

Yi Zhang\* and Hein Roelfsema

# Entrepreneurial Ecosystems, New Business Formation, and Scale-up Activity: Evidence from 286 Chinese Cities

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**Abstract:** This paper examines the effects of the quality of entrepreneurial ecosystems on new business formation and scale-up activity in China at the city-industry level. Accounting for only large and fast-growing firms, we focus on productive entrepreneurship which creates economic wealth. Based on a newly constructed panel dataset for 29 manufacturing industries and 286 prefecture-level cities of China during the period 1998–2009, we find that entrepreneurial ecosystem components, including access to finance, knowledge, marketization, local market demand, and entrepreneurial culture, are important determinants in explaining the differences in entrepreneurial activity across city-industry clusters and over time. Analysing a dynamic period in China’s industrialization with large regional variation in economic development, we show that the relative importance of the ecosystem components in shaping entrepreneurial activity changes over time when regions develop. In addition, we show that interaction between the ecosystem components – indicating system strength – has additional power in explaining new business formation and scale-up activity.

**Keywords:** entrepreneurial ecosystems, new firm formation, business scale-up

**JEL Codes:** L1, O14, O43

## 1 Introduction

Supporting entrepreneurship is key to economic development, as entrepreneurs devote themselves to using new technologies and introducing innovative products

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\*Corresponding author: Yi Zhang, Xian Jiaotong University Jinhe Center for Economic Research, Xian, 710049, China, E-mail: zhangyi.econ@mail.xjtu.edu.cn

Hein Roelfsema: Utrecht University School of Economics, Utrecht, Utrecht, Netherlands

and services, resulting in the creative destruction of unproductive practices (Van Stel, Carree, and Thurik 2005; Wennekers and Thurik 1999). Following a large early literature on how individuals become successful entrepreneurs (Shane and Venkataraman 2000), there is substantial evidence that the propensity of creating a successful innovative company is influenced by the regional entrepreneurial context in which these young firms operate and that some regions are more successful in stimulating productive new firms than others (Audretsch, Belitski, and Desai 2015; Audretsch and Belitski 2017). Central to explaining the spatial variation in new innovative business formation is the entrepreneurial ecosystem approach, see for recent surveys of this field (Alvedalen and Boschma 2017; Malecki 2018; Sternberg, von Bloh, and Coduras 2019). Entrepreneurial ecosystems may be defined as “a set of interdependent actors and factors coordinated in such a way that they are enabling productive entrepreneurship” (Stam 2015, p. 1765). Initially, a popular policy-oriented literature emerged on how to create entrepreneurial ecosystems that aimed at identifying individual components supporting startup entrepreneurship (Isenberg 2010; Mason and Brown 2014) and how entrepreneurial ecosystems may support scale-up firms that facilitate regional job creation (Autio and Rannikko 2016; Spigel 2017). The most common components studied and codified are access to finance, high ranking universities to tap talent, the presence of launching customers, and leadership by policymakers and serial entrepreneurs (Autio et al. 2014; Isenberg 2010; Mason and Brown 2014; Stam 2015). Also, there is consensus on the importance of regional entrepreneurial culture, a concept that has proven elusive to capture empirically (Autio and Levie 2015; Saxenian 1990; Spigel 2017).

On top of these individual ecosystem components, the multilateral interdependence and complementarity between them are crucial for entrepreneurial ecosystems to function as an actionable business model for the region (Adner 2017; Autio et al. 2014; Roundy, Bradshaw, and Brockman 2018). However, how to operationalize interdependence, feedback loops, and complexity of ecosystem components has so far proven to be difficult (Stam 2018). Some quantitative studies on ecosystems treated whole countries as ecosystems (Acs, Autio, and Szerb 2014; Acs et al. 2018), resulting in a discussion on the proper level at which to study entrepreneurial ecosystems (Sternberg, von Bloh, and Coduras 2019). A major empirical problem though is that for many countries the within border variance in the hard’ institutional components of ecosystems (rules and regulations) is low, while the “soft” elements (culture and mindset) at the regional level are difficult to measure. Some more recent studies choose a multilevel approach using country- and regional-level variables to show the effects of ecosystems on entrepreneurship for the US (Qian, Acs, and Stough 2013), the EU (Audretsch and Belitski 2017; Bruns et al. 2017; Content et al. 2019; Szerb et al. 2019), and China (Lai and Vonortas 2019).

