Regional Entrepreneurial Ecosystems in China

Yanzhao Lai* and Nicholas Vonortas**

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1. Introduction

In recent years the concept of the Entrepreneurial Ecosystem (EE) has drawn a lot of attention in the fields of entrepreneurship studies, economic geography and urban economics and gained popularity with policy decision makers (Autio et al., 2014; Stam and Spigel, 2016). Scholars have stressed the importance of interactions between elements of an entrepreneurial system and emphasized that entrepreneurial activity should be studied at the regional level and in close link with the regional innovation systems, stressing networks, learning and interactions (Cooke, 2001; Acs and Szerb, 2010; Audretsch and Belitski, 2016). However, our understanding of the institutional context of interactions, such as the role of universities and public research institutes, is still incomplete (Borissenko and Boschma, 2017). Moreover, EE studies have hitherto mostly concentrated on developed countries such as the United States and Europe; emerging economies like China – the focus of this paper – India or Brazil have been barely studied.

Prior entrepreneurship literature mostly concentrated on the behavior of individuals or firms (Shane and Venkataraman, 2000; Shane, 2003). More recently, scholars have pointed out that entrepreneurial activity needs to be studied in broader contexts such as their regional, temporal and social settings (Acs and Szerb, 2010; Szerb et al., 2013; Borissenko and Boschma, 2017). The individual action of creation, discovery and exploitation of entrepreneurial opportunities is considered a result of attitudes and opportunities given in a certain context where individuals work and live (Wright, 2014; Szerb et al., 2013). Empirical studies have shown the huge differences between regions within the same country or across countries in terms of entrepreneurial activities and scholars argue that regional entrepreneurial performance exhibit path dependent processes and systemic properties (Acs et al., 2014; Audretsch and Belitski, 2016). A holistic approach to entrepreneurship at various spatial scales has become necessary (Stam and Nooteboom, 2011; Acs et al., 2014; Autio et al., 2014), focusing on the role of the entrepreneurial ecosystem and the processes of how it is developed, adapted and sustained within local contexts (Szerb et al., 2013; Wright and Stigliani, 2012).

This paper develops a model capturing systemic factors that explain regional variation in

important facets of entrepreneurial activity in one important emerging economy, China. We bring to bear a unique dataset in terms of size and composition, comprising of statistical information on various aspects of the entrepreneurial ecosystems of 263 Chinese prefecture-level municipalities (out of a total of 334 in the country) from 2007 to 2015. To the best of our knowledge, only Guo et al. (2016) have until now used city-level data to study entrepreneurship in China, concentrating only on manufacturing. Other regional studies of Chinese entrepreneurship have tended to concentrate on province level (Qian, 2010; Yang et al., 2016).

The paper makes two main contributions. First, we extend theory to address a core criticism of the extant EE literature. While claiming long lists of factors that influence entrepreneurship, few studies have until now looked at entrepreneurship from a truly systemic and interdisciplinary perspective that identifies explicitly cause and effect and explains what kind of formal and informal institutions matter in the system (Qian et al., 2013; Acs et al., 2014; Borissenko and Boschma, 2017). We propose a two-stage structural model for the entrepreneurial ecosystem which identifies the factors which directly and indirectly influence regional entrepreneurial activities (new firm formation). Second, we provide an extensive empirical investigation of the effect of regional factors and institutions on the system using the aforementioned dataset of Chinese municipalities. We pay a lot of attention to the role of universities across a large set of Chinese regional entrepreneurial ecosystems and how local universities affect those ecosystems by generating new knowledge and providing human capital (Qian et al., 2013; Audretsch and Lehmann, 2005).

The empirical results confirm our systemic modeling approach: human capital, knowledge creation and absorption, risk finance and market demand are the main factors in regional entrepreneurial ecosystems that will promote local entrepreneurship directly. Moreover, and presence of high growth firms in the region, startup companies, university graduates, as well as city openness are significant predictors of both the regional stock of human capital and knowledge creation. Risk finance is found to be strongly associated with the presence of high growth firms and startups. Last, but by no means least, the study also underscored the strong positive impact of universities on regional human capital and

knowledge creation, thus indicating the crucial role of academic institutions in regional entrepreneurial ecosystems.

The rest of the paper develops as follows. The next section introduces a systems approach to entrepreneurship. Section 3 reviews the literature on the relationships between the regional factors, which lays the theoretical foundation for a two-stage model of entrepreneurial ecosystem we proposed. Section 4 explains the data and our analytical methods. Section 5 discusses the empirical results. Finally, the last section summarizes the main results and suggests policy implications.

2. Background on Entrepreneurial Ecosystems

In 1993, James Moore introduced the term "ecosystem" into economic analysis for the first time, proposing that businesses do not evolve in a "vacuum" and noting the relationally embedded nature of firm interaction with suppliers, customers and financiers (Moore, 1993). Similarly, entrepreneurial success does not take place in a vacuum. Cohen (2006) seems to have been the first to use the concept of entrepreneurial ecosystems, defining it as "… an interconnected group of actors in a local geographic community committed to sustainable development through the support and facilitation of new sustainable ventures". Entrepreneurs exist in the context of their particular geography – be that their local, regional, or national economy and society. Acs et al. (2014) pointed out that the individual entrepreneur is the core actor in building and sustaining the ecosystem; individual decision-making does not emerge in isolation from the local context where entrepreneurs run their business (Audretsch and Belitski, 2016).

Policy makers and scholars now recognize the relevance of a more holistic approach to developing entrepreneurial culture, greater access to knowledge, entrepreneurial finance, human capital and a supportive infrastructure to create an environment conducive to entrepreneurship (Isenberg, 2010; Samila and Sorenson, 2011; Rodriguez-Pose, 2013; Audretsch et al., 2015; Sorenson, 2017).

Taking a systemic view, the EE literature tends to move the entrepreneurship literature in

the direction of regional innovation systems (Cooke, 2001), mixing regions, innovation, networks, learning and interaction (Audretsch and Belitski, 2016). Both the theoretical and empirical research on entrepreneurial ecosystems have been growing (Borissenko and Boschma, 2017; Wright, 2014; Sorenson, 2017). Scholars tend to consider community entrepreneurial ecosystems that are likely defined by physical territorial boundaries. Acs et al. (2014) defined an entrepreneurial ecosystem as ‘‘a dynamic, institutionally embedded interaction between entrepreneurial attitudes, ability, and aspirations, by individuals, which drives the allocation of resources through the creation and operation of new ventures’’. Stam and Spigel (2016) define EE as “a set of interdependent actors and factors coordinated in such a way that they enable productive entrepreneurship within a particular territory”. Qian et al. (2013) define a regional system of entrepreneurship as “those economic, social, institutional and all other important factors that interactively influence the creation, discovery and exploitation of entrepreneurial opportunities”. There is widespread agreement that the local context research and systemic approach to understand entrepreneurial activity is still underdeveloped (Gustafsson and Autio, 2011; Szerb et al., 2013; Qian et al., 2013; Acs et al., 2014; Borissenko and Boschma, 2017).

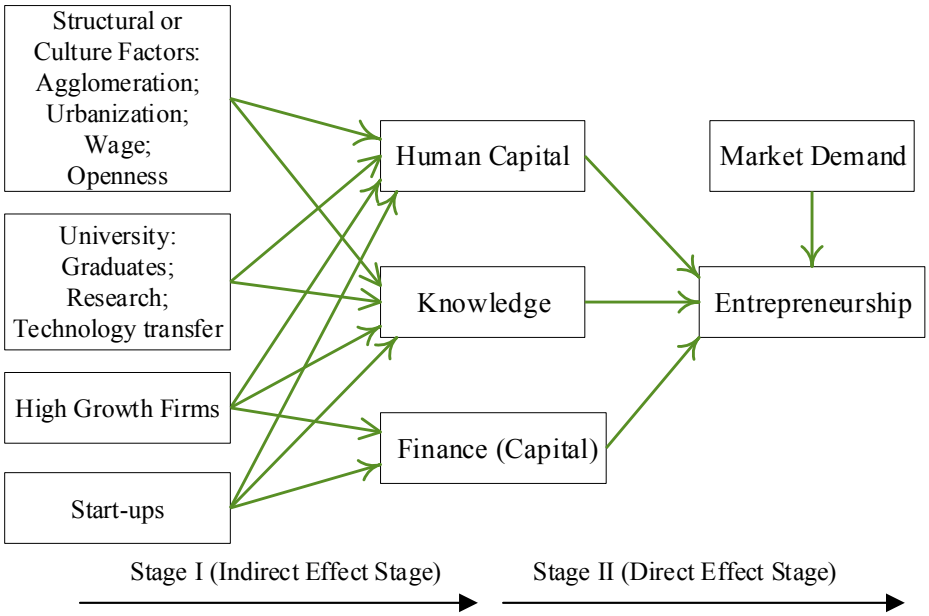
3. A Model of the Entrepreneurial Ecosystem

This section builds a two-stage model for entrepreneurial ecosystem to support our empirical analysis. The model has three goals: (a) identify the major factors that impact entrepreneurial activity; (b) provide a mechanism and explain how the system works, and capture the interconnectedness among factors; and (c) to facilitate empirical testing.

