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How Does Urban Agglomeration Integration Promote Entrepreneurship in China?

Evidence from Regional Human Capital Spillovers and Market Integration

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Abstract

Using firm birth records and startup data matched with cities' characteristics, this paper analyzes nearly 300 prefecture-level cities to examine the role of human capital and market access in shaping the economic geography of innovation-driven entrepreneurship in China. We document strong positive entrepreneurial effects of local human capital resources and market size as well as market integration and human capital spillovers from mega urban agglomerations of integrated cities. Our estimates point to an elasticity of innovation-driven entrepreneurship with respect to human capital spillovers of 0.50-0.79. The elasticity with respect to market integration is 0.53-0.89. Our results also suggest heterogeneous human capital spillover and market integration effects across urban agglomerations. These effects are more robust in first-tier urban agglomerations because first-tier urban agglomerations have a stronger economic base and greater connectivity. Strong human capital spillover and large gains from access to surrounding economic mass jointly highlight the integrated development of mega-urban agglomerations in China. We discuss policy implications that concern promotion of local innovation-driven entrepreneurship by strengthening intercity coordination, building transportation and social infrastructure, and improving urban management.

JEL classification: R11, R12, L26

Keywords: Entrepreneurship, human capital spillover, market integration, urban agglomeration.

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1. Introduction

China has witnessed an explosion in the rate of new firms and growth of entrepreneurship over the last three decades, which is causing profound impacts on economic development in China as well as elsewhere in the world. Particularly, innovation-driven entrepreneurship is taking shape in the world's fastest growing economy, epitomized by initiatives of Chinese political and business leaders aiming to take the lead in global innovation.

China has advantages in the development of innovation-driven entrepreneurship owing to rich data, talented engineers and scientists, and the government's strong role. Despite the broad debate on the impact of new technological advances and entrepreneurship involving automation on employment, the Chinese government is seeking to fully embrace sophisticated technology such as artificial intelligence and automation. The "mass entrepreneurship and innovation" initiative, first announced in 2014, aims to effectively promote the fast growth of innovation-driven entrepreneurial activity.

It is well documented in the urban economics literature that entrepreneurial activity is not evenly distributed in space, whether in developed countries (Glaeser et al., 2010) or in the developing world (Zheng and Zhao, 2017). The key determinants of the spatial distribution of entrepreneurship include economic base and infrastructure, human capital and research institutions, capital availability, culture and amenities, as well as policy and government environment, to name a few (Audretsch and Fritsch, 1994; Armington and Acs, 2002; Lu and Tao, 2010; Bosma and Schutjens, 2011; Binet and Facchini, 2015).

Among all these factors, the concentration of human capital is the most fundamental and dynamic factor to attract innovation-driven entrepreneurial activity. The flow of human capital further leads to the flow of capital. Human and venture capital reinforce each other and generate a multiplier effect that breeds fast-growing startup activity (Delgado et al., 2010, 2014) and enhances the regional innovation ecosystem (Cooke, 2001). Cities that can attract and retain talent tend to experience higher growth in new business formation and startup activity (Acs and Armington, 2006; Audretsch and Keilbach, 2007). Talent prefers to stay in close proximity to a high-skilled labor pool in order to enjoy positive knowledge spillovers (Acs and Armington, 2004).

Another strand literature looks into the human capital related determinants of entrepreneurship at the individual level. Djankov et al. (2006) use survey data on Chinese entrepreneurs and non-entrepreneurs to understand how they differ in a variety of attributes at the individual level. Harding and Rosenthal (2017) examine the impact of individual-level housing capital gains on self-employment. They find that 20% real increase in home value over a two-year period raises the likelihood of entry into self-employment by roughly 1.5 percentage points. Chen and Hu (2018) investigate how individual-level determinants correlate with different types of homeownership given the higher homeownership rate in China.

In this paper, we adopt a regional approach using local universities and a gravity measure of nearby universities to measure the local (within-city) and regional (an urban agglomeration of highly integrated cities) intensity of human capital and knowledge spillovers.

The market size effect, another important factor influencing the geography of economic activity, has been widely studied (Acemoglu and Linn, 2004; Sato et al., 2012). The purchasing power of nearby, developed cities generates higher demand for local goods and services, thus providing a higher incentive for the high-skilled workforce to engage with entrepreneurial activity. Potential markets in nearby cities results in both technological spillovers, innovation, and competition, boosting the future productivity of local firms and subsequent innovation-driven entrepreneurship. Higher productivity of establishments lead to the productive advantages of large city size (Henderson, 2003; Combes et al., 2012). Recent empirical evidence from China also highlights the role of city size and urban agglomeration in boosting city productivity (Shen et al., 2019), which is of great important to later innovation-driven entrepreneurship. We follow Hanson (2005) to calculate a gravity measure of accessibility to the surrounding economic mass, which we refer to as *market potential*, to capture the market integration effects on burgeoning innovation-driven entrepreneurship.

Today cities are connected with each other more than ever. The earlier literature documents significant geographical localization of knowledge spillovers probably due to limited travel speed and high travel costs (Jaffe et al., 1993). By contrast, the integrated development of urban agglomerations, which we refer to as urban agglomeration integration, allows spillovers to spread across space much faster than before.[1] The spatial extent of knowledge spillovers and market integration is less limited by geographical constraints given higher travel speeds and lower transportation costs (Glaeser and Kohlhase, 2005; Zheng and Kahn, 2013; Dong et al., 2018).

In a mega urban agglomeration of highly integrated cities, the entrepreneurial capacity of a city not only depends on its own human capital pool and attractiveness to talent, but also its interactions with other cities in the urban agglomeration. For instance, cities like Shenzhen and Suzhou, lacking leading universities, receive large human capital and market integration spillovers from Hong Kong and Shanghai, respectively, due to their spatial proximity to top universities in these two nearby cities. The city's local human capital pool, market size, other economic fundamentals, and favorable policies attract a substantial number of high-skilled workers and multinational firms, producing fast-growing and innovative startups.

Our contributions to the growing literature on the economic geography of entrepreneur-

[1] Major viewpoints of urban agglomeration definitions are summarized in Fang and Yu (2017).

ship in China are threefold. First, we build a comprehensive database at the prefecture level that covers the years 2000-2015.[2] Our paper complements existing studies on China's entrepreneurship which mostly rely on firm-level data before 2008 or individual-level data. Specifically, we use the number of new innovation-driven firms and the number of growth-oriented startups in each city to measure entrepreneurship at the local level.

Second, this paper presents new evidence on the nature and extent of marked spatial variations in China's innovation-entrepreneurship and identifies the determinants of the spatial differences. Based on Murray and Budden (2017), we consider a number of inputs to China's entrepreneurship capacity and develop a framework to assess innovation-driven entrepreneurship.

Specifically, we use a wide variety of metrics to capture innovation-driven entrepreneurship capacity of cities (Glaeser et al. 2010a, 2010b; Delgado et al. 2010; Delgado et al., 2014; Glaeser et al. 2015; Catalini, 2017) and categorize these inputs to entrepreneurship capacity into five major categories: (1) economic base and infrastructure, (2) research institutions and human capital, (3) capital, (4) culture and amenities, and (5) policies and governmental environment.

Our results basically show that common market forces are at work in China drawing spatial clusters of entrepreneurial activity. We find that factors, such as access to local human capital resources, local market size, agglomeration economies, high-speed transportation infrastructure (airport and high-speed rail), average personal income, city size, urban density, internet user base, R&D expenditure, population diversity, firm diversity, consumer vibrancy (restaurants and coffee shops), weather, and a strong government role are contributing factors that draw the spatial concentration of innovation-driven entrepreneurial activity.

Third, building upon our approach to assessing the economic geography of entrepreneurship, we highlight the role of human capital spillovers and market integration in the system of highly integrated cities. Figure 1 presents our framework, in which we consider a system of highly integrated cities where both local fundamentals, human capital spillovers, and market integration effects matter. From the regional perspective, specifically, we focus on two types of intercity interactions — cross-boundary spillovers from nearby human capital resources and access to the surrounding economic mass.

We show that cities benefit from human capital spillovers from local and nearby universities (e.g. Shenzhen and Suzhou), suggesting that universities in the local area and nearby places provide cities with access to a large pool of educated workforce that fosters the growth of innovation-driven entrepreneurship.[3] Our results show that innovation-driven

[2]In China, a prefecture is an administrative unit comprising, typically, a main central urban area and its much larger surrounding rural area containing many smaller cities, towns, and villages.

[3]According to our statistics, the human capital spillovers that Shenzhen received from Hong Kong as a

firm formation is elastic with respect to human capital spillovers at a rate of 0.47-0.50, while the elasticity of startups is roughly 0.79. The estimates also point to strong spillovers from access to the surrounding economic mass, registering an elasticity of 0.53-0.72 for new business creation and an elasticity of 0.90 for startup activity.

The significant effects of human capital spillover and market integration on local innovation-driven entrepreneurship provide strong suggestive evidence of mega urban agglomeration integration in China. The local vibrancy of a city's entrepreneurial activity does not only hinge on local entrepreneurial capacity fundamentals, but also on the city's ability to capture human capital spillovers from neighboring cities and access potential markets in nearby regions.

We further investigate the differential human capital spillover and market integration effects across urban agglomerations. Our estimation results suggest that the spillover effects on innovation-driven entrepreneurship are stronger in more developed and more connected urban agglomerations (such as the first-tier urban agglomerations defined in this paper, namely Pearl River Delta, Yangtze River Delta, and the Beijing-Tianjin-Hebei region). Cities in the first-tier urban agglomerations are well connected by better transportation infrastructure and well integrated possibly due to institutional advantages and efficient intercity coordination. Understanding the dynamics and the driving forces of the system of highly integrated cities in China and how they interact with China's dynamic entrepreneurial growth patterns provides us with a fruitful area for future research.

The remainder of the paper is organized as follows: Second 2 presents the empirical framework and discusses the endogeneity issue. Section 3 introduces data sources and metrics. Section 4 reports estimation results and discusses potential channels. Section 5 provides concluding remarks.

2. Conceptual Framework

Urban literature has demonstrated that certain features of local economies influence the supply of and demand for entrepreneurship, thus shifting the equilibrium level of local entrepreneurship. Studies have documented important determinants of local entrepreneurship such as market size, skilled labor, knowledge diffusion, financing, geography, culture, government support, etc.[4] On the demand side, large cities or urban clusters often have more demand for specialized products that are often invented and produced by innovation-driven

share of total human capital spillovers Shenzhen received was roughly 32% in 2015. The market integration spillovers that Shenzhen received from Hong Kong as a share of total market integration spillovers Shenzhen received was around 58%.

[4]See Glaeser et al. (2010a) for a thorough literature review of this topic.

startups (Smith, 1776). On the supply side, skilled human capital, abundance of new ideas, and knowledge spillovers are emphasized in the literature as the critical inputs of specialized products (often produced by entrepreneurs), where localization and market integration play an important role (Chinitz, 1961; Marshall, 1920). Forslid and Ottaviano (2002) argue that, given a fixed supply of entrepreneurship, the human captial of entrepreneurs is essential for new firm formation.

