, but weakened by many instruments.)
```

```
Favoring speed over space. To switch, type or click on mata: mata set matafavor space, perm.

Dynamic panel-data estimation, one-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =       310
Time variable : year                            Number of groups   =        31
Number of instruments = 21                      Obs per group: min =         1
F(0, 30)      =         .                                      avg =      5.53
Prob > F      =         .                                      max =         6
------------------------------------------------------------------------------
             |               Robust
         inn | Coefficient  std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
         INN |
             |   .0636962   .2112632     0.30   0.005    -.3677608    .4951532
             |
         RDI |
             |   .3437903   .4571907     0.75   0.058    -1.277498    .5899177
             |
         EDU |
             |   .1280798   .0856145     1.50   0.045    -.0467683    .3029279
             |
         BIS |
             |   .8657002   .3974653     2.18   0.037     .0539678    1.677433
             |
         AGE |
             |   .2080503   .2207704     0.94   0.354     -.242823    .6589235
             |
         GDP |
             |   .6067411   .4539592     1.34   0.191    -.3203673     1.53385
             |
         FDI |
             |  -.2833402   .8517664    -0.33   0.741    -2.023879    1.455199
             |
         DBI |
             |   .6907006   2.368515     0.29   0.026     2.527854    5.146452
             |
        2DBI |
             |  -.1607254   .1840391    -0.87   0.189    -.2151325    .5365833
             |
        year |
        2012 |   .0650203   4.888508     0.01   0.989    -9.918646    10.04869
        2013 |   .3394408   4.886723     0.07   0.945     -9.64058    10.31946
        2014 |   -.148702   4.892619    -0.03   0.976    -10.14076     9.84336
        2015 |  -.2029704   4.950682    -0.04   0.968    -10.31361    9.907672
        2016 |  -.1638502   4.953364    -0.03   0.974    -10.27997    9.952268
        2017 |  -.1903714   5.009223    -0.04   0.970    -10.42057    10.03983
------------------------------------------------------------------------------
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -1.44  Pr > z =  0.051
Arellano-Bond test for AR(2) in first differences: z =   0.14  Pr > z =  0.289
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(6)    =  15.98  Prob > chi2 =  0.116
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(6)    =   6.66  Prob > chi2 =  0.223
  (Robust, but weakened by many instruments.)
```

```
Favoring speed over space. To switch, type or click on mata: mata set matafavor space, perm.

Dynamic panel-data estimation, one-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =       310
Time variable : year                            Number of groups   =        31
Number of instruments = 24                      Obs per group: min =         1
F(0, 30)      =         .                                      avg =      5.53
Prob > F      =         .                                      max =         6
------------------------------------------------------------------------------
             |               Robust
         inn | Coefficient  std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
         INN |
             |   .1769164   .1569168     1.13   0.038    -.1435504    .4973832
             |
         RDI |
             |   .2346664   .3598271     0.65   0.019    -.9695313    .5001986
             |
         EDU |
             |   .0728969   .0685491     1.06   0.096    -.0670991    .2128929
             |
         BIS |
             |   .7748588   .3178898     2.44   0.021     .1256413    1.424076
             |
         AGE |
             |   .2220732   .1829322     1.21   0.234    -.1515242    .5956706
             |
         GDP |
             |   .6476344    .412317     1.57   0.127    -.1944292    1.489698
             |
         FDI |
             |  -.2888405   .7624253    -0.38   0.707    -1.845921     1.26824
             |
         DBI |
             |   .4824739   2.120969     0.83   0.022     4.814069    3.849122
             |
        2DBI |
             |   -.111795   .1433657    -0.28   0.142    -.1809967    .4045868
             |
        year |
        2012 |  -.7059132    4.47985    -0.16   0.876    -9.854987    8.443161
        2013 |  -.4315742     4.4899    -0.10   0.924    -9.601173    8.738025
        2014 |  -.8791269   4.477676    -0.20   0.846    -10.02376    8.265507
        2015 |  -.9094706   4.525537    -0.20   0.842    -10.15185    8.332908
        2016 |  -.8499123   4.537146    -0.19   0.853      -10.116    8.416177
        2017 |  -.8461089   4.574476    -0.18   0.855    -10.18844    8.496217
------------------------------------------------------------------------------
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -1.48  Pr > z =  0.039
Arellano-Bond test for AR(2) in first differences: z =   0.11  Pr > z =  0.316
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(9)    =  33.45  Prob > chi2 =  0.103
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(9)    =   9.70  Prob > chi2 =  0.176
  (Robust, but weakened by many instruments.)
```

```
Favoring speed over space. To switch, type or click on mata: mata set matafavor space, perm.