The entrepreneurship literature identifies at least 25 factors ranging from the labor market to public sector size that may influence the rate of entrepreneurial activity (Lundström and Stevenson, 2002; Henrekson and Stenkula, 2010). Our model distinguishes among two sets of factors, those that have direct impact on entrepreneurial activities and those that have indirect impact. Human capital, knowledge, finance, and market demand are argued to have direct impact on regional entrepreneurial activities. A set of structural and cultural factors, the

presence of research universities, high growth firms and start-ups are important factors that influence entrepreneurial activity in a region indirectly by impacting human capital, knowledge, and finance. The two-stage model purports to proxy entrepreneurial ecosystem dynamics (Figure 1). In this paper, we will mainly discuss the impact of supply-side factors (human capital, knowledge and finance) and assume market demand is exogenously determined. The rest of this section will discuss the two stages of the model in reverse order starting from Stage II (direct effect stage).

Figure 1. Conceptual framework of entrepreneurship ecosystem



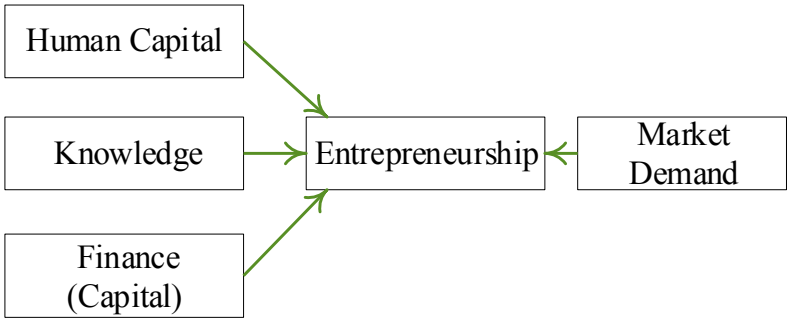
3.1 Stage II: Direct effect stage

Taking advantage of enhanced volumes of human capital, knowledge, finance and market demand, individual entrepreneurs will try to exploit opportunities by forming new firms. Meanwhile, 'entrepreneurial recycling' has successful entrepreneurs starting even more firms and taking on roles of funders and mentors of others. Failed firms provide resources for redistributed human and physical capital as well as for new entrepreneurs.

Entrepreneurial opportunities normally come from both the supply side and the demand side. On the supply side, to launch a new firm, an entrepreneur requires at least three kinds of

resources (Stuart and Sorenson, 2003; Sorenson, 2017). First, new firms typically require a new idea or foundational technology. Second, new firms need capital. Given the risks associated with capital-intensive high-technology firms, this frequently comes in the form of risk capital provided by actors such as angel investors or venture capitalists. Third, new firms require well-endowed employees. On the demand side, access to the market or the changes of market demand could also open up opportunities. For example, the growth of E-commence and the demand of transaction safety from online sellers and buyers lead to the formation of mobile and online payment firms such as PayPal and Alipay. Market demand, access to human capital, knowledge and finance are the four major factors in the Entrepreneurial Ecosystem that have direct impact on entrepreneurial activities (Figure 2).

Figure 2. Direct effect stage of the two-stage model of entrepreneurship ecosystem



3.1.1 Human Capital

The regional level of human capital is a decent predictor of localized entrepreneurial activity (Qian et al., 2013). In knowledge economy, the entrepreneurial opportunity mostly depends more on human capital than on physical assets (Eckhardt and Shane, 2010). The increase in human capital has significant implications for the individual's decision to leave the firm or university and start his/her own business. Davidsson and Honig (2003) found a positive relationship between human capital and the successful completion of the start-up process. Furthermore, entrepreneurs' human capital has positively impact on the survival rate of new entrants (Bates, 1990; Cooper et al., 1994), the growth of new technology firms (Colombo and Grilli, 2005) and the initial firm size of start-ups (Colombo et al., 2004). We hypothesize:

Hypothesis 1: Regions with higher levels of human capital will generate higher levels of entrepreneurial activity.

3.1.2 Knowledge

The endogenous growth model introduced by Romer (1986), and subsequently refined by Lucas (1990), has firmly established knowledge alongside the more traditional factors of physical capital and labor as a key factor of production with great impact on economic growth. Importantly, investment in knowledge is likely to be associated with large and persistent spillovers to other agents in the economy with the concomitant being increasing returns (Braunerhjelm et al., 2010). In parallel, scholars such as Audretsch (1995) and Acs et al. (2009) have introduced the knowledge spillover theory of entrepreneurship in an effort to explain how knowledge is converted into marketable innovations thus influencing economic growth. This theory identifies new knowledge as a source of entrepreneurial opportunities and considers entrepreneurship as a conduit of knowledge spillovers. It suggests that entrepreneurs function as a "knowledge filter" – filling the gap between new knowledge and innovation. New knowledge may be produced by various actors in an economy including incumbent firms, universities and public research institutes where for various reasons decision-makers find it difficult to justify the requisite investment to commercialize. Individual inventors take advantage of such opportunities by start new firms. (Audretsch and Lehmann, 2005). New knowledge thus represents one source of entrepreneurial opportunities; a higher stock of knowledge may be the precursor of more entrepreneurial activities (Acs et al., 2009; Qian et al., 2013).

University research and the research activities of incumbent firms are often identified as the main source of knowledge spillovers. The stock of produced knowledge is typically proxied by R&D input (investment) or measurable types of output (patents, publications) (Varga, 2000; Herderson, Jaffe, and Trajtenberg, 1998; Hall, Link, and Scott, 2003; Hulsbeck, Lehmann, and Starnecker, 2013). Knowledge as the public good has two critical properties:

non-excludability and non-rivalrousness, implying that the marginal productivity of knowledge does not need to diminish as it becomes available to more users (Stiglitz, 1999; Braunerhjelm et al., 2010). Of course, not all types of knowledge have the characteristics of a public good. Instead, most knowledge is partly excludable, leading to the presence of externalities such as knowledge spillovers. The degree of knowledge appropriability will affect innovative activities and entrepreneurship. For example, patents provide the exclusive right to inventors to commercially exploit the resulting innovations over a limited time period. On the one hand, patent applicants must disclose details of their invention, enhancing knowledge spillover; on the other hand, too many patents from incumbent firms may lower the effect of a given knowledge stock on entrepreneurship by increasing entry cost of potential entrepreneurs (Acs et al., 2009). We hypothesize:

Hypothesis 2a: Regions with higher levels of new knowledge will generate higher levels of entrepreneurial activity.

Hypothesis 2b: Regions with higher levels of new commercialized knowledge such as patent application activities will have an inverted U-shaped relationship with entrepreneurial activity.

3.1.3 Finance

The supply and accessibility of finance for new and small firms is an important condition for their growth and survival. Finance channels can take many forms such as bank loans, informal investors, business angels, venture capital, and crowdfunding. Small and newly established firms are more dependent on equity financing than large, well-established firms. For knowledge-based startups and entrepreneurial firms, business angels and venture capital are particularly important (Berger and Udell, 1998; Gompers et al., 2005; Kanniainen and Keuschnigg, 2004). Besides money, they provide various assistance and help to the generally inexperienced young business owners (Gompers, 1995). Samila and Sorenson (2011) pointed out that venture capital may encourage the founding of even more companies than it funds

directly by influencing would-be entrepreneurs' expectation and by engendering spin-offs. Entrepreneurs often enter the market first and pursue external financing later. If potential entrants assess their odds of success before attempting entry, then the availability of venture capital should have a positive effect on the evaluations of a number of capital-constrained would-be entrepreneurs. Meanwhile, venture capital may engender entrepreneurship through spin-offs—that is, through employees in incumbent firms leaving to start their own companies. Venture capital can encourage spin-offs through demonstration effect. Entrepreneurs often argue that they first thought of starting a company when they saw someone else do it, potentially even in a different industry (Sorenson & Audia, 2000). Seeing others engage in entrepreneurship can encourage would-be entrepreneurs to start firms. We hypothesize:

Hypothesis 3: Regions with access to higher levels of risk finance will generate higher levels of entrepreneurial activity.

3.1.4 Market Demand

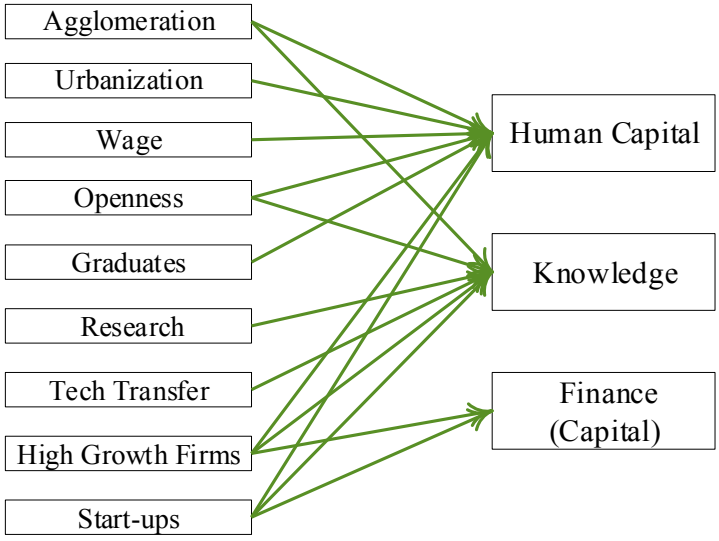
Entrepreneurial opportunities come from both the supply side and the demand side. The discovery of entrepreneurial opportunity requires the ability to recognize changes on either side. The opportunity discovery process has to do with the exploration of existing and latent markets. Higher market demand leads to opportunities for firm entry and, in turn, greater variety of products due to competition and attempts for product differentiation. Better correspondence to the diversity of consumer preferences influences the allocation of resources as producers try to respond to the preferences and purchasing habits of consumers (Eckhardt and Shane, 2010). Demand changes from exogenous shifts in culture, perception, tastes, or mood can open up opportunities (Kirzner, 1997; Schumpeter, 1934). We hypothesize:

Hypothesis 4: Regions providing access to larger markets (regional and beyond) will generate higher levels of entrepreneurial activity.