Glaeser et al. (2010a) presents a New Economic Geograhpy (NEG) model to discuss the local determinants of entrepreneurship under the production and consumption assumptions adopted by Abdel-Rahman (1988), Fujita (1988), Rivera-Batiz (1988), and Krugman (1991). In particular, we build our theoretical framework upon this model to document how human capital spillovers and market integration influence the entrepreneurship. The availability of local skilled entrepreneurial human capital and knowledge spillovers refer to a shift in an entrepreneurial supply curve. The increasing supply and concentration of entrepreneurial human capital and ideas shifts the supply curve outward and thus produces a higher level of burgeoning entrepreneurial activity (Marshall, 1920). Market integration refers to a movement along the entrepreneurial supply curve. The extent of the market allows for a clearer and more efficient division of labor, where we see the increasing returns to entrepreneurial production activity in large and highly integrated markets (Smith, 1779; Krugman, 1991).

Following the literature, we assume that the individual utility takes a Cobb-Douglas functional form as shown in Equation (1), where the utility is a function of an aggregate of separate manufactured goods (C_i) and land (L). The elasticity of substitution among different types of manufactured goods is denoted as σ.

$$U = (\int C_i^{\frac{\sigma-1}{\sigma}})^{\frac{\mu\sigma}{\sigma-1}} L^{1-\mu} \tag{1}$$

In a small city with a large open economy, we assume that the city has a fixed total supply of land ($\bar{L}$). There is a linear technological process where a producer uses $\alpha + \beta X$ units of labor to produce X units of manufactured good, where α is the fixed cost and β is the marginal cost. Some manufactured goods are traded, while others are not. The price of traded goods is normalized to $\beta\frac{\sigma}{\sigma-1}$, while the price of non-traded goods is endogenously determined.

We assume that a share ϕ of the entrepreneurs produce traded goods, while the remaining 1-ϕ produce non-traded goods. The external demand for each traded good of a city is

$$Q[\frac{(\sigma-1)P}{\sigma\beta}]^{-\sigma} \tag{2}$$

where P is the price of traded good. We suppose that the local demand for goods is endogenous. The model also assumes that there is a fixed number of entrepreneurs, denoted E_k, and the number of non-traded goods entrepreneurs is E_{-k}.

We follow the literature and endogenize the supply of entrepreneurs. Suppose that the city has an upward-sloping supply curve of entrepreneurs defined by an underlying cumulative distribution function $F(X)$, which is the share of individuals whose costs of entrepreneurship are less than X. Suppose π represents the expected profits from becoming an entrepreneur for an individual. Then the number of entrepreneurs is $F(\pi)$. We also assume that $\pi = \phi\pi_t + (1-\phi)\pi_{nt}$ where π_t and π_{nt} are the profits made by traded goods entrepreneurs and non-traded goods entrepreneurs, respectively.

For the goal of illustrating the role of human capital spillovers and market integration, we follow Glaeser et al. (2010a) and only consider a stable equilibrium of the number of entrepreneurs, which is defined to meet the Equation (3).

$$\frac{1}{F'(\pi)} > \pi'(E_k) \tag{3}$$

which suggests that an increase in entrepreneurship does not have a destablizing increase in the entrepreneur's profits.

Given the assumptions, the model implies that, in an open city, the level of entrepreneurship is increasing with demand (Q) and land area ($\bar{L}$), and is decreasing with fixed cost (α). This proposition has important implications for the role of human capital spillovers and market integration. The fixed cost can reflect the necessary inputs for entrepreneurship. Human capital spillover is one of these critical inputs needed for entrepreneurship. If skilled human capital is abundant and spillovers are large, the level of entrepreneurship would be higher.

The variables such as demand (Q) and land area ($\bar{L}$) illustrate the role of market integration in promoting the entrepreneurship. Large cities have a higher demand for specialized products produced by startups. Exogenous factors such as demand, land area, and share of traded goods can increase the returns to entrepreneurship. Moreover, geographic concentration is conducive to vertical disintegration within the urban agglomeration (Li and Lu, 2009).

Based on the theoretical discussions above, we develop several hypothesis that are empirically testable using our data. Our empirical discussions will be carried out based on these hypotheses.

Hypothesis 1. Human capital spillovers are conducive to entrepreneurial activity. Cities with a higher level of human capital spillovers will gain more new innovative firms.

Glaeser et al. (2010b) presents a model to look at the role of amenities, fixed costs, and profitability in explaining entrepreneurship. The model is extended to consider human capital as an important determinant of new firm creation. More skilled workers are intensively used in sectors with higher skill intensity. The industry characteristics of skill-intensive sectors contribute to burgeoning startup activities in innovative sectors.

Entrepreneurship would be higher in places with an abundant supply of entrepreneurs (Chinitz, 1961). Glaeser et al. (2010b) presents empirical evidence of expanding industries dependent on educated workers. Skilled human capital in the local and nearby regions increase the supply of critical inputs needed for entrepreneurship such as skilled labor and knowledge spillover, thus reducing the fixed cost and elevating the level of entrepreneurship (Carlino and Hunt, 2007; Buenstorf and Klepper, 2010).

The channel of entrepreneurship supply is reliant on the assumption of immobile workers where the work force is tied to an area due to historical or exogenous events. The immobile workers may be unique in some traits that lead them to entrepreneurship and operate strong businesses in the local area (Figueiredo et al., 2002; Michelacci and Silva, 2007). This theory has many implications for urban agglomerations in that the suppliers of human capital are integrated in the urban agglomeration due to increased human capital mobility and knowledge spillovers, enhancing the overall innovation-driven entrepreneurship in the region.

Hypothesis 2. Larger market integration effects lead to higher new firm formation rates.

Market integration in an urban agglomeration creates increasing returns to entrepreneurship due to an expanding demand, larger land area, and larger volumes of traded goods in the urban cluster. A larger market size can lead to a higher level of entrepreneurship and spur innovations (Acemoglu and Linn, 2004; Sato et al., 2012). It is also possible that the increased market size due to market integration enhances the competition, therefore making firms more specialized in innovation activity to build profitable business models. An alternative theory could be that highly integrated markets foster collaborative innovative and entrepreneurial activities across markets in urban agglomerations.

The vertical integration between cities in an urban agglomeration also plays a critical role in explaining the innovation-driven entrepreneurship. Firms perceive an incentive to enter a market and be more specialized if the market has many existing upstream and downstream firms, thus leading the new entries to become more entrepreneurial and engage more with specialized, innovative production activities. Vertical integration within the urban agglomeration facilitates outsourcing and matching between complementary specialized startups (Glaeser et al., 2010b). Under vertical integration, the share of employment in creating firms is higher.

Hypothesis 3. Urban agglomeration enhances human capital spillovers and market integration effects. The effects are stronger in higher tiers of urban agglomerations.

Closely linked cities within an urban agglomeration because of better infrastructure, culture of entrepreneurship, better intercity coordination, and political support would produce stronger human capital spillovers and market integration effects, which is consistent with the channels of human capital spillovers and market integration. The stronger human capital spillovers and market integration effects on entrepreneurship may be attributed to a positive reinforcing process, which makes entrepreneurship increasingly important drivers of regional economic development (Stough et al., 2014).

3. Empirical Framework

We estimate Equations (4) and (5) to analyze the spatial distribution of new firm births and test the hypothesis proposed in our conceptual framework. Specifically, we regress log number of new innovation-driven firms on local human capital level, human capital spillovers, local market size, and market potential from nearby cities. We also control for a variety of city fundamentals.

$$\begin{aligned}\log(y_{1,crt}) = \alpha_1 + \beta_{11} HC\_local_{1,cr,t-1} + \beta_{12} HC\_spillover_{1,cr,t-1} \\ + \mathbf{X}_{1,cr,t-1}\theta_1 + \gamma_{1,r} + \delta_{1,t} + \epsilon_{1,cr,t}\end{aligned} \quad (4)$$

$$\begin{aligned}\log(y_{1,crt}) = \alpha_1 + \beta_{13} MKT\_local_{1,cr,t-1} + \beta_{14} MKT\_nearby_{1,cr,t-1} \\ + \mathbf{X}_{1,cr,t-1}\theta_1 + \gamma_{1,r} + \delta_{1,t} + \epsilon_{1,cr,t}\end{aligned} \quad (5)$$

where $y_{1,cr,t}$ is the number of new innovation-driven firms of city c in region r at year t; $HC\_local_{1,cr,t-1}$ is the local human capital level of city c in region r at a lagged time period $t-1$; $HC\_spillover_{1,cr,t-1}$ is human capital spillovers that city c in region r receives at a lagged time period $t-1$; $MKT\_local_{1,cr,t-1}$ is the local market size of city c in region r at a lagged time period $t-1$; $MKT\_nearby_{1,cr,t-1}$ is the market potential of the nearby cities of city c in region r at a lagged time period $t-1$; $\mathbf{X}_{1,cr,t-1}$ is a vector of fundamental institutions and city controls of city c in region r at year $t-1$; $\gamma_{1,r}$ represents regional fixed effects; $\delta_{1,t}$ controls for year fixed effects; $\epsilon_{1,cr,t}$ represents unobserved city characteristics of city c in region r at year t.

The coefficients of our interest are β_{11}, β_{12}, β_{13}, and β_{14}. β_{11} captures the impact of the local human capital level on the growth of innovation-driven entrepreneurship. β_{12} reveals how local innovation-driven entrepreneurial activity responds to the human capital spillovers from nearby cities. β_{13} measures the effect of local market size on local innovation-driven entrepreneurship. β_{14} reveals how market integration influences the growth of local innovation-driven entrepreneurial activity. Since local entrepreneurial capacity inputs and beneficial intercity interaction contribute to the local innovation-driven entrepreneurial development, we expect a positive sign for β_{11}, β_{12}, β_{13}, and β_{14}.

We make an additional investigation of Equations (6) and (7) to examine how human capital spillovers and market integration shape the spatial distributions of startups.

$$\log(y_{2,cr}) = \alpha_2 + \beta_{21} HC\_local_{2,cr} + \beta_{22} HC\_spillover_{2,cr} + \mathbf{X}_{2,cr}\theta_2 + \gamma_{2,r} + \epsilon_{2,cr} \tag{6}$$

$$\log(y_{2,cr}) = \alpha_2 + \beta_{23} MKT\_local_{2,cr} + \beta_{24} MKT\_nearby_{2,cr} + \mathbf{X}_{2,cr}\theta_2 + \gamma_{2,r} + \epsilon_{2,cr} \tag{7}$$

where $y_{2,cr}$ is the number of growth-oriented startups of city c in region r; $HC\_local_{2,cr}$ represents the local human capital resources of city c in region r; $HC\_spillover_{2,cr}$ is the human capital spillovers that city c in region r receives from nearby cities; $MKT\_local_{2,cr}$ is the local market size of city c in region r; $MKT\_nearby_{2,cr}$ is the market potential of cities near city c in region r; $\mathbf{X}_{2,cr}$ is a vector of fundamental institutions and city controls of city c in region r; $\gamma_{2,r}$ represents regional fixed effects; $\epsilon_{2,cr}$ captures unobserved city characteristics of city c in region r. Similar to the discussion in the panel regression analysis, we expect a positive sign for β_{21}, β_{22}, β_{23},and β_{24}.