Dynamic panel-data estimation, one-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =       310
Time variable : year                            Number of groups   =        31
Number of instruments = 20                      Obs per group: min =         1
F(0, 30)      =         .                                      avg =      5.53
Prob > F      =         .                                      max =         6
------------------------------------------------------------------------------
             |               Robust
      loginn | Coefficient  std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
      loginn |
             |   .2287454   .1183436     1.93   0.063    -.0129444    .4704352
             |
      logbas |
             |   .1704964   .0763845     2.23   0.033     .0144984    .3264943
             |
      logfin |
             |   .2059677   .0562753     3.66   0.001     .0910383    .3208972
             |
      loginc |
             |   .3167872   .0644228     4.92   0.000     .1852183    .4483561
             |
      loginf |
             |  -.0481696   .0672998    -0.72   0.480     -.185614    .0892748
             |
      logind |
             |   .9224737   .3087233     2.99   0.006     .2919767    1.552971
             |
      loglab |
             |  -.2420176    .754059    -0.32   0.750    -1.782012    1.297976
             |
      logeco |
             |  -1.031976   .5318389    -1.94   0.062    -2.118136    .0541842
             |
      logfor |
             |  -.0349386    .081942     0.43   0.673    -.2022865    .1324092
        year |
        2012 |  -2.413272   5.442753    -0.44   0.661    -13.52886    8.702312
        2013 |  -1.701998   5.338976    -0.32   0.752    -12.60564    9.201645
        2014 |  -1.985488   5.374552    -0.37   0.714    -12.96179    8.990812
        2015 |  -1.956523   5.427414    -0.36   0.721    -13.04078    9.127736
        2016 |  -1.929294   5.496477    -0.35   0.728     -13.1546     9.29601
        2017 |   -1.82431   5.499336    -0.33   0.742    -13.05545    9.406833
------------------------------------------------------------------------------
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -1.38  Pr > z =  0.167
Arellano-Bond test for AR(2) in first differences: z =  -0.71  Pr > z =  0.476
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(11)   =  15.33  Prob > chi2 =  0.168
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(11)   =  13.75  Prob > chi2 =  0.247
  (Robust, but weakened by many instruments.)
```

```
Favoring speed over space. To switch, type or click on mata: mata set matafavor space, perm.

Dynamic panel-data estimation, one-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =       310
Time variable : year                            Number of groups   =        31
Number of instruments = 20                      Obs per group: min =         1
F(0, 30)      =         .                                      avg =      5.63
Prob > F      =         .                                      max =         6
------------------------------------------------------------------------------
             |               Robust
         inn | Coefficient  std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
         inn |
             |   .9524093   .1106918     8.60   0.000     .7263466    1.178472
             |
         bas |
             |    .048324   .0404254     1.20   0.041    -.0342357    .1308838
             |
         fin |
             |   .0883707   .0441839     2.00   0.055    -.1786064    .0018649
             |
         inc |
             |   .0436063   .0709113     0.61   0.043     -.101214    .1884266
             |
         inf |
             |   .0369473     .06928     0.53   0.098    -.1045414     .178436
             |
         ind |
             |   .0545533   .2068133     0.26   0.794    -.4769223    .3678157
             |
         lab |
             |   .4060229    .375382     1.08   0.288    -.3606094    1.172655
             |
         eco |
             |    .349087   .4943873     0.71   0.486    -1.358761    .6605866
             |
         for |
             |   .0162657   .0582844     0.28   0.782    -.1027669    .1352983
             |
     bas_inf |
             |   .0297727    .032365     0.92   0.025    -.0363255    .0958709
        year |
        2012 |  -3.366901   1.962399    -1.72   0.097    -7.374655    .6408537
        2013 |  -3.297017   1.953537    -1.69   0.102    -7.286671    .6926371
        2014 |  -3.390537   1.963557    -1.73   0.095    -7.400655    .6195805
        2015 |  -3.395162   1.986388    -1.71   0.098    -7.451908    .6615848
        2016 |  -3.453164   1.983786    -1.74   0.092    -7.504595    .5982673
        2017 |  -3.500597   1.971212    -1.78   0.086    -7.526349    .5251542