3.2 Stage I: Indirect effect stage

The first (indirect effect) stage of the model looks at the factors and institutions within the regional context that shape the stocks and flows of human capital, knowledge, and finance in the region. Such factors are argued to be affected by regional structural factors (agglomeration, urbanization, wages), general cultural factors (openness), university-related factors (students, research, channels of knowledge transfer), and entrepreneurial culture shaped by the existence of high growth firms (HGFs) and start-ups in the region (Figure 3).

Figure 3. Indirect effect stage of the two-stage model of entrepreneurship ecosystem



3.2.1 Factors affecting regional human capital

Economists, geographers and regional scientists have investigated the role of several important geographically mediated factors in determining the quantity and quality of human capital in specific locations. *We hypothesize that seven factors will be positively associated with regional human capital:*

- **Agglomeration:** as Glaeser (1999) pointed out, young and well-educated people tend to move to those cities where they may benefit from interpersonal learning. Demographic and economic structures that facilitate interactive learning can better attract human capital.

In this sense, agglomeration is likely to be a factor positively associated with human capital, in that it indicates easy access to other people and frequent face-to-face communications through which knowledge can spill over both between economic agents and between firms (Glaeser, 1999; Qian et al., 2013);

- **Urbanization:** natural amenities and more generally the quality of life in the region is considered as one of crucial factors attracting talent (Glaeser et al., 2001; Florida et al., 2008). Higher urbanization rate has been linked to higher quality of life in the focal region (Winters and Li, 2017). Talent tends to congregate in cities, bringing along innovative and entrepreneurial activities. Urban areas are associated with higher stock of human capital (Qian, 2010);
- **Wages:** wage difference cross regions could affect labor mobility especially for developing country such as China (Harris and Todaro,1970; Zhao, 2004). The region with higher wages will be more likely to attract better skilled labor;
- **Openness:** the city's openness and acceptance of diversity are expected to attract more talented people. An open city with more cultural diversity provides a platform for greater networking and communications between agents of different background and experiences, setting up a virtuous cycle of attraction of further talent to the region (Florida, 2004; Glaeser, et al. 2010).
- **Graduates:** one of the major contributions of local universities to entrepreneurship ecosystem besides research is university graduates. As the "human capital factories", universities are one of the major technological assets of a region (Mason and Brown, 2014). Feld (2012) argued that the most important contribution that universities make to a start-up community is its students who bring new ideas. Acs and Armington (2006) provide empirically evidence to show that the share of college graduates is positively associated with new firm formation rates at the regional level. Audretsch and Lehmann (2005) also demonstrated a positive relationship between university students and knowledge-based startups in Germany.
- **High Growth Firms:** high growth firms play an extremely important role in the economy and are crucial for job creation (Coad et al., 2014). A large number of empirical studies

have investigated the job contribution of HGFs. Storey (1994) found that 4% of firms create 50% of the jobs and 6% of all firms generated 49.5% of all new jobs created by existing firms in UK during 2002–2008 (NESTA, 2009). Job opportunities in a region would, of course, be one of the major attractions of skilled human capital. For example, Acs and Mueller (2008) have pointed out that regions with more high growth firms create more jobs and attract talent to metropolitan areas in United States.

- **Start-ups:** a steady stream of new firm creation will not only bring more job opportunities but also expand regional entrepreneurial culture. In turn, job opportunities and entrepreneurial culture will attract more talented people to the region. Successful start-ups can influence individuals' expectations for their own odds of success (Sorenson and Audia, 2000). To the extent that people see successful entrepreneurs as salient examples, they will perceive their probability of success as higher (Bosma et al., 2012). Even when these start-ups fail, they can provide resources through redistributed capital, entrepreneurs, and skilled personnel (Mason and Brown, 2014).

3.2.2 Factors affecting regional knowledge

New knowledge plays a crucial role in the entrepreneurial ecosystem. Scholars have investigated the geographically mediated factors in determining regional knowledge production. *We hypothesize that six factors will be positively associated with the creation/circulation of new knowledge in a region:*

- **Agglomeration**: agglomeration, a term used here to signify the clustering of firms and people, provides the physical proximity facilitating the flow of knowledge and ideas. Short distance brings people together, favors information contacts, and facilitates the exchange of knowledge. The larger the distance between agents, the less the intensity of the positive knowledge externalities, and the more difficult it becomes to transfer knowledge (Boschma, 2005). This seems to continue even in the era of widespread use of information technology, the reason being that a very significant share of what is being exchanged is of tacit nature;

- **Openness**: social diversity may directly influence the process of knowledge creation in the sense that a diversified population with different knowledge and cultural backgrounds encourages new combinations of existing knowledge which, in a classic Schumpeterian fashion, lead to the birth of further new knowledge (Qian et al., 2013). Empirical work has also shown that human capital mobility contributes to new knowledge creation by increasing the diversity of knowledge, skills and cultures in a region (Crescenzi et al., 2007)
- **Research:** a quite extensive literature has pointed out the role of universities as influential agents in regional innovation and entrepreneurial systems. Universities operate as both generators and distributors of valuable knowledge (Czarnitzki et al., 2016; Etzkowitz and Leydesdorff, 2000; Cowan and Zinovyeva, 2013; Qian et al., 2013). Jaffe (1989) and Feldman (1994) provided early evidence that regional corporate innovative activities respond positively to spillovers from university research. Their findings have been supported repeatedly by more recent research.
- **Channels of Knowledge Transfer:** in recent years universities have become increasingly entrepreneurial and the rate of technology commercialization at universities has been growing substantially (Bercovitz and Feldman, 2006; Link et al., 2015). More channels of knowledge transfer facilitate industry's access to new knowledge at lower R&D cost by collaborating with universities (Agrawal, 2001; Looy et al., 2011), enhance the absorptive capacity of both sides (universities, firms) for new knowledge, and may generate more knowledge spillovers from academia (Audretsch and Lehmann, 2005).
- **High Growth Firms:** even though HGFs do not necessarily operate in high-tech sectors (Daunfeldt et al., 2015; Acs, 2010), innovation is of crucial importance for a handful of 'superstar' high-growth firms (Coad and Rao, 2008). Sales growth normally leads to more diversified market demand and HGFs are expected to widen or deepen the private sector's technological competences to meet these demands with efficient innovation system (Coad et al., 2014). Meanwhile, more resources will come along when firms grow fast. Easier access to finance will provide necessary human capital and facilities that required for R&D.

- **Start-ups:** innovations are often brought to the market and dissipated throughout the economy by young entrepreneurial firms (Lerner and Tåg, 2013). Acs and Audretsch (1988) early on showed that small firms contributed almost half of the innovation in their sample. New smaller firms also choose more risky product introduction strategies compared with more established firms (Aron and Lazear, 1990). They fail more often, but they also successfully bring riskier high-impact innovations to the market more frequently. Moreover, regions with large populations of small and young firms produce deeper pools and denser network of innovation that give people easier access to the required knowledge and help generate more innovation (Sorenson, 2017)

3.2.3 Factors affecting regional finance

There is no disagreement that finance is a central pillar of the entrepreneurial ecosystem. A long stream of literature has investigated the factors determining the supply of money and investment in a region, basically differentiating between institutions, the incentives for the supply of capital, and the demand for capital (Gompers and Lerner, 1999, 2001). *In this paper we take a narrow view and focus on the demand for capital under the implicit assumption that supply-side constraints have eased up in emerging economies in recent decades. We hypothesize that two demand-side factors related to entrepreneurship will be positively associated with the availability of investment finance in a region:*

- **High Growth Firms:** in a pioneering study, Jeng and Wells (2000) examine the factors that influence venture capital fundraising in 21 countries. They reach similar conclusions to Black and Gilson (1998): the strength of the initial public offering (IPO) market – long understood as a core exit mechanism for risk capital (Lerner and Tåg, 2013) – is an important determinant of venture capital commitments. HGFs have become for attractive to equity investors or banks, because holding periods for VCs are shortened (Michelacci and Suarez, 2004) and HGFs will more likely and sooner go to IPO. The venture capitalist may see other successful investment on HGFs as similar to themselves and perceive their probability of success as higher. We argued that the city with more HGFs or IPO firms

will increase venture capitalist's expected return of their investment and attract more VCs to the region.

- **Start-ups:** similarly, to other investors, venture capitalists choose to place money in financial assets that could generate significant monetary returns (Samila and Sorenson, 2011). Gompers and Lerner (2010) have argued that the willingness of highly skilled managers and engineers to work in entrepreneurial environments is one of the major factors that determine the supply of equity for entrepreneurial firms in the economy. Entrepreneurial culture would encourage more individuals to start their own business and lead venture capital to take hold in the region (Mason and Brown, 2014).