Although these studies make substantial progress in capturing the effects of ecosystem components and their interdependence, they fall short in two aspects. First, multilevel studies have limited variation in ecosystems within countries. Second, so far, there are no quantitative studies that analyse the dynamics of ecosystems both in terms of ecosystem emergence (Lichtenstein 2014) and evolution (Mack and Mayer 2016). For these reasons, there is consensus among entrepreneurial ecosystem scholars – as expressed in the leading recent surveys of the field (Boschma 2017; Malecki 2018; Spigel 2018) – that three elements are in short supply: studies that have enough regional variation to capture cross-sectional effects; studies that include a longitudinal component to capture the evolution of ecosystems; and studies that explicitly take up the interdependence of ecosystem components.

Referring to these three gaps, our study aims to contribute to the literature by (i) focusing on new business formation and scale-up activity at the city-industry level and thus introducing a novel and narrow boundary to the empirical measurement of an entrepreneurial ecosystem, (ii) examining the effects of entrepreneurial ecosystem components over time, and (iii) including a measure of interdependence tailored to quantitative analysis. First, in the context of China (large enough to study subnational variation in ecosystems), we analyse the effects of ecosystems at the city-industry level to capture variation in entrepreneurship across industries within a city. Second, regarding the analysis of ecosystems over time, this study captures the longitudinal effects of how entrepreneurial ecosystems shape entrepreneurial activities and shows the relative importance of entrepreneurial ecosystem components over time with panel analysis. As a third contribution, we analyse the interdependence of ecosystem components identified in the literature and bring hypotheses to a dataset that is rich enough to test the interactions among the ecosystem components. In contrast to qualitative analysis in the context of developed economies (Brown and Mason 2017; Mack and Mayer 2016), we show that in China the importance of the system effect increases over time, both for new business formation and scale-up activity.

Our analysis is based on a large newly constructed panel dataset by the authors for 29 manufacturing industries and 286 prefecture-level cities of China during the period 1998–2009. To measure entrepreneurship outcomes, we focus on only productive entrepreneurship, or young firms that create economic progress through innovation and job creation. For entrepreneurial ecosystem components, we create indices for access to finance, knowledge, marketization, local market demand, and entrepreneurial culture. Moreover, we use interaction terms of the components to investigate the multilateral interdependence and system strength. Using a fixed effects panel estimation model to control for unobserved time-invariant city-industry characteristics, we find strong support for individual

ecosystem components affecting entrepreneurial activity. By studying a dynamic period in China's industrialization with highly unequal regional development, we track the differential effects of ecosystem components over time and across regions. Further, we show that the system effect on entrepreneurial activity is significantly positive and becomes more important over time.

The rest of the paper is organized as follows. Section 2 introduces the entrepreneurial ecosystem literature to motivate the contributions of the paper and to derive explicit hypotheses. Section 3 introduces the data sources, constructed variables, and the estimation strategy. Section 4 presents some stylized facts about the data. Section 5 is the results section in which we provide the baseline results as well as the interactions of interest in an integrated framework. In Section 6 we discuss these results. Section 7 concludes and is the part where we aim to draw up some policy recommendations and support for future research.