We argue that human capital spillovers are plausibly exogenous given the predetermined locations of universities. To establish a causal connection between entrepreneurship and market integration, we build a Bartik instrumental variable (IV) to instrument the market integration (Bartik, 1991). Chen at al. (2017) point out two possible weaknesses of the Bartik IV. First, it constrains growth rates for all industries in each city to equal their respective national growth rates rather than the actual industry patterns, often leading to a weak IV issue. Second, the Bartik IV is ineffective when the national trends are relatively weak compared to idiosyncratic city-level shocks, resulting in a weak first stage.

Built upon Detang-Dessendre et al. (2016) and Chen et al. (2017), we regress the GDP growth and the growth in market integration variable between 2000 and subsequent years T on 2000 employment shares of 20 industries, control variables, and provincial fixed effects in city c.

$$\%\triangle y_{2000-T} = \alpha_0 + \textstyle\sum_{i=1}^{20} \alpha_i * shr_{ci} + \beta \boldsymbol{X_{cT}} + \gamma_p + e_{cT} \tag{8}$$

where $\%\triangle y_{2000-T}$ is the growth rate of GDP or market integration from initial year 2000 to year T. shr_{ci} is the 1990 employment share of industry sector i in city c as the total employment in industry i. $\boldsymbol{X_{cT}}$ represents the control variables at city c in a subsequent year T. γ_p is the provincial fixed effects. e_{cT} is the idiosyncratic error for city c in year T.

We then use the predicted GDP/market integration growth rate ($\%\triangle \hat{y}_{2000-T}$) from Equation (8) and the GDP/integration in the initial period to predict the GDP/market integration in year T.

$$y_{cT} = (1 + \%\triangle \hat{y}_{2000-T}) y_{c2000} \tag{9}$$

This modified version of Bartik IV should be best linear unbiased estimator (BLUE) since it is based on OLS using initial city industry shares and does not constrain to national growth rates.

4. Data and Measurement

We follow Murray and Budden (2017) to consider an array of determinants of entrepreneurship capacity for a city. Table 1 presents the variables and their associated categories. We categorize the entrepreneurship-capacity measures into five categories, namely, (1) economic base and infrastructure, (2) research institutions and human capital, (3) capital, (4) culture and amenities, and (5) policies and governmental environment. The regional variation in these decisive factors can jointly explain China's noticeable regional difference in innovation-driven entrepreneurship.

Table 2 provides descriptive statistics for all variables used in this study and reports data sources. We organize the table in such a way that variables from the same data sources are presented next to each other. We label the data sources of each variable and describe them in the notes below the table.

4.1. Innovation-driven Entrepreneurship

We exploit annual firm registration records from 2000-2015 in the registry database of State Administration for Industry and Commerce (SAIC), which is the official agency for firm registration in China, to calculate new firm formation rates. This annual database covers the information of all firms that registered by the end of each year, with a variable noting the firm's operation status: "New Opening," "In Operation," or "Closed." A firm that opened in year t will be categorized into "New Opening Firms" in the dataset of year t and into "Firms in Operation" from year $t+1$. This database also records each firm's detailed information, including its name, standard two-digit industry code (SIC Code), and precise address in longitude and latitude.

We then aggregate firm data to obtain the city's total number of new firms across sectors over 2000-2015 and match these data by sector with other city attributes. The average number of newly registered firms is roughly 9,000, with a standard deviation of 20,000 or so, implying large regional variation in entrepreneurship.

While there is no universal definition of entrepreneurial activity, in this paper, we use a narrow definition of entrepreneurship, which points to growth-oriented startup businesses with high-skilled employment. Since newly established firms may not be representative of entrepreneurial activity, we define a set of innovation-driven sectors of which the share of employees with a college degree or above lies in the top 25% of all sectors. We then record the number of these technology-sophisticated firms in each city over the last 16 years (2000-2015) to measure the city's burgeoning innovation-driven entrepreneurship.

We also use a new data source — Ctoutiao's entrepreneurship and innovation database — to measure entrepreneurship in China. Ctoutiao is a Chinese data and news company specializing in entrepreneurship and venture capital. The company collects data on a variety of firm attributes and provides the geocoded firm location of startups, investment firms, and innovation spaces through one of its products — Entrepreneurship and Innovation Map.[5] The dataset covers over 300 prefecture-level or county-level cities and is constantly updated. On average, there are over 1,000 startups, about 24 investment firms, and roughly 51 innovation spaces for each city. Again, large standard deviations suggest the uneven spatial distribution of entrepreneurship and venture capital in China.

Figure 2 presents the spatial distribution of startups, investment firms, and innovation spaces. Larger and richer cities tend to attract spatial clusters of entrepreneurial activity. Note that we observe booming entrepreneurship not only in first-tier cities (Beijing, Shanghai, Guangzhou, and Shenzhen), but also in some provincial cities in the western regions, such as Xi'an and Chengdu.

Figure 3 shows strong heterogeneity in the entrepreneurship trend across different sectors. One salient observation is that Beijing and Shanghai dominate in the burgeoning science-tech startup activity, while Shenzhen dominates in finance and IT entrepreneurship. Additionally, we observe a sharp upward movement in entrepreneurship during the 12th Five Year Plan, especially in the science and technology, finance, and IT sectors. To sum up, China's entrepreneurship varies greatly across time, cities, and sectors.

[5]Entrepreneurship and Innovation Map can be accessed at http://www.ctoutiao.com/cmap.php?act=chart.

4.2. Local Measures of Human Capital and Market Size

We use the number of colleges and universities in a city to measure the city's human capital level. The number of universities in each city is calculated based on the full list of 2015 regular high education institutions released by Ministry of Education of the People¡s Republic of China. Among the local colleges and universities in each city, we further distinguish Project 985 and 211 universities from other universities.[6] For 985 universities and 211 universities, we collected relevant information from Yangguanggaokao, which is an official website for public information on the college entrance exam and admissions. There are, on average, 8 colleges or universities in each city, with substantial variations across cities.

The human capital effects from college and universities are multidimensional. To capture the spillover of deep knowledge and skill, we also measure each city's university quality using a quality indicator published by New Oriental, which is currently the largest comprehensive private educational company in China. We measure the higher education quality of each city according to a ranked list of the top 700 public universities in China, which includes each university's ranking, within-city ranking, and overall score.[7] Specifically, we compute the rank-weighted average score of universities in a city as the quality index of the city's human capital.

4.3. Measures of human capital spillovers and market access in a system of highly integrated cities

We measure two types of intercity interactions — human capital spillovers and market integration effects.[8] We take a geographical approach to measure these intercity interactions.

[6]Project 985 is a project to promote the development and reputation of the Chinese higher education system by founding world-class universities in the 21st century. Project 211, a project of National Key Universities and colleges, was initiated in 1995 by the Ministry of Education of the People's Republic of China, with the intent of raising the research standards of high-level universities and cultivating strategies for socio-economic development.

[7]Higher education in China centers on a system of 2,000 universities and colleges, with more than six million students. The system includes Bachelors, Masters and Doctoral degrees, as well as non-degree programs.

[8]In a robustness check, in addition to the local air pollution level, we also construct an instrumental variable using $Neighbor_{it} = \sum_j w_{ij} \cdot smoke\,emissions_{jt} \cdot e^{-d_{ij}}$ to capture the negative pollution externalities from economic activity of nearby cities following Zheng et al. (2014), which could be viewed as a third intercity interaction. $Neighbor_{it}$ represents imported pollution of city i from neighboring cities ($j \neq i$); $w_{ij} = 1$ is a dummy variable that turns on when city j is located in the dominant wind direction of city i and equals 0 otherwise; $smoke\,emissions_{jt}$ is city j's smoke emissions in year t; d_{ij} is the great-circle distance between city i and j. Note that there is a concern about the possibility that imported air pollution from nearby regions (e.g. Hebei Province) is driven by the megacity's local demand (e.g., Beijing). To address this issue, we follow Zheng et al. (2014) and set $d_{ij} > 120\,km$ to minimize the likelihood that the cross boundary instrumental variable is correlated with city i's local economic activity. The analysis shows that there is a crowding-out effect of air pollution on entrepreneurs. The results are available upon request.

Following the literature (Ahlfeldt and Maennig, 2010; Ahlfeldt, 2011; Hidalgo et al., 2017), we define human capital spillover as the inverse distance-weighted effective number of universities in neighboring cities:

$$Human\,capital\,spillover_i = \sum_j N_j e^{-\alpha d_{ij}}\;(i \neq j) \tag{10}$$

where N_j is the number of universities in city j; α is the spatial decay parameter; d_{ij} is the distance between city i and j. We set the spatial decay parameter to 0.02 in our main specifications and vary it from 0.01 to 0.05 for a robustness check. The use of the number of universities as a proxy for human capital level is reasonable in that proximity to college educated workers drives the spatial concentration of employment, which provides an educated workforce for innovation-driven entrepreneurial activity (Rosenthal and Strange, 2008). This measure also reflects the fact that human capital spillovers attenuate sharply with distance.

As the nearby city's potential market has a larger effect on the local city's demand for goods and services, we follow Hanson (2005) to calculate a market potential index, excluding the city's own market size, to measure access to the surrounding economic mass, where the effects are referred to as market integration effects.

$$Market\,potential_{i,t} = \sum_j Income_{j,t} e^{-\alpha d_{ij}}\;(i \neq j) = \sum_j GDP_{j,t} e^{-\alpha d_{ij}}\;(i \neq j) \tag{11}$$

where $GDP_{j,t}$ is the GDP output of city j in year t; α is the spatial decay parameter; d_{ij} is the great-circle distance between city i and j. Similarly, we set the spatial decay parameter to be 0.02 in our main specifications and vary it from 0.01 to 0.05 for a robustness check. Similar to human capital spillovers, the access to the surrounding economic mass can reflect the benefits of urban agglomerations and we expect the market integration effects to attenuate sharply with distance.

4.4. City Controls

We use data on restaurants and coffee shops from Dianping.com, the Chinese equivalent of Yelp, to measure each city's consumer amenities. Our point-of-interest (POI) data cover the time period from 2013-2014, and contain more than 12 million POI data points in China. Restaurant and coffee shops are reasonable proxies for city consumer amenities because dining-out and socializing are major leisure activities that urban residents seek. Moreover, China's unique business dining culture amplifies the effect of social interaction on promoting entrepreneurial activity.

The information on industrial parks is obtained from an official document jointly released by the National Development and Reform Commission, the Ministry of Land and Resources, and the Ministry of Housing and Urban-Rural Development, which has recorded all approved industrial parks through the end of 2006.

The high speed rail data is a panel dataset for 320 cities from 2003 to 2015, including a dummy variable indicating whether a city had a high speed rail station in operation for each year. The information on operating year is collected from 12306 (an official website for train ticket selling, http://news.gaotie.cn) and the official website of each prefecture government.

Improvements in the quality of the business environment will increase the size of each city's (high-skilled) workforce in China (Gabriel and Rosenthal, 2004) In China, the business environment is strongly influenced by government regulations. We use statistics from a World Bank report to measure three different aspects of the business environment, namely, percent of small and medium-sized enterprises that have access to loans, property rights protection, and businesses' time spent with four government regulators (number of days per year).