4. Empirical Evidence

For the past three decades, the process of economic reform and transformation in China has unleashed the power of entrepreneurship which is increasingly critical for the country's economic development (Guo et al., 2016). Before the Open-Door Policy, entrepreneurship in China only existed on a very small scale in the form of the black market and underground economy (Harding, 1993). In 1980, four southern cities were approved by the State Council as Special Economic Zones (SEZ) and were granted entrepreneurship supportive policy measures such as private property rights protection and tax benefits (Wang, 2013). The subsequent success of these four cities encouraged the government to expand this experiment into other provinces and let other regions gradually embrace the market economy and the concept of entrepreneurship (Cai, 2008; Xu, 2011). In 2000, total revenues earned by Chinese state-owned industrial enterprises and those in the non-state-owned sector Chinese private enterprises were roughly the same at about 4 trillion yuan each. By 2013, while total revenues of state-owned companies had risen just over six-fold, while revenues in the non-state sector had risen by more than 18 times (Forbes, April 5th 2016).

During the 1990s, the government launched reforms of the township and village enterprises and of the state-owned enterprise sector. Most township and village enterprises were privatized, de jure or de facto (Wei et al., 2017). By 2011, the township and village

enterprise sector had almost disappeared (Xu and Zhang, 2009). The number of state-owned firms declined from 3.2 million (8.64 percent of the total number of firms) in 2007 to 2.29 million (3.02 percent of the total) in 2015 (Table 1). The much larger drop in the number of state-owned enterprises was part of a deliberate policy of "grasping the large and letting go of the small"—that is, privatizing small state-owned enterprises and consolidating bigger ones (Hsieh and Song, 2015). China is now the world's second-biggest economy, but economic development has been extremely unbalanced across regions. Some provinces such as Shanghai would rank fairly high in the global league; the poorest province, Guizhou, has an income per head close to that of India (Economist, 2016). The unbalanced economic development and entrepreneurship across regions in China provides an opportunity to understand how the variation of regional factors affect entrepreneurial ecosystems.

Table 1. Number of Firms in China (2007–2015)

	Total Firms (10000)	Private Firms (10000)	Private (%)	State-owned Firms (10000)	State-owned (%)	Foreign Firms (10000)	Foreign (%)
2007	3705.50	3344.58	90.260%	320.28	8.643%	40.64	1.097%
2008	3888.79	3574.75	91.924%	270.55	6.957%	43.49	1.118%
2009	4240.11	3937.52	92.864%	259.16	6.112%	43.43	1.024%
2010	4589.37	4298.39	93.660%	246.45	5.370%	44.53	0.970%
2011	5009.59	4724.15	94.302%	240.79	4.807%	44.65	0.891%
2012	5425.87	5144.99	94.823%	236.82	4.365%	44.06	0.812%
2013	5964.13	5690.15	95.406%	229.38	3.846%	44.60	0.748%
2014	6803.34	6530.43	95.989%	226.48	3.329%	46.43	0.683%
2015	7593.75	7316.16	96.344%	229.47	3.022%	48.12	0.634%

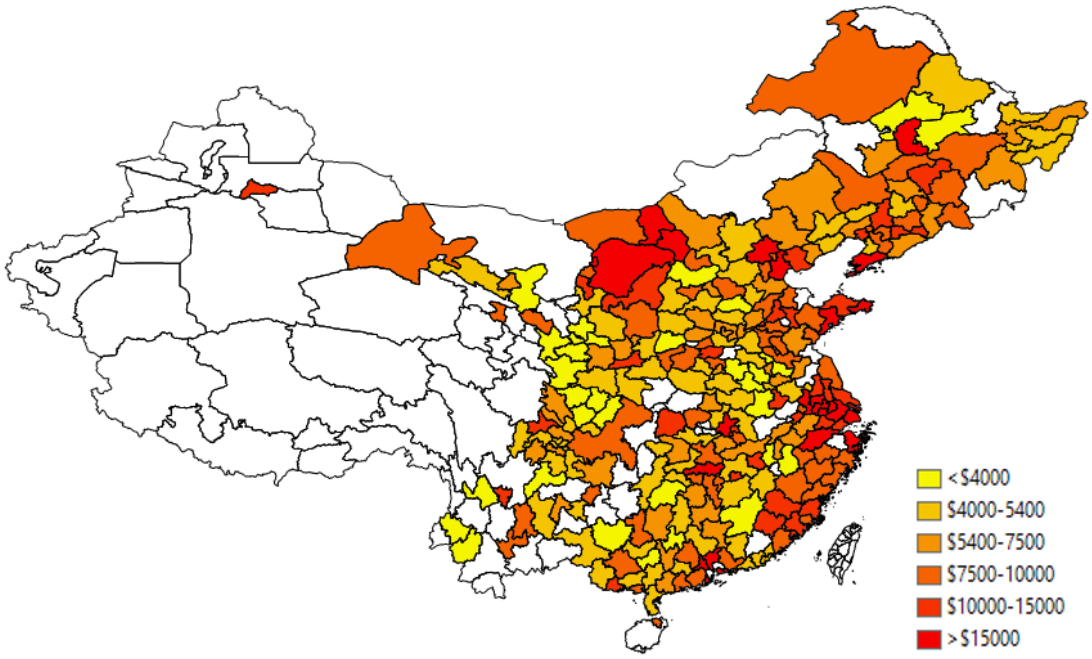
Source: Tabulated by authors based on China State Administration for Industry and Commerce Yearbook from 2007 to 2015; Note: Firms ownership classification is based on the ownership information on firm registration. Foreign-invested firms include both fully foreign-owned and sino-foreign joint ventures. All firm ownership types other than "private" or "foreign" are grouped in "state-owned."

4.1 Data

We construct a panel dataset for the time period 2007 to 2015 by matching the location of new firms to the location of risk finance companies (VCs) and other statistical information such as patenting activity and university technology transfer at the city level. This dataset

covers 263 Chinese prefecture-level municipalities[1](Figure 4), 78.74% of China's prefecture-level municipalities (334 in total) and 1.175 billion population (87.7% of total population).

Figure 4. Cities by 2015 GDP per capita in US dollars



Source: The GIS map is based on the data from China city statistical yearbook 2015;
Note: The information of white color areas is unavailable.

Seven main data sources were utilized to construct the dataset:

- National Company Credit Information System (NCCIS): China's State Administration of Industry and Commerce (SAIC) has launched this online system that covers companies registered with the SAIC or local AICs in the 31 provinces, autonomous regions and municipalities across the country. The system provides company information such as name, year of establishment, address, business sector, shareholders and capital contributions, etc.
- China city statistical yearbooks: The National Bureau of Statistics provides 295 prefecture-level municipality data including GDP, FDI inflows, permanent and residential population, area size, number of university faculty, number of college students, etc.

[1] The administrative system of China consists of five hierarchical levels of government: (1) central; (2) provincial; (3) prefecture; (4) county and (5) township.

- Asset Management Association of China: Lists 7211 Private Equity and 1528 Venture Capital companies providing information such as company name, date of establishment, and location.
- Province Intellectual Property Office (PIPO): PIPO from 31 provinces publish city-level monthly statistical reports of patenting activity of prefecture-level municipalities in the province.
- Higher Education Statistical Survey: The surveys conducted by Ministry of Education contains the R&D information about 651 public universities in China. The information includes university publications, number of technology transfer contracts, funding resources, revenue from patent licensing and other 23 indicators relevant to R&D.
- CSMAR database: Provides information on all Chinese listed companies including fundamentals, pricing, capital structure, corporate governance, transactions, events, news, and ownership data.
- Sixth National Population Census: Also referred to as the 2010 Chinese Census which covers educational attainment, age and sex, migration/geographic mobility and other population composition and demographics information.

4.2 Empirical Model

The models illustrated in Figures 1-3 have suggested two stages of an entrepreneurial ecosystem. Equation (1) below corresponds to Stage II of the model considering entrepreneurial activity as a function of human capital, knowledge, risk finance, and market demand. The SEZ dummy variable and GDP per capita variable are introduced as controls for regional policy and the level of regional economic development respectively. Equations (2), (3) and (4) correspond to Stage I, reflecting the factors affecting regional human capital, knowledge and risk finance. Such factors include a set of structural (agglomeration, urbanization and regional wage) and cultural factors (regional openness), and the presence of research universities, high growth firms and startups in the locality. Meanwhile, there are other unobservable factors that influence Stages I and II. To capture such city-specific differences in both stages, we estimate a reduced form equation with a fixed-effect panel regression

technique. An F-test rejects the null hypotheses of all fixed effects jointly being zero, thus leading to the adoption of a fixed-effect regression technique.

Stage II: Direct Effect Stage

$$\text{Entrepreneurship}_{it}=\beta_1\text{Human Capital}_{it}+\beta_2\text{Knowledge}_{it}+\beta_3\text{Finance}_{it}+\beta_4\text{Market Demand}_{it}$$
$$+\theta_{\text{Entrepreneurship, i}}+\varepsilon_{\text{Entrepreneurship, it}} \quad (1)$$

where $\text{Entrepreneurship}_{it}$ is the value of Entrepreneurship for city *i* at time *t*; $\varepsilon_{\text{Entrepreneurship,it}}$ is the time-varying error terms and i.i.d; $\theta_{\text{Entrepreneurship,i}}$ is the unobservable time-invariant fixed effects.