## 2 Conceptual Background and Hypotheses Development

### 2.1 Related Literature

Much of the early literature on entrepreneurship has a clear focus on the role of the individual entrepreneurs in business success and the role that such entrepreneurs play in creative destruction through “neue kombinationen” (Schumpeter 1934). In the Schumpeterian tradition, the market economy creates disequilibrium situations and entrepreneurs quickly spot arbitrage opportunities to generate profits with new offerings. Though entrepreneurs need to be superior in recognizing such opportunities (Shane and Venkataraman 2000), the speed with which they can move and make decisions is influenced by the institutional context. Hence, several empirical studies have started to link institutions at the national level (e.g. rule of law, dominant culture) to the emergence of the entrepreneurial society (Bjørnskov and Foss 2013, 2016; Bosma, Sanders, and Stam 2018; Urbano, Aparicio, and Audretsch 2019). This work also culminates in the construction of the currently most popular Global Entrepreneurship and Development (GEDI) Index that combines many institutional variables at the country level to opinions on entrepreneurship of stakeholders through the Global Entrepreneurship Monitor survey (Acs, Szerb, and Autio 2016).

The large literature on regional entrepreneurial ecosystems that closely related to this work may be captured in three overlapping waves and an emerging fourth wave. The first wave was started by practitioners (entrepreneurs and

policymakers) in the early 2000s and asked how policies supporting entrepreneurship should be shaped in a regional context (Isenberg 2010; Mason and Brown 2014). The aim of the first wave contributors was to identify intermediate policy targets in the form of objectively measurable ecosystem components that are directly connected to innovative startup entrepreneurship. The foundation of the practice-based approach to entrepreneurial ecosystems largely is the documentation and conceptual capture of entrepreneurial narratives that deal with the question of how the local environment has determined entrepreneurial success (Feld 2012). One of the main reasons for creating these narratives is that they shape the identity of entrepreneurial regions and put individual entrepreneurs at the center of development. As a confrontation with the earlier literature on institutions and policies, putting entrepreneurs and their values of reciprocity first is a provocative break with the view that policy is all important in shaping local economic development. It was also the start of thinking about entrepreneurial leadership in ecosystems and making the entrepreneurial *lead* as the central actor (agent). Much energy in the first wave is also put in finding ecosystem components that feed entrepreneurial leadership. Going through the factors identified, important components include access to finance, strong local government support and regulation, launching customers in the form of large companies, the integration of local knowledge institutions, and regional entrepreneurial culture.

A second wave introduces theoretical concepts to provide a conceptual background to the ecosystem components identified in the first wave and introduces the challenges of analysing the interdependence and complexity of individual components. The second wave focuses on how the practice-oriented components of the first wave connect to theoretical lenses like social construction (Spigel 2017) or institutionalism (Stam and van de Ven 2019), and concepts like (dynamic) capabilities (Autio et al. 2014). This created a search for providing theory embedded formal definitions of the ecosystem components and of the entrepreneurial ecosystem itself (Autio and Levie 2015). Because many of these theoretical concepts stress the interdependence and complexity of structures and networks, much of the focus shifted from the individual components to capturing comprehensive factors and system effects. This resulted in a narrowing down of the many components to integrate them into overarching factors, investigate how these factors are interdependent, and analyse how to define and at what level to measure entrepreneurial ecosystem effects (O'Connor et al. 2018; Spigel 2017). Although there are a multitude of approaches loosely captured under complex systems analysis (Roundy, Bradshaw, and Brockman 2018), the consensus is that regional systems should focus on ensuring a strong culture of entrepreneurship (social construction), effective social interaction between agents (networks) and collective leadership, ownership and incentives (institutionalism), as well as high-

quality infrastructure to support entrepreneurship (Spigel 2017). Much of this conceptual literature discusses how these institutional elements interact with each other to arrive at a specific regional success formula. By doing so, the second wave moves away from the analysis of ecosystems as “ingredients” towards the analysis of “recipes” in which ingredients interact to form a regional business model (Adner 2017).