------------------------------------------------------------------------------
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -2.42  Pr > z =  0.015
Arellano-Bond test for AR(2) in first differences: z =  -1.57  Pr > z =  0.117
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(10)   =   4.50  Prob > chi2 =  0.622
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(10)   =  12.90  Prob > chi2 =  0.229
  (Robust, but weakened by many instruments.)
```

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Favoring speed over space. To switch, type or click on mata: mata set matafavor space, perm.

Dynamic panel-data estimation, one-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =       310
Time variable : year                            Number of groups   =        31
Number of instruments = 26                      Obs per group: min =         1
F(0, 30)      =         .                                      avg =      5.50
Prob > F      =         .                                      max =         6
------------------------------------------------------------------------------
             |               Robust
         inn | Coefficient  std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
         inn |
             |   .8863353   .0576824     5.37   0.000      .768532    1.004139
             |
         bas |
             |   .0148736   .1298044     0.11   0.026    -.2799696    .2502223
             |
         fin |
             |   .0141457   .0390987     0.36   0.015    -.0939958    .0657044
             |
         inc |
             |   .1287846   .2354627     0.55   0.088    -.3520944    .6096635
             |
         inf |
             |   .1331619   .2415556     0.43   0.072    -.3601605    .6264843
             |
         ind |
             |   .0599871   .2539624     0.24   0.815    -.4586732    .5786474
             |
         lab |
             |  -.0700009   .3870866    -0.18   0.858    -.8605373    .7205354
             |
         eco |
             |   .9779243   1.033912     0.95   0.352    -1.133607    3.089455
             |
         for |
             |  -.0614919   .0618061    -0.99   0.328    -.1877169     .064733
             |
      fin_inf |
             |   .0184693   .0616622     0.30   0.167    -.1074616    .1444003
             |
        year |
        2012 |  -2.334349   2.743706    -0.85   0.402    -7.937744    3.269045
        2013 |  -2.230493   2.687816    -0.83   0.413    -7.719745     3.25876
        2014 |  -2.373357    2.77661    -0.85   0.399     -8.04395    3.297236
        2015 |  -2.392064   2.851443    -0.84   0.408    -8.215487    3.431359
        2016 |  -2.392219   2.764634    -0.87   0.394    -8.038356    3.253917
        2017 |  -2.486055   2.863379    -0.87   0.392    -8.333855    3.361746
------------------------------------------------------------------------------
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -1.83  Pr > z =  0.067
Arellano-Bond test for AR(2) in first differences: z =  -1.69  Pr > z =  0.292
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(10)   =   9.11  Prob > chi2 =  0.522
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(10)   =  14.17  Prob > chi2 =  0.165
  (Robust, but weakened by many instruments.)
```

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Favoring speed over space. To switch, type or click on mata: mata set matafavor space, perm.

Dynamic panel-data estimation, one-step system GMM
------------------------------------------------------------------------------
Group variable: id                              Number of obs      =       310
Time variable : year                            Number of groups   =        31
Number of instruments = 20                      Obs per group: min =         1
F(0, 30)      =         .                                      avg =      5.63
Prob > F      =         .                                      max =         6
------------------------------------------------------------------------------
             |               Robust
         inn | Coefficient  std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
         inn |
             |   .9444006    .104461     9.04   0.000     .7310627    1.157738
             |
         bas |
             |   .0562779   .0373168     1.51   0.042     .0199333     .132489
             |
         fin |
             |   .0629656   .0461273     1.37   0.082     .1571702    .0312389
             |
         inc |
             |   .0690663   .0666253     1.04   0.008     .0670007    .2051333
             |
         inf |
             |   .0609922   .0540886     1.13   0.068     .0494714    .1714558
             |
         ind |
             |   .0794509     .11401     0.70   0.491    -.1533887    .3122905
             |
         lab |
             |   .3105612   .3450755     0.90   0.375    -.3941771    1.015299
             |
         eco |
             |  -.4548811   .3758632    -1.21   0.236    -1.222496    .3127339
             |
         for |
             |  -.0277568   .0553967    -0.50   0.620    -.1408921    .0853784
             |
     inc_inf |
             |   .0101897   .0436211     0.23   0.017    -.0788965    .0992759
        year |
        2012 |  -2.846462    2.64629    -1.08   0.291    -8.250908    2.557984
        2013 |   -2.67696   2.642352    -1.01   0.319    -8.073363    2.719443
        2014 |  -2.884942   2.684779    -1.07   0.291    -8.367992    2.598109
        2015 |  -2.915426   2.720283    -1.07   0.292    -8.470984    2.640132
        2016 |  -3.018105   2.651835    -1.14   0.264    -8.433875    2.397666
        2017 |  -2.991694   2.731019    -1.10   0.282    -8.569178    2.585791