Stage I: Indirect Effect Stage

$$\text{Human Capital}_{it}=\alpha_1\text{Agglomeration}_{it}+\alpha_2\text{Urbanization}_{it}+\alpha_3\text{Openness}_{it}+\alpha_4\text{Wage}_{it}+\alpha_5\text{Graduates}_{it}$$
$$+\alpha_6\text{HGF}_{it}+\alpha_7\text{Startup}_{it}+\theta_{\text{Human capital, i}}+\varepsilon_{\text{Human capital, it}} \quad (2)$$

$$\text{Knowledge}_{it}=\gamma_1\text{Agglomeration}_{it}+\gamma_2\text{Openness}_{it}+\gamma_3\text{Research}_{it}+\gamma_4\text{Channels of Knowledge Transfer}_{it}$$
$$+\gamma_5\text{HGF}_{it}+\gamma_6\text{Startup}_{it}+\theta_{\text{Knowledge, i}}+\varepsilon_{\text{Knowledge, it}} \quad (3)$$

$$\text{Finance}_{it}=\delta_1\text{HGF}_{it}+\delta_2\text{Startups}_{it}+\theta_{\text{Finance,i}}+\varepsilon_{\text{Finance,it}} \quad (4)$$

where $\text{Human Capital}_{it}$, Knowledge_{it} and Finance_{it} are the value of human capital, knowledge and finance for city *i* at time *t*; $\varepsilon_{\text{Human Capital,it}}$, $\varepsilon_{\text{Knowledge,it}}$ and $\varepsilon_{\text{Finance,it}}$ are the time-varying error terms and i.i.d; $\theta_{\text{Human Capital,i}}$, $\theta_{\text{Knowledge,i}}$ and $\theta_{\text{Finance,i}}$ are the unobservable time-invariant fixed effects.

4.2 Variables and Measures

Table 2 summarizes the utilized measures for all exogenous and endogenous variables along with the data source. The following part of this section elaborates on these measures.

Table 2. Variable description

Factor	Variables	Variable description	Data sources
Entrepreneurship	New Firms	Number of new firms per 10000 population	NCCIS
	New Tech-based Firms	Number of new technology-based firms per 10000 population	NCCIS
Human Capital	Human Capital	Percentage of population holding a bachelor's degree	Sixth National Population Census
Knowledge	Patent	Number of patent application per 10000 population	Province Intellectual Property office
	Pubilication	Number of university population per 10000 population	Higher Education Statistical Survey
Finance	Venture Capital	Number of Venture Capital companies per 10000 population	Asset Management Association
Market Demand	Demand	GDP of the city	China city statistical yearbooks
University	Graduates	College students enrollment divided by 4 per 10000 population	China city statistical yearbooks
	Research	Number of university facutly members per 10000 population	Higher Education Statistical Survey
	Channels of Knowledge Transfer	Number of Tech transfer contacts from university per 10000 population	Higher Education Statistical Survey
High Growth Firms	High Growth Firms	Number of publicly listed firms per 10000 population	CSMAR
Start-ups	Start-ups	Number of firms formed in the last two years per 10000 population	NCCIS
Structural Factors	Agglomeration	Population per square Kilometers	China city statistical yearbooks
	Urbanization	Percentage of the population living in urban areas	Sixth National Population Census
	Wage	Average wage in logs	China city statistical yearbooks
Culture Factor	Openness	Openness index	Sixth National Population Census
Government	SEZ	Dummy variable which established national SEZ is 1 and 0 otherwise	Minstry of Science and Technology
Control	GDP	GDP per capita in logs	China city statistical yearbooks

4.2.1 Dependent variable: Entrepreneurship

Entrepreneurship is the dependent variable and the central item this paper tries to explain and understand. Following other empirical studies (Acs and Armington, 2006; Qian et al., 2013), entrepreneurship is measured through the new firm formation rate calculated by

dividing the number of total firm births in the city by its total population. To capture the dynamic of entrepreneurial ecosystem, the measures of new firm formation rates at two levels are tested in this paper. The first one, called the general entrepreneurship, uses the new firm formation rate for all industries as a measure for entrepreneurship. The second one, called the tech-based entrepreneurship, adopts the new firm formation rate for technology-based industries as the measure for entrepreneurship. The China Industry Classification system is widely used in the collection of official statistical data on companies and organizations throughout Mainland China. As defined in Chinese national standard number "GB/T 4754", the China Industry Classification system defines three industries: primary, secondary and tertiary. These three industry levels are subsequently broken down into 20 industries groups[2] and 95 industry categories. Due to the data limitation, we could only access the information to 20 industries group. Therefore, we define “Scientific research, technical service and geologic examination industry” and “Information transfer, computer service and software industry” as technology-based industry.

4.2.2 Independent variables

- **Knowledge:** Academic and scientific research, the R&D of incumbent firms are often identified as the main source of knowledge spillovers. Publications and patents are widely employed as measures for knowledge (Varga, 2000; Herderson, Jaffe, and Trajtenberg, 1998; Hall, Link, and Scott, 2003; Hulsbeck, Lehmann, and Starnecker, 2013). In this study, we use the number of new academic publication relative to population as the measurement of new knowledge of each city and the number of newly patent application per capita as the measurement of new commercial knowledge.
- **Human Capital:** Human capital, defined as knowledge and skills embodied in people (Schultz, 1961), is traditionally measured in terms of educational attainment. A typical

[2] Twenty industries groups: 1. Farming, forestry, animal husbandry and fishery; 2. Mining Industry; 3. Manufacturing Industry; 4. Production and supply of electric power, gas and water; 5. Construction industry; 6. Traffic, storage and mail business; 7. Information transfer, computer service and software industry; 8. Wholesale and retail trade; 9. Accommodation and food industry; 10. Finance industry; 11. Realty business; 12. Leasehold and business service industry; 13. Scientific research, technical service and geologic examination industry; 14. Water conservancy, environment and public institution management; 15. Neighborhood services and other service industry; 16. Education; 17. Sanitation, social security and social welfare industry;18.Cultural, physical and entertainment industry; 19. Public administration and social organization; 20. International organizations

measure is the percentage of adults (age 25) with a bachelor's degree or above (Florida, 2002; Acs and Armington, 2006; Qian et al., 2013). Similarly, our measure of human capital is the percentage of population with a bachelor's degree or above.

- **Finance:** Before 1999, venture capital was largely unknown to Chinese. 2007, China's revised Partnership Enterprise Law cleared the path for the establishment of western-style VC funds based on limited partnership, triggering the rapid formation of private VC firms. The amount of money that is pledged to venture capital funds in the region will be the ideal measurement of risk finance of the city. However, due to the issues such as non-disclosure agreements in venture capital industry, it is very hard to access the information of the actual amount of each investment. Chen et al. (2010) found out that the region with more venture capital firms will have more venture capital-backed investments. Based on their findings, our analysis adopted the number of VC office per capita as the measure of finance of the city.
- **Market Demand:** The factor Market Demand aims at describing the market available to potential entrepreneurs. Larger markets allow firms to develop and benefit from economies of scale and could potentially give incentive to entrepreneurship and innovation (Annoni and Kozovska, 2013). Following the similar measurement from previous study (Stam, 2017), we introduce two proxies as the measures of market demand: the GDP of the focal city.
- **High Growth Firms:** There is lack of consensus about the definition of high-growth firm among previous studies (Acs, 2010; Coad et al., 2014). For example, one proxy of HIE was proposed by Acs, Parsons, and Tracy (2007) and they define a high-impact firm as an enterprise in which sales have doubled over the most recent 4-year-period and which has an employment growth quantifier of 2 or greater over the same period. Plummer, Acs (2010) argued that another proxy measure of HGFs is IPO firms. High growth rate is one major requirement to list on the Shanghai and Shenzhen Stock Exchange Board[3]. With the access of public listed companies' information from 1991 to 2017, we could identify

[3] Chinese Securities and Exchange Commission (SEC) require new applicant for listing on the Shanghai and Shenzhen Stock Exchange Board shall either (a) have generated profits for the latest two consecutive years, in a cumulative amount of not less than RMB 10 million or (b) have generated profits for the immediately preceding year, with a net profit of not less than RMB 5 million and an operating income for the immediately preceding year of not less than RMB 50 Million, the annual growth rate for the latest two years of not less than 30%.

number of firms that list on Shanghai and Shenzhen Stock Exchange Board from 2007 to 2015. In this study, we define high growth firms as the companies in the city which are listed on Shanghai and Shenzhen Stock Exchange Board.