The third wave is an attempt to keep the theoretical lenses on the one hand, and on the other hand operationalizing the new complex insights into policies that support productive entrepreneurship (Acs et al. 2017; Autio and Levie 2015; Stam and van de Ven 2019). Again, there appears to be convergence, where the primary institutional components from the practice-based literature are linked to more theoretically based insights, and where the interaction of the elements that lead to a unique regional composition is examined in particular. Coming out from this wave is the integrative approach of analysing ecosystem components and their interaction (Stam and van de Ven 2019). Also, following the conceptual literature, more attention is paid to linking the insights with the emerging literature on the complex systems approach to economic policy making.

The third wave research provides many tools for quantitative analysis, so that an emerging fourth wave caters to the demands for evidence-based policy making and aims at using the ecosystem components and concepts for interdependence and complexity in quantitative studies. Upcoming are multilevel studies combining countries and regions in a cross-sectional setting. After initially finding no significant ecosystem effects (Bruns et al. 2017), in recent work using latent variables Content et al. (2019) find that ecosystem constructs affect entrepreneurial activity across European regions. One study close to ours is Lai and Vonortas (2019), which is also focused on Chinese cities and investigates the direct and indirect effects of regional factors on the strength of entrepreneurial ecosystems using a structural equation model. This is quite complementary to our focus of using panel methods to study evolution over time of the effects of ecosystem strength on new business formation and scale-up activity.

Following the call to action from the recent surveys on entrepreneurial ecosystems (Boschma 2017; Malecki 2018), we add to the fourth wave of quantitative research by studying the effects of ecosystems over time taking into account that ecosystem components are interdependent in how they affect entrepreneurial outcomes. We follow the emerging definition of the entrepreneurial ecosystems in Stam (2015) as mentioned on page 2, although it should be mentioned that the definition of entrepreneurial ecosystem remains a topic of sometimes heated debate and a unifying concept for empirical guidance has still to emerge (Sternberg, von Bloh, and Coduras 2019). There are two main elements in this definition. The first is that entrepreneurial ecosystems enable productive

entrepreneurship as opposed to necessity-driven entrepreneurship. The second is the word “interdependent” that emphasizes explicitly the way in which individual ecosystem components can work together to result in productive entrepreneurship.

## 2.2 Hypotheses Development

As discussed in the previous subsection, over time the entrepreneurial ecosystem literature has provided several systematic findings linking individual entrepreneurial behavior to regional contextual conditions. A challenge is to link these conceptual notions to metrics coming from secondary sources (O'Connor et al. 2018), but progress has been made. What is least debated is that regional access to finance is crucial for the success of startups and scale-ups (Kerr and Nanda 2009; Samila and Sorenson 2010). Access to finance is often measured by the availability of bank loans and the presence of venture capital in the region (Leendertse, Schrijvers, and Stam 2020). Also, there is a close connection between new firm formation and local knowledge and human capital (Acs and Armington 2004), in the form of local universities and higher vocational studies (Klofsten et al. 2019), entrepreneurship specific education and training (Rauch and Rijsdijk 2013), and the creation of new knowledge for example through R&D investment (Qian, Acs, and Stough 2013). There is also consensus on the importance of supporting institutions in entrepreneurship (Baumol 1996; Boudreaux and Nikolaev 2019). As an important aspect of the institutional environment, the quality of government has shown to play a crucial role in entrepreneurship (Stam and van de Ven 2019). In the context of China, local institutional quality can be captured by the degree of marketization in the local economy (Wang, Fan, and Yu 2017). For national level studies, the role of the government in setting regulatory frameworks that support entrepreneurship is very important as well (Stam 2015). However, as such legislation may not differ that much between regions, there is little reason to include it in within-country analysis. Then, for business-to-business startups, launching customers are important for young firms, which may be captured by the presence of large firms in the supply chain of startups in the region (Howells 2006). For business-to-consumer startups, regional spending by households is important (Eckhardt and Shane 2003). It is well documented that emerging market consumers are especially keen on the products of innovative startups that improve their lives (Zhou 2006). Lastly, there is also a broad consensus that the most difficult concept to capture in specific metrics is the local entrepreneurial culture (Spigel 2018). If the objective is to describe ecosystem strengths, the number of startup firms can be regarded as some kind of revealed entrepreneurial culture (O'Connor et al. 2018; Stam and van de Ven 2019). Also, there are aggregated

measures at the country level on trust and social capital that emerge from organizations like the World Values Survey and the indices coming from the cross-cultural literature like for example the well-known Hofstede indices. In addition, the culture element may be captured by social attitudes towards entrepreneurship (Fritsch and Wyrwich 2014; Hayton, George, and Zahra 2002). This leads to our first hypothesis on the importance of ecosystem components:

**Hypothesis 1:** The key components of entrepreneurial ecosystems (access to finance, knowledge, marketization, demand, and culture) will have a positive influence on entrepreneurial activity.

Recently, there is increased attention being paid to the evolution of entrepreneurial ecosystems (Mack and Mayer 2016). In their work, the foundation of the evolutionary process rests in the interaction of the individual ecosystem components that create specific paths of development over time. Through their case study approach, they hypothesize that the interaction of history, culture, and institutions connects to observable ecosystem components and the development of these components. They then show the changes in the relative importance of ecosystem components over time. However, the theoretical foundations on the dynamics of entrepreneurial ecosystems are still in short supply. Building on empirically validated arguments developed in the evolutionary approach to clusters (Menzel and Fornahl 2010), entrepreneurial ecosystems would see a birth, growth, sustain, and decline process. The driving process is that firms develop absorptive capacity and learning capabilities which interact with various ecosystem components differently over time. Hence, the full value of an ecosystem as a system will only accrue to firms over time when absorptive capacity of these firms evolves with the ecosystem components themselves. Given the dynamics in China, we would argue that the birth and growth stages are especially relevant for our study. An important insight of this literature is that system components need strengthening over time before they may become effective in shaping entrepreneurial outcomes. This boils down to our second hypothesis with respect to how entrepreneurial ecosystems may shape entrepreneurship over time:

**Hypothesis 2:** The effects of the ecosystem components on entrepreneurial activity become larger and more significant over time when regions develop.

One may argue that entrepreneurial success in a region has more to do with how entrepreneurial actions are supported by the entrepreneurial ecosystem as a whole. Hence, one may see the entrepreneurial ecosystem as a regional business model in itself supporting local entrepreneurs as customers. It functions as a secret sauce for entrepreneurial success, in which especially the interaction between the components of ecosystems is important in supporting individual entrepreneurial



actions (Autio et al. 2018; Roundy, Bradshaw, and Brockman 2018). However, there is limited empirical evidence on the interaction effects of the entrepreneurial ecosystem components on regional entrepreneurial success. An important reason is multicollinearity between the factors that may explain regional entrepreneurial outcomes. To work around this, several variables have to be grouped together and have to be standardized to capture the overall concept of for example institutions and knowledge capital. Therefore, in order to find the secret source for success, one has to find out in what way components interact to explain the relation between ecosystem differences and entrepreneurial outcomes across regions and over time. This results to our third hypothesis on system interdependence:

**Hypothesis 3:** The interaction between ecosystem components capturing their alignment will positively affect new business formation and scale-ups and will become more important over time.

From a policy perspective, it is often argued that startup ecosystems may not be able to support ambitious entrepreneurship and scale-ups (Autio and Rannikko 2016; Mason and Brown 2014). For example, whereas funding by family, friends, and angel investors is important for startup firms, scale-ups may rely more on bank finance (Kerr and Nanda 2015). Also, protection of intellectual property through formal institutions may be more important in later stages of firm growth (Gans, Stern, and Wu 2019). The ability of appropriation of intellectual property for scale-ups may also reflect high levels of tertiary education, whereas startups may rely more on high levels of secondary education. In addition, launching customers may be more important for startups than for scale-ups. All in all, we expect that the entrepreneurial ecosystem components play a different role in supporting scale-ups than they do in supporting new business formation. Therefore we have:

**Hypothesis 4:** Ecosystem components, their interdependence, and evolution will stimulate new business formation differently than they do scale-up firms.