We calculate the Shannon diversity index to measure population diversity using the following equation.

$$Population\,Diversity_i = -\sum_{j=1}^{n} \frac{N_{ij}}{N_i} \times ln(\frac{N_{ij}}{N_i})$$

where N_i is the total number of population in province i in year 2010 and N_{ij}: total number of population born in province j but living in province i in year 2010. A higher population index value indicates a more diverse population

Similarly, we calculate the firm diversity index using the following equation.

$$Firm\,Diversity_{it} = -\sum_{k=1}^{n} \frac{M_{ikt}}{M_{it}} \times ln(\frac{M_{ikt}}{M_{it}})$$

where M_{it}: total number of existing firms in province i in year t; M_{ikj}: total number of existing firms of industry k in province i in year t. A higher firm diversity index value indicates more types of firms.

Here, we do not discuss each variable used in the paper in detail, given the large number of variables. The data sources and summary statistics for all other variables are listed in Table 2.

5. Results

5.1. Human Capital Spillovers and Market Integration

We sketch the scatter plots of human capital spillovers vs. new firm formation (Figure 4) and market integration vs. new firm formation (Figure 5). The scatter plots demonstrate a strong log-log linear relationship between human capital spillovers/market integration and entrepreneurship. We use regression analysis to uncover these effects.

Table 3 presents the estimation results of human capital spillovers and their effects on local entrepreneurial activity. Columns (1)-(4) of Table 3 report the results from a panel fixed effects model, where we use data from 2000-2015 and use the log of the number of new innovation-driven firms as the dependent variable. Columns (5)-(6) report results from OLS regressions, where we use data from 2014-2015 and use the log of the number of growth-oriented startups as the dependent variable. We focus on human capital spillovers and include a variety of entrepreneurial capacity inputs from our framework (see Table 1) in our regression.

Specifically, in Columns (1) and (3), we run the panel fixed effects regressions controlling for regional fixed effects and year fixed effects, with no controls for human capital spillovers. We then add the log of the effective number of universities in Columns (2) and (4) to test our hypothesis of large human capital spillovers from nearby cities. Compared to Columns (1) and (2), we control for high-speed rail access, the log of the number of internet users, and the log of the R&D expenditure to see whether the results still hold because our sample size decreases from 3,902 to 1,828 with these three controls. Despite the reduced sample size, the R^2 increases from 0.793 to 0.826 in Column (3), compared to Column (1), and increases from 0.795 to 0.828 in Column (4), compared to Column(2). Columns (5) and (6) are similar to the specifications in Columns (3) and (4) except that we apply pooled OLS regression analysis and control for regional fixed effects but no year fixed effects in Columns (5) and (6).

We report standard errors that are clustered by cities to allow for arbitrary within-city auto-correlation patterns. Other controls including cumulative FDI, share of tertiary sector, distance to the coast, distance to seaports, and number of rainy days are controlled for in all specifications but not reported. The estimation results reveal the determinants of the marked regional difference in China's innovation-driven entrepreneurship. The coefficients on these controls are available upon request.

A consistently positive, significant coefficient on human capital spillovers in Columns (2), (4), and (6) suggests a strong human capital spillover effect on local innovation-driven entrepreneurial activity from nearby cities. Cities receive large gains in innovation-driven entrepreneurial growth from nearby cities with a high local human capital level. A 10% increase in human capital spillovers leads to 4.7%-5.0% increase in the number of new innovation-driven firms and 7.9% increase in the number of growth-oriented startups.

The effect of local human capital resources, as measured by the number of universities in the local area, is always significantly positive and its size stays largely consistent with or without the control of the human capital spillover, corroborating the central role of concentrated local human capital in attracting entrepreneurial activity. Our estimates point to an elasticity of new innovation-driven firms with respect to local human capital level of 0.49-0.68 and an elasticity of growth-oriented startups of 0.27.

Note that the size of the spillover effects identified in our regressions is comparable to that of the effect of local human capital stock. In other words, the human capital spillovers that accrue to local geographical areas have almost the same or even larger power in explaining the local burgeoning innovation-driven entrepreneurship. The size of the human capital spillover effects has not been paid enough attention in existing empirical studies that examine the economic geography of entrepreneurship.

We control for many additonal inputs to local entrepreneurial capacity. The number of incumbent innovation-driven firms is included to capture the agglomeration economies of innovation-driven activity (Glaeser and Kerr, 2010). Airport presence and high-speed rail access are included to take into account the transportation infrastructure. With respect to city size, our findings indicate that larger cities have a higher level of entrepreneurial activity. In contrast, we find mixed signs of the effects of population density on innovation-driven entrepreneurship, suggesting that city density may impact entrepreneurship in different sectors quite differently (Zheng and Zhao, 2017). Moreover, burgeoning innovation-driven entrepreneurship tends to be higher in cities with a larger internet base, suggesting the important role of knowledge spillovers and interactions through the internet in facilitating the free exchange of ideas. The results also show that R&D is important for promoting innovation-driven entrepreneurship. Additionally, we find suggestive empirical evidence that entrepreneurs value consumer amenities in the city (Glaeser et al., 2001) and the diversity of firms present in the city promotes path-breaking entrepreneurial activity.

In Table 4, we replicate the analysis in Table 3 but instead focus on market integration. Table 4 presents the estimation results from both the panel fixed effects model and the pooled OLS model. The effect of market integration on local innovation-driven entrepreneurship is significantly positive across all specifications. A 10% increase in access to the surrounding economic mass leads to 5.3%-7.2% increase in burgeoning innovation-driven firms and contributes to 8.9% increase in the number of growth-oriented startups. The log of GDP registers an elasticity of new innovation-driven firms with respect to local market size of 0.19-0.40 and the elasticity of growth-oriented startups with respect to local market size is 0.18. We observe similar results for control variables compared to those in Table 3.

It is worth noting that the effect of market integration is greater than that of local market size in all specifications, implying that market integration provides the local city with greater purchasing power and higher demand for local goods and services compared to those provided by the local market. This empirical analysis suggests the use of intercity market integration as a mechanism to enhance the efficiency of markets and promote local innovation-driven entrepreneurial growth in an era of mega urban agglomeration.

5.2. Human Capital Spillovers and Market Integration: Interaction Effects

Our baseline results include human capital spillovers and market integration in two separate regression specifications mainly due to the concern of multi-collinearity. The correlation between human capital spillovers and market integration is obvious as more developed cities tend to have higher level of cumulative fundamentals and human capital endowment such as first-class universities and high-skilled labor pool. This is especially true for China.

To see the joint interaction effects, we include both human capital spillovers and market integration variables in the regression as well as their interaction term. The estimation results are presented in Table 5. In all specifications, we include city fixed effects, year fixed effects, and prefectural-level controls in addition to the factors identified in our framework. Column (1) only includes local human capital level and market size without controlling for human capital spillovers and market integration. Column (2) adds variables of human capital spillovers and market integration to Column (1). In Column (3), we further introduce an interaction term of human capital spillovers and market integration to examine whether there is any synergy between these two forces.

The coefficients on local human capital level and market size are significantly positive across all specifications, registering similar magnitudes compared to those in our original specifications. The positive, significant coefficients on spillover in columns (2) and (3) demonstrate strong human capital spillovers and market integration. Both effects are of similar economic sizes to our original results. The estimation results suggest that our findings are not driven by the omission of any of these variables (to partly mitigate the multi-collinearity issue).

Column (3) presents an insignificant coefficient on the interaction effects of human capital spillovers and market integration. Although it is interesting to ask whether human capital spillovers and market integration reinforce each other in the urban development process, our observed data do not show such a synergy between these two types of effects. We look through the literature on the economic geography of entrepreneurship and find no formal theory to predict the existence of such an interaction effect. We leave this for future research.

We build the Bartik IV following Chen et al. (2017) and re-estimate the regression specification using the 2SLS estimation. The regression results are presented in Table 6. We obtain similar results.

5.3. Urban Agglomeration Integration and Heterogeneous Effects

In this section, we investigate the differential spillovers of human capital and market integration to innovation-driven entrepreneurship across different urban agglomerations. China has thirteen urban agglomerations, namely Zhongyuan Urban Agglomeration, Beijing-Tianjin-Hebei Urban Agglomeration, Guanzhong Plain Urban Agglomeration, North Bay Urban Agglomeration, Hubao'e Urban Agglomeration, Harbin-Changchun Urban Agglomeration, Shandong Peninsula Urban Agglomeration, Chengdu-Chongqing Urban Agglomeration, Western Coast of the Strait Urban Agglomeration, Pearl River Delta Urban Agglomeration, Liaozhongnan Urban Agglomeration, Yangtze River Delta Urban Agglomeration, and Yangtze River Midstream Urban Agglomeration. As of February 2018, seven of these urban agglomerations have been officially recognized by the State Council of the People's Republic of China. Figure 6 shows the geographical distribution of the thirteen urban agglomerations.

Based on the level of economic development and the connectivity of the regions, we categorize these thirteen urban agglomerations into two different tiers. The first-tier urban agglomerations include the Beijing-Tianjin-Hebei Urban Agglomeration, the Pearl River Delta Urban Agglomeration, and the Yangtze River Delta Urban Agglomeration. The second-tier urban agglomerations include the remaining ten urban agglomerations. We generate two dummy variables indicating whether a city is in the first-tier urban agglomerations or in the second-tier urban agglomerations, respectively. We then interact these two dummy variables with human capital spillovers and access to surrounding economic mass to test the heterogeneous spillover effects across different tiers of urban agglomerations.

Panel A of Figure 7 shows higher new firm formation rates and startup growth in urban agglomerations. Panel B of Figure 7 presents a more detailed breakdown and demonstrates that the entrepreneurial growth is decaying from the highest tier to the lowest tier of urban agglomerations. Figures 8 and 9 show that human capital spillovers and market integration also decrease from the highest tier to the lowest tier of urban agglomerations. We uncover these effects using regression analysis.

In Table 7, in addition to the control of the interaction term between the urban agglomeration dummy variable and the spillover variable, Columns (1) and (2) have the same specifications as the ones in Column (4) in Tables 3 and 4, where we conduct a panel regression analysis. Similarly, regression specifications of Columns (3) and (4) are the same as the one in Column (6) in Tables 3 and 4, where we conduct a pooled OLS regression analysis and control for the interaction term between the urban agglomeration dummy variable and the spillover variable. In particular, Columns (1) and (3) compare human capital spillovers and market integration effects between cities inside mega urban agglomerations and cities that do not belong to any of the urban agglomerations. Columns (2) and (4) further investigate whether there are differential spillovers in cities from the first-tier urban agglomerations and cities from the second-tier urban agglomerations. Panel A presents results for differential human capital spillovers, while Panel B reports results for heterogeneous effects of market integration on local innovation-driven entrepreneurship.

Our results reveal that, in terms of attracting burgeoning innovation-driven entrepreneurial activity, the cities that are in the mega urban agglomerations benefit more from human capital spillovers from nearby cities and from access to the potential markets in neighboring cities. We further break down the differential effects to different tiers of urban agglomerations. We show that human capital spillovers and market integration effects are robust in the first-tier urban agglomerations. Compared to the cities that do not lie in any of the thirteen urban agglomerations, the elasticity of innovation-driven entrepreneurship with respect to human capital spillovers is 0.10-0.21 higher in the first-tier urban agglomerations and the elasticity with respect to market potential is 0.03-0.04.