- **Start-ups:** There is also lack of consensus about the definition of start-ups by firm's age. For example, Criscuolo et al. (2007) define start-ups as the firm of age from 0 to 2 in their OECD report. Yli-Renko et al. (2001) define young technology-based firms as the firm of age from 1 to 10. Due to the fact that new Chinese Company Law only became effective on January 1, 2006[4] and our data covers from 2007-2015. In this study, we define start-ups as the firms of age from 0-2.
- **Agglomeration:** Agglomeration or clustering of firms and people provides the physical proximity which facilitates the flow of knowledge and ideas among people (Delgado et al., 2010; Porter,1998; Qian et al., 2013). We use population density as a proxy for agglomeration. A higher population density means easier access to other people and more opportunities for face-to-face communications. Agglomeration is calculated as the population per square kilometers
- **Openness:** The Hukou system (or the household registration system) is used to control the flow of population by the Chinese government. Individual's Hukou determines which city or county this person belongs to and whether she/he has rural or urban status. Qian (2010) applied the ratio of the permanent population (citizens with Hukou) to residential population as the measurement of openness. However, we found out that some of the cities the residential population is more than household population (implies people left the city but still keep their Hukou in the city) which could lead the original measurement be negative which is problematic for our estimation. Hence, we built a new index to measure city's openness. The method is below:

  1) RH=residential population/household population. The greater RH is, the more open the city. Technically, the range of the RH index should be $(0, \infty)$. The RH index was

[4] On October 27, 2005, the People's Republic of China adopted a new Company Law. This law became effective on January 1, 2006.' The New Company Law replaces the Old Company Law, which had been adopted in 1993. The New Company Law is a complete revision of the old law. Almost nothing of the old law survived the revision. Drafters estimate approximately ninety percent of the provisions of the new law are unique. The New Company Law governs two types of corporations: limited liability companies and joint stock companies. The changes to limited liability companies are especially important to foreign investors in China because the statutes governing foreign direct investment in China require foreign investors to operate through a Chinese limited liability company (Dickinson, 2007).

normalized as a result;

2) $Openness(i) = 1 - \frac{Max(RH_i) - RH_i}{Max(RH_i) - Min(RH_i)}$, where i represent city i. The range of Openness index is (0,1). The closer to 1, the city is more open.

- **University:**

1) **Graduates:** cities with more universities and university students present potential advantages in human capital attraction. The university therefore is hypothesized to play a crucial role in the distribution of human capital. Due to the data limitation, we could only access to the data of university enrollment of each city. The proxy of university graduates in this paper is the university enrolled students divided by 4. The variable of university graduates is measured by the university enrolled students divided by local population.

2) **Research:** The faculty in universities plays a leading role in all these aspects and accordingly the size of the faculty may determine the extent to which universities facilitate regional innovative and entrepreneurial activity. The university research variable is therefore measured by the number of university faculties per capita.

3) **Channels of Knowledge Transfer**: since early 2000s, the Chinese leadership hopes to use the leverage that can be gained from research universities to acquire innovation and technological capability in more of its industrial sectors. As such, these universities have acquired a new mission in addition to teaching and research—the third mission—as key agents for commercializing technology. Entrepreneurial university will more likely collaborate with industry and generate new knowledge and entrepreneurial opportunity (Agrawal, 2001; Looy et al., 2011). The number of university technology transfer contracts per capita is defined as the measurement for channels of knowledge transfer.

4.2.3 Control Variables

Government: property rights, a properly functioning financial system, dispute resolution mechanisms and other market economy norms are crucial for regional entrepreneurship (Acs

and Virgill, 2010). Establishing special economic zones (SEZ) were considered a test base for liberalization of trade, tax and other policies nationwide for the Chinese government. Through the SEZ initiative, the Chinese government guarantees to protect their assets, accrued profits and other rights. This was a very important commitment, since there was no constitutional protection of private property rights outside the SEZs until a constitutional amendment in 2004 (Wang, 2013). Another benefit of SEZs for firms is tax incentive. The companies in the SEZ would enjoy 5-year or even longer time tax holiday[5] if they qualified as "high and new technology enterprises" (New Oriental NYSE:EDU SEC filings, 2010). We use the dummy variable SEZ to identify the government effect in the analysis of direct-effect stage, where 1 represents the existence of national SEZ and 0 otherwise. The definition of variable ***Urban***, ***Wage,*** and ***GDP*** is provided in Table 2 and descriptive statistics of all variables are shown in Table 2.

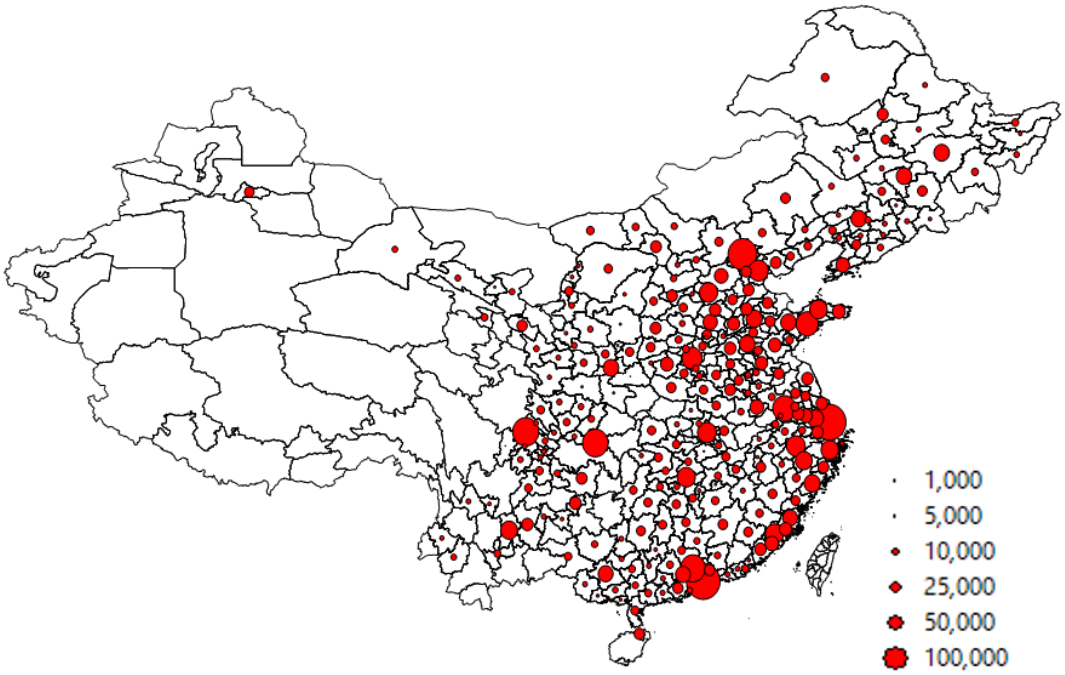
5. Results

Figure 5 shows two maps of the number of new firms and new technology-based firms in 2015. A larger dot indicates a larger number of new firms and new technology-based firms in the city. As expected, the unbalanced economic development cross regions in China also leads to huge regional variation of entrepreneurial activity. In our dataset, 9,241,414 new firms and 520,869 new technology-based firms are identified in 2015. As displayed in Panel A of Figure 1, in 2015 Shenzhen had 342,863 new firms making it the most entrepreneurial city in China. Other cities such as Ya'an (in the southwest province, Sichuan) only had 1500 new firms. The regional variation of entrepreneurial activity across regions becomes even bigger when we focus on the newly technology-based firms. As displayed in Panel B of Figure 1, the top 10 cities (out of 263) had 267,222 new technology-based firms in 2015, which was 51.3

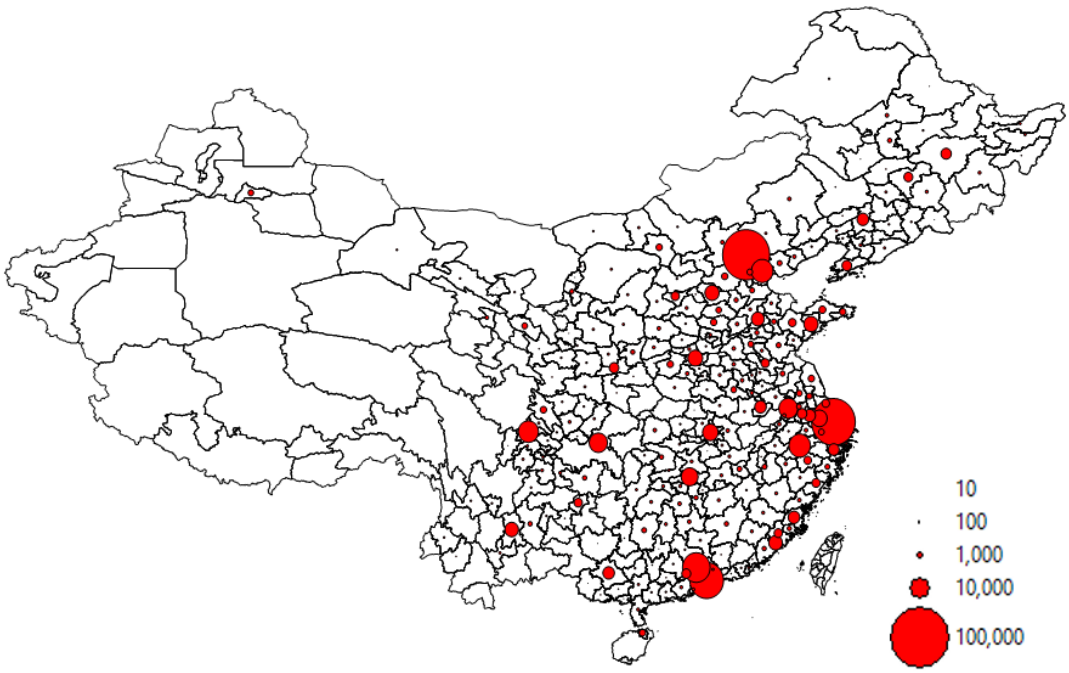
[5] On March 16, 2007, the National People's Congress passed the Enterprise Income Tax Law, or the EIT Law, which took effect on January 1, 2008. The EIT Law applies a uniform 25% enterprise income tax rate to both foreign-invested enterprises and domestic enterprises. On April 21, 2010, the State Administration of Taxation issued the Circular Regarding Further Clarification on Implementation of Preferential EIT Rate during Transition Periods, or "Circular 157." According to Circular 157, if an enterprise is qualified as a "high and new technology enterprise" and is also in a tax holiday period, including "2-year exemption plus 3-year half rate," "5-year exemption plus 5-year half rate" and other tax exemptions and reductions, then it would be entitled to pay tax, at its own election, at the lower of 15% or 50% of the specific tax rate set for the transitional period of preferential tax treatment (i.e., 18% in 2008, 20% in 2009, 22% in 2010, 24% in 2011 and 25% in 2012).

percent of the total number of new technology-based firms in China. All empirical analysis is based on data for these 263 cities in China during the period 2007 to 2015. Summary statistics are listed in Table 3.