------------------------------------------------------------------------------
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -2.18  Pr > z =  0.029
Arellano-Bond test for AR(2) in first differences: z =  -1.53  Pr > z =  0.126
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(10)   =   7.48  Prob > chi2 =  0.380
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(10)   =  12.72  Prob > chi2 =  0.239
  (Robust, but weakened by many instruments.)
```

Appendix 2

Definition of Business Incubators

Citation	Definition
Plosila and Allen, 1985	Business incubators are facilities that promote the early development of a profit-oriented company.
Allen and Rahman, 1985	Business incubators are facilities that help companies grow early by providing rental space, shared office services and business consulting assistance.
Allen and Rahman, 1985	Business incubators are a collective and temporary place to accommodate companies that offer space, assistance, and services that meet the needs of companies that are being launched or have just been established.
Smilor and Gill, 1986	Business incubators seek to effectively link talent, technology, capital and skills to enhance entrepreneurial talent and to accelerate the development of local economy.
Allen and Bazan, 1990	Business incubators are networks or organizations that provide skills, knowledge and motivation, real estate experience, business provision and shared services.
Allen and McCluskey, 1991	An incubator is a facility that provides affordable space, shared office services, and business development assistance in an environment that is conducive to new business creation, survival, and early-stage growth.
Hackett and Dilts, 2004	Business incubator is a shared office space facility that seeks to provide incubation (e.g., portfolio or client or tenant company) with a strategic value-enhancing intervention system (e.g., business incubation) from business monitoring and assistance.
Hughes et al., 2007	Business incubators are facilities that accommodate young and small companies to help them develop quickly into a competitive business.
NAIB, 2007	Business incubators can focus on low-cost commercial space and various business services to help entrepreneurs in the early stages of business development
Eshun, 2009	Business incubators are environments that are formally designed to stimulate the growth and development of new and early-stage companies by increasing their opportunities to acquire resources aimed at facilitating the development and commercialization of new products, new technologies, and new business models. Business incubation is also a social and managerial process aimed at supporting the development and commercialization of new products, new technologies, and new business models.
Schwartz and Hornych, 2010	Business incubation is a unique and very flexible combination of business development processes, infrastructure and people designed to nurture new and small businesses by supporting them through the initial stages of development and change.
Mubarak and Busler, 2010	Business incubators are business support processes that accelerate the successful development of start-ups and start-ups by providing targeted resources and services to entrepreneurs. This service is usually developed or regulated by incubator management and is offered both in the business incubator and through its contact network. The main objective of business incubators is to produce successful companies that will make this program financially viable and independent. These incubator graduates have the potential to create jobs, revitalize the environment, commercialize new technologies, and strengthen local and national economies.

Appendix 3

The summary of innovation

Innovation is a core element for the economic growth of any knowledge-based economy (Finegold et al., 2004). The definition of innovation is about giving a new idea or method of doing something. It is linked to the invention in the way of generating ideas (Oxford Dictionary, 2018). According to various scholars (see Table 2), there is an explicit difference between invention and innovation; the invention is all about the generation of a new idea for a new product or processes while innovation means the initial application of that idea into a real-world scenario (Damanpour et al., 2011; Hauschildt and Salomo, 2011; Ivanova and Leydesdorff, 2014).

Definition of Innovation

Citation	Definition
Oxford University Press, 2016	The etymological meaning of innovation is derived from the Latin word "Innovare," which means to "make new" or "renew".
Hauschildt and Salomo, 2011: 4	Innovation is either a new product or process that differs "noticeably" from a state of comparison.
OECD, 2018	Innovations include significant improvements in technical specifications, components and materials, integrated software, ease of use or other functional characteristics
Damanpour et al., 2011	Innovation refers to the introduction of a new or significantly improved product (good or service).
Jassawalla and Sashittal, 2002	Innovation is process of adoption in ideology and practices. The adoption varies in the level of intensity and flexibility in different academic institutions.
Kaiser, 2009	Innovative work consists of three interrelated behavioural tasks: idea generation, idea promotion and idea realization.