We also run regressions in Table 7 including human capital spillovers and market integration simultaneously. The results are presented in Table 8. In terms of intuition, we find similar results. The human capital spillovers and market integration effects are stronger in designated urban agglomerations. When dividing urban agglomerations further into different tiers, human capital spillovers and market integration effects decay with the level of the tier. The effects are significantly larger for the first tier urban agglomerations.

That said, the relative coefficient sizes are somewhat different from what we have in Table 7. Table 7 finds larger human capital spillovers as opposed to market integration effects, while market integration effects become stronger when we include both factors simultaneously. The volatility of the point estimates are mainly due to the issue multi-collinearity. In this sense, as comparisons, we still keep the results from including human capital spillovers and market integration in the paper.

We further estimate the same specifications using our Bartik IV. The results are presented in Table 9. The findings are largely consistent with those in Table 8.

5.4. Heterogeneity across Time Periods

In this section, we further analyze the heterogeneity in human capital spillovers and market integration effects over time. We include human capital spillovers and market integration simultaneously and estimate variants of specifications using 2SLS. We divide our estimation window into four sub-periods with equal time length. Panel A presents the results of the general effects. Panel B further breakdowns the analysis into different urban agglomeration tiers. The estimation results are presented in Table 10.

The human capital spillovers seem to have decayed during the estimation window. The spillovers are the strongest in the initial years and then have dissipated. There might be two explanations for this finding. First, the mobility constraint in China has been relaxed in the last decade. Second, Chinese local governments have provided all types of incentives to attract the skilled human capital, making the labor market much more mobile than before. However, our measure of human capital spillovers based on the location of universities may not be able to capture the mobility in skilled labor. One may use alternative measures of human capital spillovers to re-examine the time heterogeneity. We leave this for future research.

The overall market integration effects have increased during our estimation window. The effects are stronger in first-tier urban agglomerations. The heterogeneous market integration effects suggest that Chinese cities are more closely connected thanks to the improvement in infrastructure such as high-speed rail, aviation network, the booming IT sector, intercity coordination, etc. Urban agglomerations facilitate market integration (vertical disintegration) and increase the market size and demand for specialized products.

6. Discussion and Conclusion

This paper presents new evidence on the nature and extent of marked spatial variations in entrepreneurship in China. In particular, we investigate the roles of human capital spillovers and market integration in shaping the geography of entrepreneurship in a context of urban agglomeration integration.

Given the dynamic nature of human capital resources, we use an inverse distance weighted measure to disentangle the impact of local human capital on entrepreneurial activity from intercity human capital spillovers within a system of highly integrated cities. We find suggestive evidence of strong local human capital effects and intercity human capital spillovers. The elasticity of innovation-driven firm formation rate with respect to the local human capital level is 0.49-0.68, while the elasticity of startups is around 0.27. The elasticity of new innovation-driven firms with respect to human capital spillover is roughly 0.47-0.50 and the elasticity of startups is roughly 0.79.

Our analysis of heterogeneous effects identifies larger human capital spillovers and market integration effects in the first-tier urban agglomerations, within which cities have stronger economic bases, better institutions, and are highly integrated. Cities in the Beijing-Tianjin-Hebei Urban Agglomeration, the Pearl River Delta Urban Agglomeration, and the Yangtze River Delta Urban Agglomeration are the most vibrant and integrated urban areas that can retain talents and generate high demand for local goods and services. It is imperative to initiate policies aimed at reducing inequality among urban agglomerations and promoting innovation-driven entrepreneurial activity in underdeveloped urban agglomerations to provide them with new economic growth engines.

Cities with high-quality local universities and colleges have access to a large pool of specialized and skilled workforce members from which high-quality entrepreneurs emerge and thus receive large productivity gains to local firms due to human capital spillovers (Rauch, 1993; Moretti, 2004; Shapiro, 2006). It is also widely documented that the qualities of the entrepreneur play a more important role in determining new firm performance than market demand and the availability of factors of production (Barkham, 1992, 1994), although we do not observe relative coefficient sizes that are consistent with this argument. However, it is certain that the supply of high-quality entrepreneurs provides startups (especially technologically sophisticated firms) with an environment that facilitates innovation and growth. On a priori grounds, we ascribe China's marked spatial variation in the formation rate of innovative, growth-oriented new firms to regional differences in local human capital resources and its ability to gain human capital spillovers from other cities.

We also show a strong role of local market size and market integration in determining local entrepreneurship, possibly because larger market size leads to stronger incentives for individuals to become entrepreneurs (Di Addario and Vuri, 2010; Sato et al., 2012). The elasticity of innovation-driven firm formation rate with respect to local market size is 0.19-0.40, while the elasticity of startups is around 0.18. The elasticity of new innovation-driven firms with respect to market integration spillovers is roughly 0.53-0.72 and the elasticity of startups is roughly 0.90.

Overall, the strong spillover effect identified in our paper implies the ongoing urban agglomeration integration in China. We use the administrative boundary of cities to delineate the urban agglomeration boundaries in our analysis. However, it is worth noting that the boundary of the urban agglomeration is endogenous and hinges on a variety of factors such as transportation speed and cost (Dong et al., 2018), cross-city industry relatedness, and regional social connectedness. With regard to transportation network and its impact on urban entrepreneurship, it is imperative for urban policymakers to initiate policies that concern both urban management and infrastructure investment as traffic congestion might impede productivity gains to local entrepreneurial firms from knowledge and human capital spillovers (Firth, 2017). Another thought on defining urban agglomerations might be that whether regions and urban are connected to each other is not solely dependent on pure geographical proximity but often on relatedness of existing industries. The geographical concentration of related industries within an urban agglomeration would greatly promote human capital and knowledge spillovers, and enhance market integration, creating a synergy for sustaining innovation-driven entrepreneurial growth (Hildago et al., 2018).

Furthermore, for a single city's perspective, its strategy may be to maximize human capital spillovers and enhance market integration to boost local innovation-driven entrepreneurship. However, competition between cities may not lead to the overall desirable outcome for the whole urban agglomeration. A better win-win solution may be to consider the maximizing problem within urban agglomeration as a whole and promote local innovation-driven entrepreneurship through intercity coordination efforts within the urban agglomeration. In this respect, the integrated development of China's Greater Bay Area, including Hong Kong, Macau, and nine Guangdong cities, requires great intercity coordination efforts to transform the mega urban agglomeration into an innovation-driven entrepreneurship powerhouse (Cheung, 2018).

A promising research area would be to study how policies (such as subsidy, tax cut, and other favorable treatments) impact entrepreneurial firms' location choices in China and how policy push leads to possible spatial misallocation of human capital resources, space resources (entrepreneurship parks, innovation spaces, public rental housing targeting at young entrepreneurs, etc.), and capital resources (on both the government side and venture capital side). In addition, there is certainly more work required to improve the metrics of China's entrepreneurial activity. For instance, the quality and the quantity of entrepreneurship should be given equal attention when instituting local and regional policies aimed at facilitating innovation and entrepreneurship. We leave it for future research.

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Figure 1. Entrepreneurship, human capital spillovers, and market integration

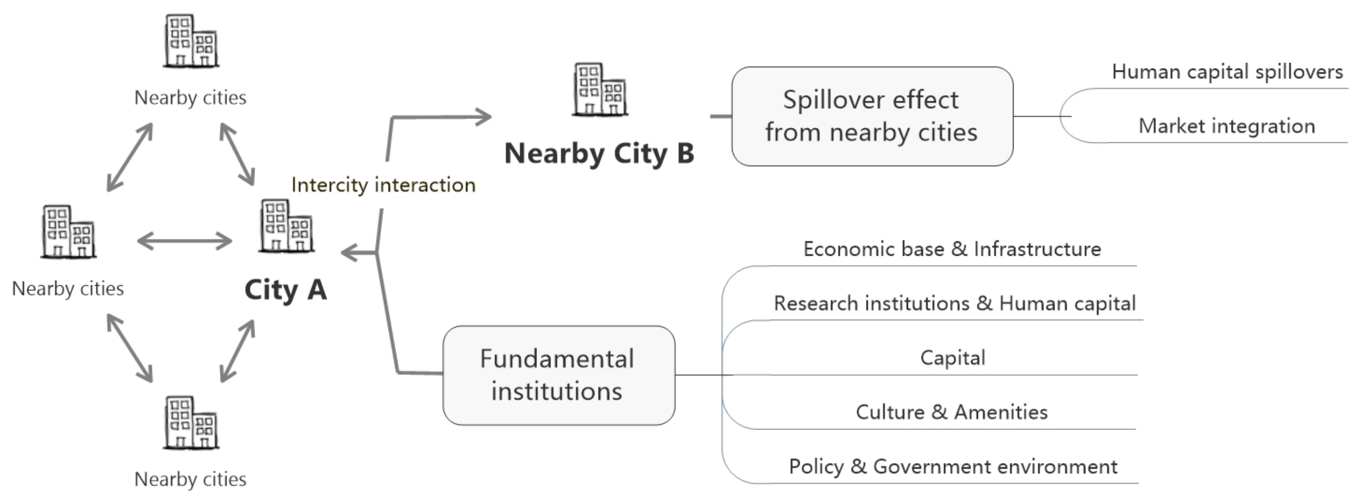
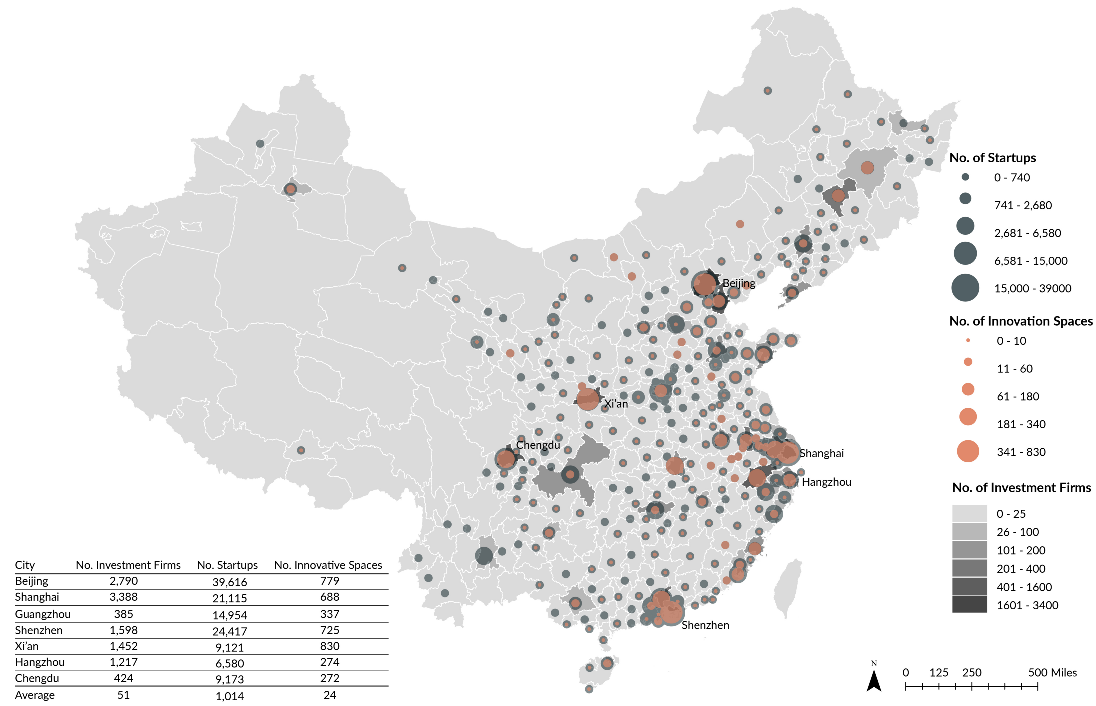