Figure 5. The distribution of New Firms in 2015



Panel A: number of new firms



Panel B: number of new tech-based firms

Regression results of direct-effect stage and estimating the entrepreneurship rate (new firms and new tech-based firms) for 2007–2015 are presented in Tables 4 and 5. To capture the dynamic of entrepreneurial ecosystem, the measures of new firm formation rates at two levels are tested in this paper. The first one, called the general entrepreneurship, uses the new firm formation rate for all industries as a measure for entrepreneurship. The second one, called the technology-based entrepreneurship, adopts the new firm formation rate for technology-based industries as the measure for technology-based entrepreneurship.

Table 3. Descriptive statistics

VARIABLES	N	Mean	S. D	Min	Max
New firms	2,200	36.55	29.53	0.158	325.5
Startups	2,200	53.93	42.78	0.152	576.4
New Tech-based firms	2,200	2.449	4.017	0	105.3
GDP	2,200	1.873e+07	2.572e+07	848,176	2.512e+08
GDP per capita	2,200	10.33	0.652	8.189	12.24
Openness	2,200	0.138	0.0644	0	1
Urban	2,200	0.338	0.224	0.0435	1
Wage	2,200	10.45	0.368	9.368	11.64
Density	2,200	467.9	491.6	5.104	5,548
Graduates	2,200	163.2	203.4	0	1,288
Faculty	2,200	9.232	11.77	0	76.97
Publication	2,200	3.529	7.041	0	62.70
Tech transfer	2,200	0.0475	0.175	0	2.538
Patent	2,200	8.714	15.24	0	161.5
HGF	2,200	0.0126	0.0212	0	0.191
VC	2,200	0.00237	0.00894	0	0.128
Human Capital	2,200	0.0922	0.0564	0.0164	0.405
SEZ	2,200	0.307	0.461	0	1
Number of City	263	263	263	263	263

As the Table 4 shows, the positive and statistically significant coefficients of the human capital and venture capital (VC) suggested that both the general and tech-based entrepreneurial activities will be greater if the city could attract more talents to the region or has easier access to finance, where Hypothesis 1 and Hypothesis 3 are supported. The positive and statistically significant coefficients of the publication and patent suggest, entrepreneurial activities tend to

be greater where knowledge is more prevalent, where Hypothesis 2a is supported. To test the inverted U-shaped relationship between entrepreneurial activity and patent application activities, we introduced the variable "patent squared" into our analysis. The coefficient of patent is positive and significant, indicating that it is positively related to the general and tech-based entrepreneurship and the coefficient for its squared term is negative and significant, which indicates Hypothesis 2b is supported. As the table 4 shows, introducing the publication and patent variable together to the model or estimating them separately do not influence the estimates of other variables.

However, the negative coefficients of market demand variable GDP in general entrepreneurship case are positive but insignificant coefficients in tech-based cases, suggesting larger local market will discourage regional entrepreneurship, which is inconsistent with the Hypothesis 4. One possible explanation is that most entrepreneurship is necessity-driven but not opportunity-driven. The individuals in developing countries such as China will be less likely to engage into entrepreneurial activities if they could find jobs in big companies (Acs and Virgill, 2010). Meanwhile, in the original model as we presented in table 4, only city-specific fixed-effect was considered. From 2007 to 2015, 2007 global financial crisis and 2009 European debt crisis have deeply affected the export-driven economy such as China. Furthermore, policy impact such as the "Mass Entrepreneurship" initiative proposed by Chinese government to support entrepreneurs only happened until 2014. To capture the economic environment and policy changes from 2007 to 2015, we introduced time fixed-effect into our panel data analysis.

Table 4. Direct-Effect Stage with city fixed-effect panel

VARIABLES	New Firms	New Tech-based Firms	New Firms	New Tech-based Firms	New Firms	New Tech-based Firms
Publication	0.704**	0.460***			0.683**	0.459***
	(0.283)	(0.0474)			(0.284)	(0.0474)
Patent			0.197**	0.0383**	0.186*	0.0310*
			(0.0999)	(0.0171)	(0.0999)	(0.0167)
Patent Squared			-0.00146*	-0.000409***	-0.00141*	-0.000376***
			(0.000772)	(0.000132)	(0.000771)	(0.000129)
Human Capital	928.2***	97.01***	902.1***	93.29***	901.9***	93.15***
	(48.10)	(8.050)	(50.26)	(8.585)	(50.19)	(8.386)
VC	365.2***	156.8***	373.1***	161.3***	381.8***	167.1***
	(83.55)	(13.98)	(85.94)	(14.68)	(85.90)	(14.35)
GDP	-1.69e-07***	4.77e-09	-1.73e-07***	7.36e-09	-1.77e-07***	4.87e-09
	(6.18e-08)	(1.03e-08)	(6.21e-08)	(1.06e-08)	(6.20e-08)	(1.04e-08)
SEZ Dummy	3.160**	-0.000311	2.882**	-0.121	3.046**	-0.0107
	(1.426)	(0.239)	(1.428)	(0.244)	(1.427)	(0.238)
GDP per capita	12.00***	-0.833***	11.95***	-0.751***	11.76***	-0.876***
	(1.601)	(0.268)	(1.606)	(0.274)	(1.606)	(0.268)
Constant	-174.1***	0.0258	-169.8***	0.912	-170.2***	0.654
	(13.65)	(2.284)	(13.82)	(2.361)	(13.80)	(2.306)
Observations	2,200	2,200	2,200	2,200	2,200	2,200
R-squared	0.632	0.449	0.631	0.425	0.632	0.452
Number of city	263	263	263	263	263	263
City FE	YES	YES	YES	YES	YES	YES

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 5 shows that the results are all consistent with our hypothesis when we include both city and time fixed-effect. All the coefficients of human capital, knowledge, finance and market demand are positive and statistically significant. The results suggest that entrepreneurial opportunities do not appear to be exogenous but rather systematically positive affected by regional human capital, knowledge production and spillovers, access to finance and market. The coefficient of "patent squared" is negative and significant, indicating Hypothesis 2b is still supported.

Table 5. Direct-Effect Stage with city and time fixed-effect panel

VARIABLES	New Firms	New Tech-based Firms	New Firms	New Tech-based Firms	New Firms	New Tech-based Firms
Publication	1.040***	0.443***			1.012***	0.443***
	(0.252)	(0.0456)			(0.252)	(0.0456)
Patent			0.206**	0.0327**	0.190**	0.0260
			(0.0884)	(0.0163)	(0.0881)	(0.0160)
Patent Squared			-0.00119*	-0.000304**	-0.00114*	-0.000280**
			(0.000683)	(0.000126)	(0.000680)	(0.000123)
Human Capital	472.6***	95.35***	457.8***	98.40***	441.4***	91.19***
	(53.80)	(9.742)	(55.72)	(10.29)	(55.65)	(10.08)
VC	375.4***	146.4***	359.9***	146.0***	376.9***	153.5***
	(73.87)	(13.38)	(76.23)	(14.08)	(76.05)	(13.77)
GDP	1.94e-08	1.94e-08*	1.26e-08	2.07e-08**	8.95e-09	1.90e-08*
	(5.49e-08)	(9.95e-09)	(5.53e-08)	(1.02e-08)	(5.51e-08)	(9.98e-09)
SEZ Dummy	-1.222	-0.281	-1.519	-0.362	-1.360	-0.292
	(1.275)	(0.231)	(1.280)	(0.236)	(1.276)	(0.231)
GDP per capita	4.187	1.954***	5.219*	2.483***	3.731	1.831***
	(2.822)	(0.511)	(2.822)	(0.521)	(2.835)	(0.513)
Constant	-61.57**	-26.35***	-67.68**	-30.39***	-55.21*	-24.93***
	(28.42)	(5.146)	(28.56)	(5.274)	(28.62)	(5.181)
Observations	2,200	2,200	2,200	2,200	2,200	2,200
R-squared	0.717	0.504	0.715	0.481	0.718	0.505
Number of city	263	263	263	263	263	263
City FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Our model distinguishes among two sets of factors, those that have direct impact on entrepreneurial activities and those that have indirect impact. A set of structural and cultural factors, the presence of research universities, high growth firms and start-ups are important factors that influence entrepreneurial activity in a region indirectly by impacting human capital, knowledge, and finance. Empirical results of indirect-effect stage are presented in Table 6.