Ivanova and Leydesdorff, 2014	The definition of innovation is about giving new idea(s) or method(s) of doing something.
Cooke et al., 1998: 1564	The regional innovation system is the system in which organisation or enterprises are systematically engaging in interactive learning through an institutional milieu characterized by embeddedness.
Iammarino, 2005: 499	The regional innovation system constitutes the localised innovation network of various organisations and institutions in several sectors whose activities and interactions generate, absorb, and diffuse new knowledge within or outside the region in economies.

For the conversion of a new idea (invention) to a practical application (innovation), organizations require to take strategic and well-calculated approaches to ensure the

process is fully effective (Hauschildt and Salomo, 2011: 4; Fu, 2012). However, for this to be achieved, it is appropriate for an organization to have the basic relevant knowledge, resources, and an environment for the generation of new knowledge (Filieri, R. and Alguezaui, 2014). It is worth noting that, generation and commercialization of new knowledge might take time and an organization might require some external sources to fulfil its internal requirements, so that it can convert a new idea (codes/methods) into a practical approach (product) in the form of an innovative product development process (Panahi et al., 2013; Rubin et al., 2015; Ramesh, 2017). Therefore, innovation is about new idea or diffusion (Fu, 2012).

The regional innovation system (RIS) concept is used for the local process of innovation (Benneworth et al., 2016). In many countries around the world, especially in China, it gains attention and become the hub of innovation at the regional level to achieve innovation capabilities and competitive advantages at local firms (Cooke et al., 1998: 1564; Iammarino, 2005: 499; Witherspoon et al., 2013; Zhao et al., 2017). The objective of knowledge-based regions is to become an innovative region for economic development (Mian et al., 2016; Ramesh, 2017). Regional level innovation academia generates knowledge (in the form of research results) and transfer to the firms for innovation. In which case the business incubators promote innovation performance for regional development by enhancing knowledge commercialisation and knowledge utilisation (Alavi and Leidner, 2001; Wallsten, 2001; Sindakis et al., 2015).

The developments in the field of RIS enhances the regional innovation capabilities for competitive advantages in the world (Benneworth et al., 2009). Literature shows that many studies have been conducted on the RIS topic in the past decade due to its distinctive nature and set of a systematic process for innovation at the local level considering this is not possible at the national level (Fu, 2012; Adelowo et al., 2015). Another reason behind RIS development is the increase in competition in the business market (Cooke et al., 1997; Alavi and Leidner, 2001; Evers et al., 2010). Therefore, knowledge generation and transfer to the industry becomes important for socio-economic development at the RIS level (Doloreux, 2004; Afzal, 2013). Knowledge generation starts the process of innovation where innovation diffusion is based on the activities through collaboration and interaction between sectors (Schulze et al., 2015). Innovation activities in the innovation system force policymakers to promote

innovation through research collaboration in the region, and this collaboration is also based on facilities (Finegold et al., 2004; Panahi et al., 2013; Ramesh, 2017). Therefore, further evaluation of policies is required for establishing and promoting new policies relevant to innovation activities in the region (Whittington et al., 2009; Geisler and Wickramasinghe, 2015).

The research community has agreed on the importance of innovation in the regional perspective, along with some critical question on the existence of RIS (Sindakis et al., 2015). The national level defines innovation policies sometimes with partial ignorance at the regional level institutions, which may cause some risks (Freeman and Soete, 2009). Some scholars have mentioned that RIS does not ignore the importance of research set by the central government in their national and international policies (Chaminade and Vang, 2008). At the regional and national level, the local market has sufficient resources to compete at the national and international levels according to market trends, especially technology (Chan and Lau, 2005). Therefore, policies must support knowledge and technology from the regional set boundaries (Cooke et al., 1997).

RIS model supports knowledge generation and transfer for application into the product line, supported by regional government policies (Cooke et al., 1997). The knowledge generation, transfer, and application can be made through a collaboration between sectors in the respective region (Wallsten, 2001). The knowledge generation and its transfer are known as "knowledge infrastructure". The purpose of this is to support innovation (Witherspoon et al., 2013). It can be achieved through interaction and collaboration between different sectors such as university and industry (Evers et al., 2010). For example, the university produces new knowledge and transfers it to the industry where industry applies it for business purposes (Finegold et al., 2004; Cabrera et al., 2006; Geisler and Wickramasinghe, 2015).