Figure 2. Economic geography of entrepreneurship in China



City	No. Investment Firms	No. Startups	No. Innovative Spaces
Beijing	2,790	39,616	779
Shanghai	3,388	21,115	688
Guangzhou	385	14,954	337
Shenzhen	1,598	24,417	725
Xi'an	1,452	9,121	830
Hangzhou	1,217	6,580	274
Chengdu	424	9,173	272
Average	51	1,014	24

Figure 3. Spatial-temporal and sectoral heterogeneity in new firm growth

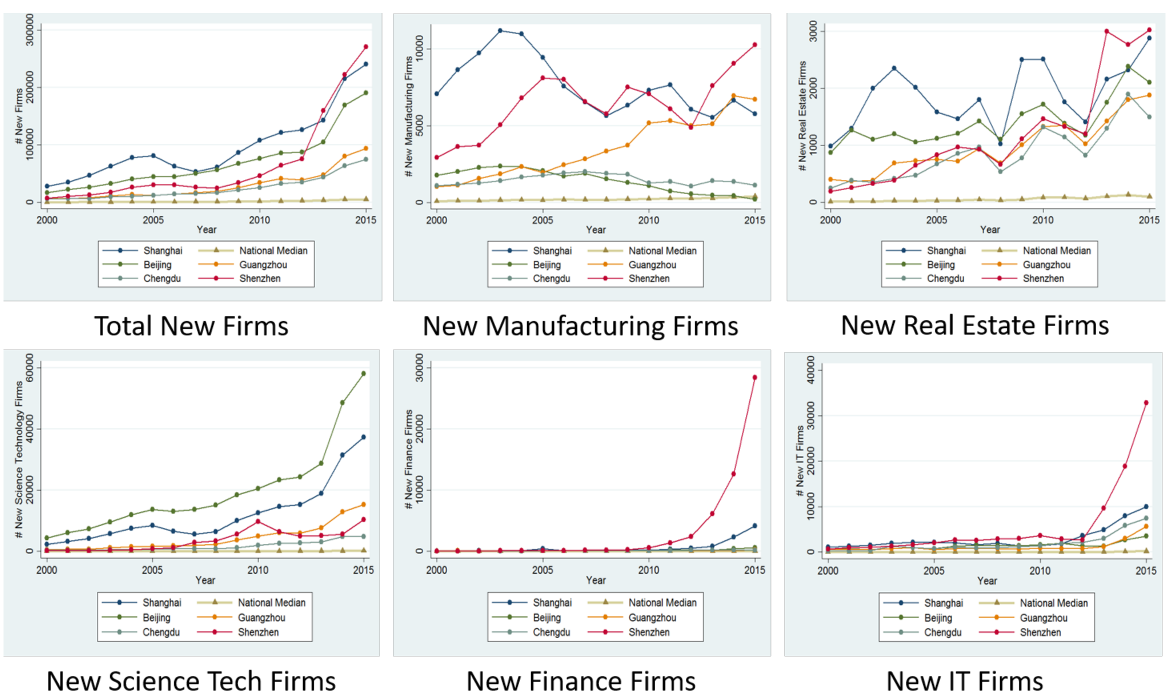


Figure 4. Human capital spillovers and new firm formation.

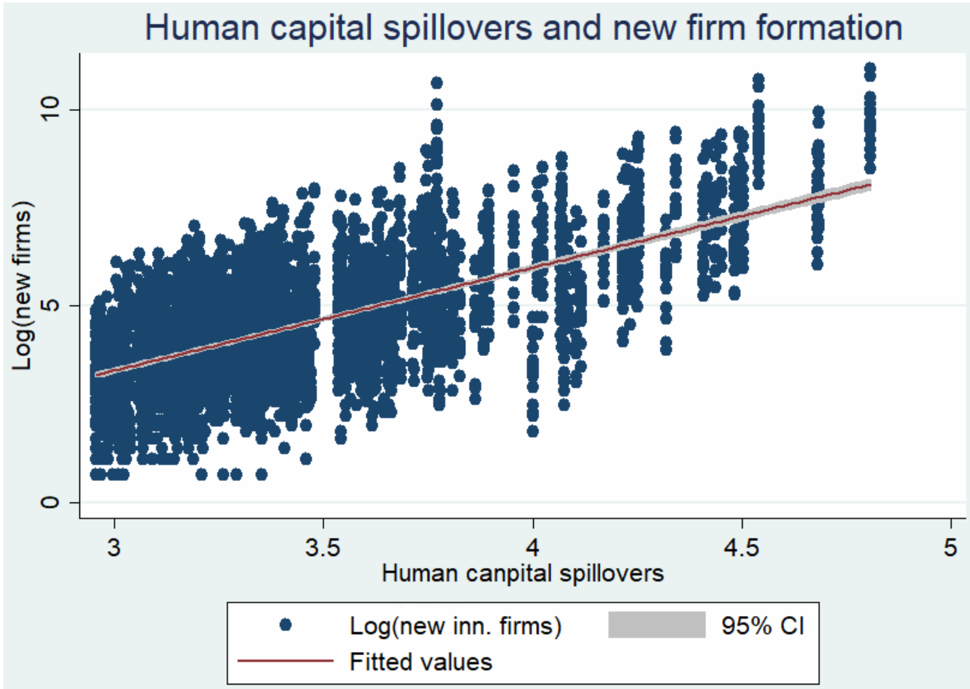


Figure 5. Market integration and new firm formation.

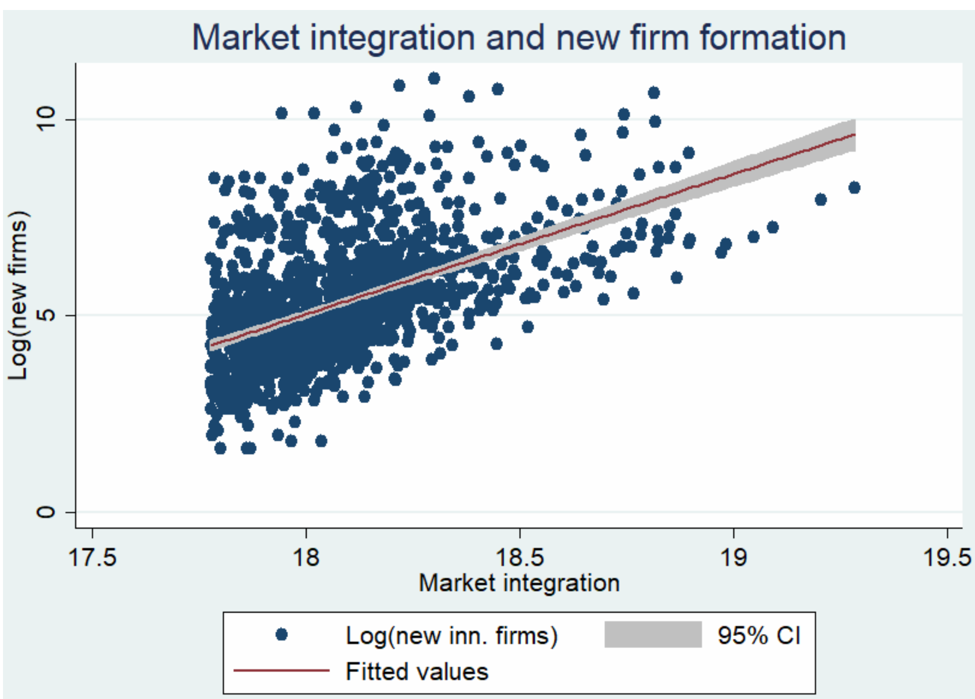


Figure 6. China's 13 urban agglomerations

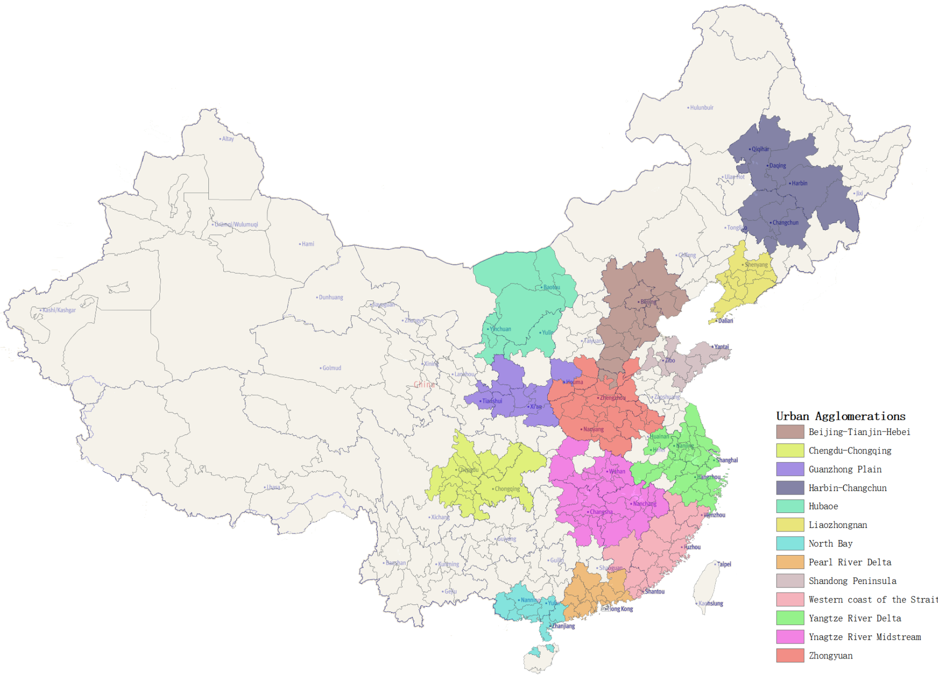
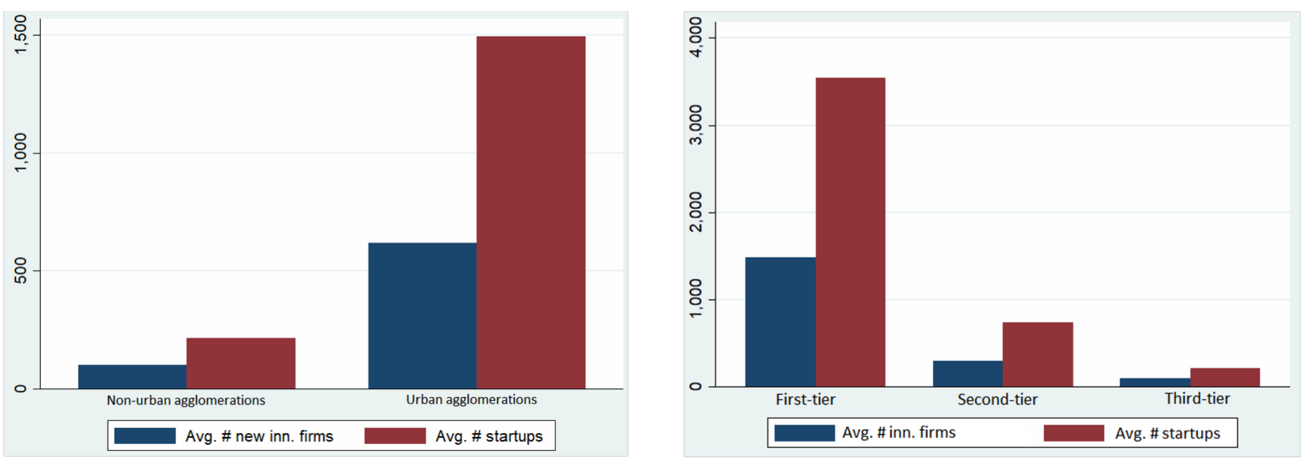


Figure 7. Urban agglomeration and entrepreneurship.