Table 6. Indirect-Effect Stage with city fixed-effect panel

VARIABLES	Human Capital	Publication	Patent	VC
HGF	0.536***	4.219	727.6***	0.710***
	(0.0420)	(7.222)	(44.18)	(0.0258)
Startups	0.000153***	0.00310***	0.0889***	2.94e-05***
	(8.01e-06)	(0.000974)	(0.00596)	(3.66e-06)
Graduates	3.04e-05***			
	(4.31e-06)			
Openness	0.161***	-2.093	69.70***	
	(0.00973)	(1.696)	(10.38)	
Urban	0.000168			
	(0.00428)			
Wage	0.0238***			
	(0.000703)			
Agglomeration	9.33e-06***	-0.000705	-0.00492	
	(3.14e-06)	(0.000541)	(0.00331)	
Faculty		0.0538***	-0.0977	
		(0.0129)	(0.0791)	
Tech Transfer		0.533*	-1.323	
		(0.286)	(1.752)	
Constant	-0.203***	3.407***	-11.65***	-0.00818***
	(0.00709)	(0.267)	(1.634)	(0.000300)
Observations	2,200	2,200	2,200	2,200
R-squared	0.833	0.030	0.369	0.414
Number of city	263	263	263	263
City FE	YES	YES	YES	YES

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

For human capital, except the coefficient of urban is positive but statistically insignificant, the other coefficients of high growth firms, startups, graduates, openness, wage and agglomeration are all positive and statistically significant, which suggest our hypothesis are consistent and these regional factors will have positive impact on city's attractiveness of skilled labor and talents. According to our analysis in direct-effect stage, regional entrepreneurship will be systematically positive affected by regional human capital. The results from the direct and indirect effect stage suggest that the factors such as regional high growth firms, startups, graduates, openness, wage and population density will positively influence entrepreneurial activity indirectly by affecting regional human capital.

For knowledge, to capture the dynamic of entrepreneurial ecosystem, two measures of new knowledge are tested in this paper. The first one is academic publication and the second one is patent application. Academic publication is trying to capture the new knowledge creation as public goods. Patent application is trying to capture the new commercial knowledge creation which is impure public goods. The coefficients of startups are positive and statistically significant when we apply both knowledge measurement. For academic publication, the variable faculty and technology transfer are both positive and statistically significant. The positive relationship between the number of university faculty members and academic publication is obvious. The positive relationship between technology transfer and academic publication suggest that a more entrepreneurial university or closer university-industry linkage will enhance university's research performance and knowledge creation. For patent application, the coefficients of regional openness, high growth firms and startups are positive and statistically significant, suggesting a more open and diversified city will likely produce more knowledge. Meanwhile, high growth firms and startups in the region are crucial for regional knowledge creation.

For finance, the coefficient of two demand-side factors high growth firms and startups are both positive and statistically significant, suggesting the existence of high growth firms and startups in the region will attract risk finance companies such as venture capitalist and business angles.

Table 7. Empirical results, university in Entrepreneurial Ecosystem

Direct-effect Stage (Stage II)			Indirect-effect Stage (Stage I)			
VARIABLES	New Firms	New Tech-based Firms	VARIABLES (University)	Human Capital	Publication	Patent
Publication	1.012***	0.443***	Graduates	3.04e-05***		
	(0.252)	(0.0456)		(4.31e-06)		
Patent	0.190**	0.0260	Faculty		0.0538***	-0.0977
	(0.0881)	(0.0160)			(0.0129)	(0.0791)
Human Capital	441.4***	91.19***	Tech Transfer		0.533*	-1.323
	(55.65)	(10.08)			(0.286)	(1.752)

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

As Table 7 shows, the results from our two-stage analysis indicate that the presence of research intensive university will improve the entrepreneurial ecosystem. Four variables are related with university in our model: publication, graduates, faculty and technology transfer. In Stage II, the coefficients of human capital and knowledge (variable: publication and patent) are positive and statistically significant, indicating higher regional human capital and knowledge creation will directly improve the entrepreneurial ecosystem. Higher level of academic publication in the region will improve the new firm formation rate through knowledge spillover. In Stage I, the positive and significant coefficients of graduates in indirect-effect stage suggest university graduates have positive impact on regional human capital attraction. The more graduates from local university, the more firms will be formed in the region because of the growth of regional human capital. However, according to our analysis, the role of university-linkage in entrepreneurial ecosystem is ambiguous. On the one side, the positive and significant coefficient of tech transfer in the knowledge (publication) production estimation indicates that the closer relationship between university and industry will help the university research production which would improve regional entrepreneurial ecosystem; on another side, the negative coefficient of tech transfer in the patent estimation suggests that university and industry linkage might hurt overall regional knowledge creation. One explanation is that the university-industry collaboration might benefit the companies which are collaborating with university and enhance the research capability of these companies. The higher level of research ability within the incumbent company will help these companies become more competitive hence reduce the possibility of innovations from other companies.

6. Conclusions

The purpose of this article was to investigate regional variation in entrepreneurial activity. The article introduces a systems approach to entrepreneurship to model regional entrepreneurial ecosystems in China. The paper makes two main contributions. First, it addresses a core concern that few studies have until now looked at entrepreneurship from a truly systemic and interdisciplinary perspective that identifies explicitly cause and effect in the

entrepreneurial ecosystem. In response, we propose a two-stage structural model for the entrepreneurial ecosystem which identifies the factors which directly and indirectly influence regional entrepreneurial activities. Second, the paper extends the extant thin empirical literature on city-level entrepreneurial ecosystems in rapidly growing emerging economies by bringing to bear a unique dataset in terms of size and composition, comprising of statistical information on various aspects of the entrepreneurial ecosystems of 263 Chinese municipalities (out of a total of 334 in the country) from 2007 to 2015. We use this rich source of data to confirm/support our holistic modeling approach that includes four direct-effect factors and six indirect-effect factors of the entrepreneurial ecosystem, emphasizing the role of research-intensive universities.

The theoretical framework and the empirical results of this research shed light on public policy making at the regional levels to build an entrepreneurial economy. Our analysis shows that human capital, knowledge creation and absorption, risk finance and market demand are the main factors in regional entrepreneurial ecosystem which will promote local entrepreneurship directly. The first major implication for building an efficient entrepreneurial ecosystem is to create a regional environment that produces and attracts appropriate human capital, since high stock of human capital not only promotes entrepreneurial absorptive capacity and facilitates entrepreneurial activity, but also allows easier access to well-endowed employees which lower the entry cost of new firms. The second major implication is to create a regional environment that is supportive to research. The empirical results have shown that both academic publications and patents have positive and significant impacts on new firm formation and confirmed the existence of knowledge spillover entrepreneurship. The third major implication is to create a regional environment that is attractive to organizations providing risk finance. Easier access to finance will encourage startup formation by fueling would-be entrepreneurs' expectation and by engendering spin-offs.

The two-stage entrepreneurial ecosystem model offers a clear framework which helps us to understand how different regional factors and institutions influence entrepreneurial activity. Six factors were identified to affect regional entrepreneurship indirectly through their association with human capital, knowledge and finance. The presence of high growth firms in

the region, startup companies, university graduates, as well as city openness are significant predictors both of the regional stock of human capital and of knowledge creation. Risk finance is found to be strongly associated to the presence of high growth firms and startups.

The role of research-intensive universities in regional entrepreneurial ecosystems is another focus of this paper. Our analysis underscored the strong positive impact of university graduates and academic research activities on regional human capital and knowledge creation. Since human capital and knowledge are two major drivers of entrepreneurship, this provides a strong endorsement of policies to support local universities in order to attract talent and create new knowledge to the local community.

In accordance with extant analyses in developed countries, our results imply that, in order to build a regional entrepreneurial economy, public policies should encourage the development of high growth firms and a more open society. High growth firms in the region will not only serve as a magnet for talent but also be major knowledge creators and attractors of risk finance. Openness signals low barriers to entry for skilled labor and the presence of a diversified local labor market that facilitates the discovery and exploitation of innovative ideas. Public policies promoting non-discrimination and fairness and encouraging diversity should foment more innovative regional economies.

We believe our results have broader appeal than for a single country. They tend to confirm received understanding of the entrepreneurship phenomenon. Future studies should try to replicate in other emerging economies.

In this paper, we discussed four direct effect factors and six indirect factors that are associated with entrepreneurial ecosystem. This, of course, is a theoretical construct: the entrepreneurial ecosystem and the interrelationships it depends on are far more complex in the real world. In the direct-effect stage, we mainly focused on the impact of supply-side factors (human capital, knowledge and finance) and assumed that market demand is exogenously determined. Future research on how regional factors influence entrepreneurial activity indirectly by impacting market demand is needed. Moreover, government policies such as direct subsidies to entrepreneurs and tax breaks must be appropriately handled in future EE studies. In the indirect-effect stage, data availability limited our analysis to six factors. Other

factors such as regional infrastructure, entrepreneurial history, and foreign direct investment also deserve attention. Finally, university-industry linkages require additional attention to demonstrate the channels through which the effects permeate the local economy.

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