Appendix 4

The summary of the findings from previous business incubators and regional innovation performance.

Findings Form the Literature

Authors	Proxy for business incubators	Research sample	Conclusion
Lalkaka (2002)	Performance and number of business in country level.	US, China, Brazil, and India.	The exponential business incubators development positively related with innovation performance.
Tamasy (2007)	Performance and number of business in country level.	US, UK, New Zealand, Germany	The development of business incubators may have both positive and negative impact on innovation performance.
Baskaran et al., (2019)	Number of business in country level.	China, Japan, Malaysia and Singapore	The development of business incubators may have both positive and negative impact on innovation performance.
Wang et al., (2020)	Number of business in regional level.	China	The development of business incubators has positive impact upon regional innovation performance.
Sedita et al., 2019	Multilevel index of business in regional level.	Italian	The development of business incubators has positive impact on innovation performance.
Xiao and North, 2018	Number of business in regional level.	China	The development of business incubators has positive impact on innovation performance.
Sedita et al., 2017	Performance and number of business in industry level.	Italian	The development of business incubators has positive impact on innovation performance but limited by the portfolio of collaborations for innovation.
Lalkaka, 2003	Performance of business in country level.	China, Brazil	Business incubators facilitate innovation activities in development countries
Özdemir and Şehitoğlu,	Number of business in country	Turkey	Business incubators have been widely accepted as

Authors	Proxy for business incubators	Research sample	Conclusion
2013	level.		essential sources of innovation.
Ratinho and Henriques (2010)	Number of business in country level.	Portugal	Business incubators promote knowledge development, but modest contribution of economies development.
Lukeš et al., (2019)	Number of business in firms' level.	Italian	Business incubators have negligible impact on innovation and economic growth.
Corsi and Di Berardino (2014)	Multilevel index of business in regional level.	Italian	Business incubators promote knowledge development, the robust determined by the founder's team of incubators and environment.
Binsawad and Hawryszkiewycz (2019)	Performance of business in country level.	Saudi Arabia	Business incubators positively support innovative technology via knowledge donation and collection.
Salameh and Quandah (2018)	Number of business in firms' level.	Jordanian	Reward, pre-purchasing, donation etc. has the most positive impact on innovation and value creation.
Oliveira and Trento (2018)	Number of business in firms' level.	Chile, Israel and Italy	Capabilities, leaderships and resources is kay factors for business incubators to promote innovation performance development.
Samaeemofrad and Van (2018)	Multilevel of business incubator performance index	European countries	Business incubator contributing to innovation and support technology-based start-ups through access to networks, monitoring, knowledge development and dissemination, finance and administrative mobilization, and creation of exposure.
Silva and Cunha (2018)	Number of business incubators	Brazil	Business incubators promoting the

Authors	Proxy for business incubators	Research sample	Conclusion
	in firms' level		entrepreneurship and innovation, but lower-than-expected.
Battistella et al. (2018)	Performance and number of business incubators in firms' level	Italy	Business incubators contributing to innovation development by providing infrastructure, funding and entrepreneurs network etc.
Sun et al. (2020)	Number of business incubators in country level	China	The disparities between pure technical efficiency and scale efficiency may reduce innovation performance.
Lobosco et al. (2019)	Performance and number of business incubators in firms' level	Brazilian and Portuguese	Business incubator strategically facilitate the innovation and economic development.
Sanyal,and Hisam, 2020	Performance of business incubators	Oman	Business incubators contributing to innovation production and facilitate the economy development.
Games et al. (2020)	Multilevel index of business incubator	Indonesia	Business incubators promote innovation and enhancing competitiveness with policy support.
Kreusel et al. (2018)	Performance and number of business incubators	Germany	The private sectors precipitate into incubation activities may change the established theory framework for entrepreneurial and innovation activities.
Yamockul et al. (2019)	Performance of business incubators	Thailand	Business incubators contributing to innovation and its own performance development by providing management, support and precipitate services.
Wang (2017)	Number and performance of business incubators	China	Business incubator is the main drives of regional innovation.
Surana et al.	Multilevel index of	India	Business incubators

Authors	Proxy for business incubators	Research sample	Conclusion
(2020)	business incubator		support innovation and sustainable development.

Appendix 5

Research Method and Methodology