Panel A: Entrepreneurship in urban agglomerations and non-urban agglomerations.

Panel B: Entrepreneurship in different urban agglomerations tiers.

Figure 8. Human capital spillovers in different urban agglomeration tiers.

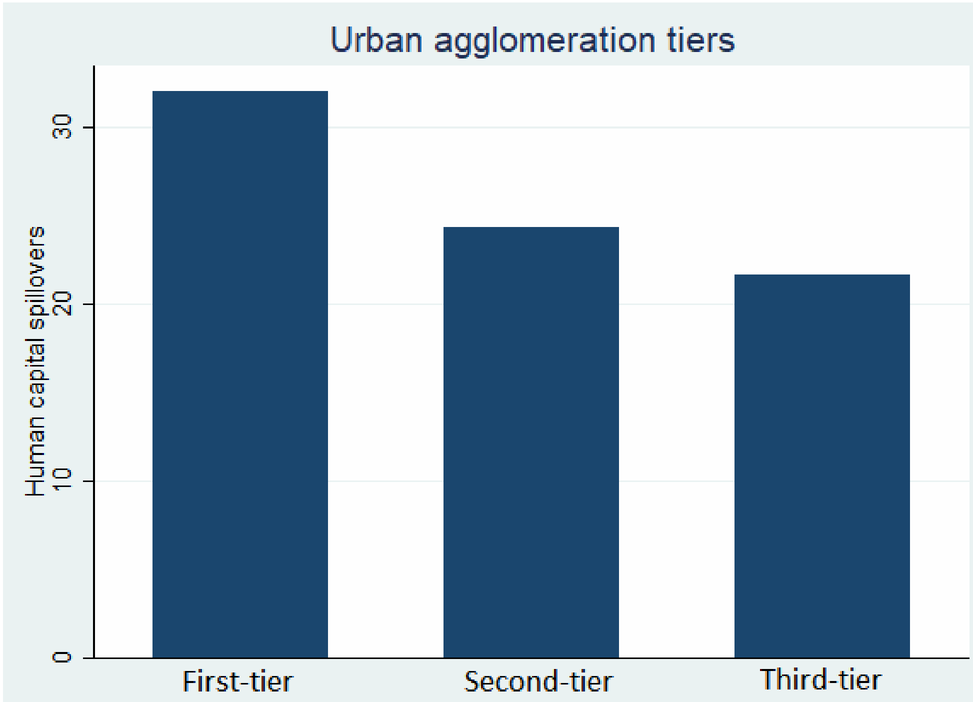


Figure 9. Market integration effects in different urban agglomeration tiers.

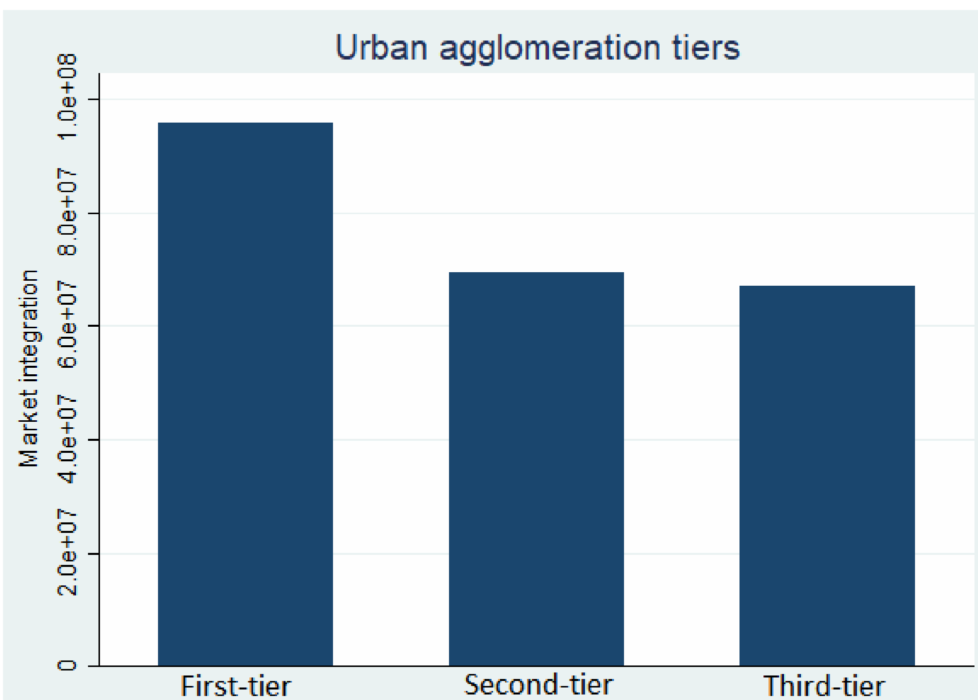


Table 1: Fundamental institutions: entrepreneurial capacity inputs

Categories	Entrepreneurship-capacity	
(1) **Economic base & infrastructure**	Local	Market size, industrial composition, industrial parks, Cum. FDI, airport, subway, high-speed rail, # internet users
	Spillover	Market potential of nearby cities
(2) **Research institutions & human capital**	Local	University, population weighted average schooling years
	Spillover	Inverse distance weighted effective number of universities
(3) **Capital**	Research funding (R&D expenditure), venture capital (investment firms)	
(4) **Culture and amenities**	Local	Pop. diversity, firm diversity, migration cost, pop. density Restaurants, coffee shops, air quality, weather
	Spillover	Imported air pollution from nearby cities
(5) **Policy & government environment**	Government initiative, property rights protection index % access to loans, time spent with government regulators	

Table 2: Summary statistics: entrepreneurship, spillovers, and foundational institutions

Variables	Description	Obs.	Mean	Std. dev.
PM_{10}[1]	PM_{10} concentration in air (mg/m^3)	761	0.10	0.05
Startups[2]	No. of startup companies	311	1038.5	3259.5
Spaces[2]	No. of innovation spaces	304	23.6	93.8
Investment firms[2]	No. of investment firms	311	51.2	287.4
New firms[3]	No. of newly registered firms	4944	4119.7	1.2×10^4
New high-tech firms[3]	No. of newly registered high-tech firms	5087	417.8	0.22×10^4
Firm diversity[3]	The diversity of firm stocks	5087	1.8	0.4
University[4]	No. of local universities	320	8.2	14.8
Human capital spillover[4]	Inverse distance weighted no. of univeristies	320	24.9	6.7
Avg. schooling[5]	Average years of schooling (year)	320	8.6	0.6
Migration cost[5]	Migration cost index	286	224.1	15.7
Cum. FDI ($Bn)[6]	Cumulative FDI	6515	1.7	7.2
% tertiary sector[6]	Employment share of tertiary sector (percent)	6074	42.6	12.9
Internet users[6]	No. of household internet subscribers ($\times 10^4$HH)	3240	43.9	74.7
R&D exp.[6]	Expenditure on science & tech (RMB Bn)	2869	0.40	1.6
Pop. diversity[6]	Diversity of city population	320	0.38	0.32
Pop. density[6]	Population density (pers./km^2)	6009	1200.3	2434.3
Industrial park[7]	No. of industrial parks	320	4.8	5.2
University quality[8]	Index of university quality	320	67.3	57.5
Airport[9]	Whether having an airport (=1)	312	0.53	0.50
Subway length[9]	Total length of subway line (km)	312	14.1	74.4
High speed rail[10]	Whether connected by high speed rail line (=1)	6312	0.08	0.27
Restaurants[11]	No. of restaurants and coffee shops	312	6306.8	10713.4
% access to loan[12]	Percent of firms having access to bank loans	120	0.60	0.14
Property rights protection[12]	Property rights protection index	120	0.64	0.17
Time with Gov.[12]	Time spent with four government regulators (days/year)	120	0.04	0.01

Source: (1) Data Center of PRC's Ministry of Environmental Protection; (2) ctoutiao.com; (3) State Administration for Industry and Commerce; (4) Ministry of Education; (5) 2010 Population Census; Migration cost index (Henderson et al., 2018); (6) City Stats Yearbook; Initial year is 2000; (7) Ministry of Housing & Urban-Rural Dev; (8) New Oriental; Index is calculated as the rank-weighted average score of the universities in a city; (9) AutoNavi; (10) 12306.cn; (11) dianping.com; (12) "China Governance, Investment Climate, and Harmonious Society: Competitiveness Enhancements for 120 Cities in China." World Bank. 2006.

Table 3: Human capital spillover: new firm and startup regressions

		Panel FE				OLS	
		DV: Log(# new inn. firms)				DV: Log(# startups)	
		(1)	(2)	(3)	(4)	(5)	(6)
Spillover	Log(human cap. spillover)		0.472**		0.501**		0.785***
			(0.200)		(0.199)		(0.224)
Res. institutions	Log(# university)	0.679***	0.673***	0.488***	0.486***	0.269***	0.274***
		(0.086)	(0.084)	(0.085)	(0.084)	(0.079)	(0.077)
Economic base & infrastructure	# Incumbent inn. firms	0.072	0.073	0.055***	0.057***	0.023*	0.022*
		(0.047)	(0.047)	(0.017)	(0.017)	(0.012)	(0.012)
	Airport (= 1)	0.170**	0.230***	0.132	0.194**	0.075	0.158**
		(0.083)	(0.088)	(0.083)	(0.086)	(0.074)	(0.079)
	High-speed rail (= 1)			0.050	0.046	0.060	0.027
				(0.051)	(0.051)	(0.075)	(0.074)
	Log(GDP per capita)	0.214***	0.215***	0.234***	0.232***	0.329***	0.319***
		(0.049)	(0.049)	(0.058)	(0.058)	(0.091)	(0.090)
	Log(population size)	0.233***	0.247***	0.116*	0.131**	0.124	0.204*
		(0.048)	(0.048)	(0.061)	(0.062)	(0.116)	(0.114)
	Log(population density)	-0.046	-0.052*	0.049	0.040	0.113*	0.081
		(0.031)	(0.031)	(0.036)	(0.036)	(0.057)	(0.058)
	Log(# internet users)			0.281***	0.281***	0.523***	0.505***
				(0.054)	(0.054)	(0.165)	(0.157)
Capital	Log(R&D expenditure)			0.082***	0.081***	0.172***	0.182***
				(0.026)	(0.026)	(0.045)	(0.044)
Culture & amenities	Log(# restaurants)	0.234**	0.234**	0.184*	0.186**	0.156	0.153
		(0.105)	(0.101)	(0.097)	(0.093)	(0.100)	(0.093)
	Firm diversity	0.572***	0.602***	1.287***	1.323***	0.095	0.128
		(0.217)	(0.217)	(0.206)	(0.204)	(0.134)	(0.126)
	City fixed effects	✓	✓	✓	✓	✓	✓
	Year fixed effects	✓	✓	✓	✓		
	Other controls	✓	✓	✓	✓	✓	✓
	Obs.	3902	3902	1828	1828	261	261
	Overall R^2/adj. R^2	0.793	0.795	0.826	0.828	0.896	0.901

Standard errors clustered by cities. * $p < 0.1$, ** $p < 0.05$, ***$p < 0.01$

Table 4: Market integration: new firm and startup regressions

		Panel FE				OLS	
		DV: Log(# new inn. firms)				DV: Log(# startups)	
		(1)	(2)	(3)	(4)	(5)	(6)
Spillover	Log(market integration)		0.724**		0.534*		0.894***
			(0.335)		(0.311)		(0.319)
Economic base & infrastructure	Log(GDP)	0.297***	0.400***	0.185***	0.245***	0.176*	0.175*
		(0.066)	(0.088)	(0.065)	(0.080)	(0.104)	(0.100)
	# Incumbent inn. firms	0.072	0.041*	0.061***	0.051**	0.021	0.023*
		(0.048)	(0.021)	(0.022)	(0.024)	(0.013)	(0.013)
	Airport (= 1)	0.312***	0.248***	0.217**	0.197**	0.099	0.137*
		(0.109)	(0.094)	(0.091)	(0.084)	(0.075)	(0.078)
	High-speed rail (= 1)			0.061	-0.020	0.061	0.053
				(0.051)	(0.048)	(0.078)	(0.078)
	Log(GDP per capita)	0.114*	0.089	0.184***	0.075	0.309***	0.293***
		(0.058)	(0.096)	(0.070)	(0.089)	(0.089)	(0.089)
	Log(population size)	0.259***	0.387***	0.145**	0.247**	0.128	0.199
		(0.058)	(0.107)	(0.065)	(0.103)	(0.119)	(0.121)
	Log(population density)	-0.039	0.126***	0.042	0.101**	0.132**	0.140**
		(0.033)	(0.048)	(0.038)	(0.049)	(0.059)	(0.057)
	Log(# internet users)			0.332***	0.336***	0.573***	0.538***
				(0.059)	(0.077)	(0.170)	(0.166)
Capital	Log(R&D expenditure)			0.083***	0.074***	0.148***	0.156***
				(0.027)	(0.028)	(0.052)	(0.052)
Culture & amenities	Log(# restaurants)	0.472***	0.368***	0.308**	0.268***	0.197*	0.182*
		(0.153)	(0.133)	(0.131)	(0.102)	(0.110)	(0.103)
	Firm diversity	0.645***	1.195***	1.352***	1.460***	0.113	0.172
		(0.213)	(0.214)	(0.200)	(0.216)	(0.133)	(0.133)
City fixed effects		✓	✓	✓	✓	✓	✓
Year fixed effects		✓	✓	✓	✓		
Other controls		✓	✓	✓	✓	✓	✓
Obs.		3902	1056	1828	900	261	261
Overall R^2/adj. R^2		0.781	0.871	0.820	0.872	0.893	0.895

Standard errors clustered by cities. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 5: Human capital spillover and market integration: interaction effects.

		DV: Log(# new inn. firms)		
		(1)	(2)	(3)
Spillover	Log(human cap. spillover)		0.579**	0.635**
			(0.249)	(0.245)
	Log(market integration)		0.680*	0.861**
			(0.350)	(0.376)
	Log(human cap. spillover)×Log(market integration)			-0.442
				(0.333)
Res. institutions	Log(# university)	0.375***	0.180*	0.178*
		(0.068)	(0.105)	(0.105)
Economic base & infrastructure	Log(GDP)	0.344***	0.320***	0.329***
		(0.063)	(0.068)	(0.069)
	# Incumbent inn. firms	0.168**	0.101**	0.135**
		(0.066)	(0.041)	(0.058)
	Airport (= 1)	0.122*	0.178**	0.188**
		(0.069)	(0.072)	(0.073)
	Log(GDP per capita)	0.129*	0.111	0.106
		(0.071)	(0.088)	(0.087)
	Log(population size)	0.308***	0.407***	0.406***
		(0.063)	(0.087)	(0.087)
	Log(population density)	0.052	0.095**	0.085*
		(0.037)	(0.043)	(0.044)
Culture & amenities	Log(# restaurants)	0.155*	0.202**	0.206**
		(0.088)	(0.080)	(0.081)
	Firm diversity	1.265***	1.644***	1.646***
		(0.146)	(0.159)	(0.159)
	City fixed effects	✓	✓	✓
	Year fixed effects	✓	✓	✓
	Other controls	✓	✓	✓
	Obs.	3902	3902	3902
	Overall R^2/adj. R^2	0.822	0.889	0.889

Standard errors clustered by cities. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 6: Human capital spillover and market integration: 2SLS estimation of the interaction effects.

		DV: Log(# new inn. firms)		
		(1)	(2)	(3)
Spillover	Log(human cap. spillover)		0.472*	0.531**
			(0.255)	(0.249)
	Log(market integration)		0.717**	0.910**
			(0.349)	(0.378)
	Log(human cap. spillover)×Log(market integration)			-0.471
				(0.330)
Res. institutions	Log(# university)	0.266***	0.196*	0.193*
		(0.084)	(0.106)	(0.105)
Economic base & infrastructure	Log(GDP)	0.680***	0.400***	0.411***
		(0.139)	(0.079)	(0.079)
	# Incumbent inn. firms	0.121**	0.096**	0.132**
		(0.055)	(0.039)	(0.056)
	Airport (= 1)	0.081	0.156**	0.165**
		(0.072)	(0.073)	(0.073)
	Log(GDP per capita)	-0.031	0.052	0.046
		(0.091)	(0.089)	(0.089)
	Log(population size)	0.287***	0.381***	0.379***
		(0.066)	(0.088)	(0.088)
	Log(population density)	0.030	0.093**	0.083*
		(0.042)	(0.046)	(0.047)
Culture & amenities	Log(# restaurants)	0.101	0.190**	0.195***
		(0.068)	(0.075)	(0.076)
	Firm diversity	1.281***	1.617***	1.623***
		(0.171)	(0.195)	(0.194)
	First F-stat	68.36	79.86	93.48
	City fixed effects	✓	✓	✓
	Year fixed effects	✓	✓	✓
	Other controls	✓	✓	✓
	Obs.	3462	3462	3462
	Overall R^2/adj. R^2	0.810	0.880	0.880

Standard errors clustered by cities. * $p < 0.1$, ** $p < 0.05$, ***$p < 0.01$

Table 7: Heterogeneous spillovers across urban agglomerations

	Panel FE		OLS	
	DV: Log(# new inn. firms)		DV: Log(# startups)	
	(1)	(2)	(3)	(4)
Panel A: Human capital spillovers				
Log(human capital spillover)	0.051*		0.127***	
$\times$Urban agglomeration	(0.030)		(0.034)	
Log(human capital spillover)		0.104***		0.213***
$\times$1st tier urban agglomeration		(0.037)		(0.047)
Log(human capital spillover)		0.045		0.116***
$\times$2nd tier urban agglomeration		(0.030)		(0.034)
Panel B: Market integration				
Log(market integration)	0.013*		0.013**	
$\times$Urban agglomeration	(0.007)		(0.006)	
Log(market integration)		0.035***		0.031***
$\times$1st tier urban agglomeration		(0.009)		(0.009)
Log(market integration)		0.010		0.011**
$\times$2nd tier urban agglomeration		(0.007)		(0.006)

Standard errors clustered by cities. * $p < 0.1$, ** $p < 0.05$, ***$p < 0.01$

Table 8: Heterogeneous human capital spillovers and market integration effects

	Panel FE		OLS	
	DV: Log(# new inn. firms)		DV: Log(# startups)	
	(1)	(2)	(3)	(4)
Log(human capital spillover)	0.058*		0.059**	
×Urban agglomeration	(0.031)		(0.029)	
Log(human capital spillover)		0.085**		0.125***
×1st tier urban agglomeration		(0.042)		(0.044)
Log(human capital spillover)		0.064		0.045
×2nd tier urban agglomeration		(0.039)		(0.037)
Log(market integration)	0.107*		0.115**	
×Urban agglomeration	(0.060)		(0.054)	
Log(market integration)		0.125*		0.234***
×1st tier urban agglomeration		(0.069)		(0.080)
Log(market integration)		0.067		0.064
×2nd tier urban agglomeration		(0.071)		(0.068)

Standard errors clustered by cities. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 9: Heterogeneous human capital spillovers and market integration (2SLS estimation results)

	Panel FE		OLS	
	DV: Log(# new inn. firms)		DV: Log(# startups)	
	(1)	(2)	(3)	(4)
Log(human capital spillover)	0.051*		0.127***	
×Urban agglomeration	(0.030)		(0.034)	
Log(human capital spillover)		0.104*		0.213***
×1st tier urban agglomeration		(0.037)		(0.047)
Log(human capital spillover)		0.045		0.116***
×2nd tier urban agglomeration		(0.030)		(0.034)
Log(market integration)	0.013*		0.013**	
×Urban agglomeration	(0.007)		(0.006)	
Log(market integration)		0.035***		0.031***
×1st tier urban agglomeration		(0.009)		(0.009)
Log(market integration)		0.010		0.011**
×2nd tier urban agglomeration		(0.007)		(0.006)

Standard errors clustered by cities. * $p < 0.1$, ** $p < 0.05$, ***$p < 0.01$

Table 10: Differential effects across time periods.

DV: Log(# new inn. firms)	2000-2003 (1)	2004-2007 (2)	2008-2011 (3)	2012-2015 (4)
Panel A: Overall effects				
Log(human cap. spillover)	0.755***	0.442	0.326	0.290
	(0.290)	(0.271)	(0.307)	(0.304)
Log(market integration)	0.453	0.686*	0.849**	1.019***
	(0.378)	(0.376)	(0.399)	(0.392)
Ob.	861	865	868	868
adj. R^2	0.862	0.872	0.860	0.863
Panel B: Effects of different tiers				
Log(human cap. spillover)	0.075	0.121*	0.099	0.062
×1st tier urban agglomeration	(0.066)	(0.069)	(0.066)	(0.072)
Log(human cap. spillover)	0.035	0.046	0.040	0.009
×2nd tier urban agglomeration	(0.064)	(0.068)	(0.065)	(0.075)
Log(market integration)	0.056	0.067	0.077*	0.082*
×1st tier urban agglomeration	(0.040)	(0.041)	(0.043)	(0.049)
Log(market integration)	0.045	0.049	0.053	0.063
×2nd tier urban agglomeration	(0.038)	(0.038)	(0.040)	(0.048)
Ob.	861	865	868	868
adj. R^2	0.759	0.757	0.762	0.701

Standard errors are clustered by cities. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$