### 3 Data and Method

Our data combines several datasets consisting of variables at city and industry level. City-level variables are mainly from China City Statistical Yearbook 1998–2009 compiled by the National Bureau of Statistics of China. We also manually compile city-level data on the number of approved patent applications from China Patent Full-text Database. In addition, data on social trust is taken from the China General Social Survey in 2003, jointly conducted by the HKUST's Survey Research

Center and the Sociology Department of the People's University of China.<sup>1</sup> In line with the used definition of the entrepreneurial ecosystems that enable productive entrepreneurship, we focus on productive young firms and rule out the consideration of necessity-driven entrepreneurship. To link data to theory, we use firm size as a proxy for productivity and aggregate the industry-level variables from the Chinese Industrial Enterprises Database, which has a threshold to cover private firms with annual sales higher than RMB five million. Accounting for the interdependence of industries, we sort industries into clusters using their input-output linkages (see Appendix I for detailed information on the identification of industry clusters). By merging the datasets, we arrive at data for 286 cities and 29 manufacturing industries (6 clusters).

Using these data, we aim to explain entrepreneurial behavior at the city and industry cluster level. There is much discussion on which variables capture entrepreneurship at the aggregate level (Acs and Armington 2006; Qian, Acs, and Stough 2013; Stam et al. 2009). In this study, we employ two frequently used constructs to measure productive entrepreneurship (with annual sales higher than RMB five million). The first variable is the measure of the number of newly registered private firms (*New\_Business*) also used in the World Bank Entrepreneurship Database and reports. As the age of a firm can be calculated using the difference between the year of the survey and the establishment year of the firm, we can identify new productive businesses in the sample period. As a second dependent variable, to better capture the type of entrepreneurship of interest to policymakers aiming for growth and innovation (Stam et al. 2009), we use the emerging consensus OECD definition for a scale-up or gazelle. We take the number of firms established less than five years (young firms) and with a growth rate of sales above 20 percent in each of the last three years (*Gazelle*).<sup>2</sup> Both dependent variables are first scaled by the total number of firms and then standardized to have variance one.

As in much of the empirical literature, we emphasize five domains in the entrepreneurial ecosystem, including the availability of finance, human capital and knowledge, institutions, markets for products, and entrepreneurial culture, and use the most commonly deployed metrics in quantitative studies. *Finance* is measured by the share of bank finance to private enterprises in a city (captured by interest payments) adjusted for the share of these firms in the local economy.

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**1** The Survey is conducted at the provincial level. The level of provincial trust is assessed based on the response to the following question: "Do you trust strangers?" The level of trust of a province is calculated by averaging the scores of the respondents located in that province.

**2** Because of the threshold of five million RMB to enter the survey, the necessity-driven entrepreneurship effect is less of a concern.

Though the presence of venture capital is critical in determining the success of entrepreneurial activity in developed countries (Lerner et al. 2018; Levie and Autio 2008), in developing countries like China with less sophisticated financial markets, the banking sector plays a more important role in providing access to capital for private businesses (Ayyagari, Demirgüç-Kunt, and Maksimovic 2010; Cull, Demirgüç-Kunt, and Morduch 2009). *Knowledge* is an index that combines the share of college students in the total population and the number of patents per capita in a city. The former is positively associated with the availability of qualified human resources (Florida 2002; Sternberg 2012) and the latter captures the stock of know-how in an entrepreneurial ecosystem (Acs, Anselin, and Varga 2002; Qian, Acs, and Stough 2013). The index of *Marketization* captures the role of government in the market, measured by government spending as a share of GDP, the share of public sector employment in total population, the share of subsidies to state-owned enterprises relative to their share in the local economy, and the number of total private enterprises per capita. To capture the effect of large market size on entrepreneurship (Sato, Tabuchi, and Yamamoto 2012), we measure local *Demand* from households using the average wage of households and their deposit balance in the year-end in a city, and from industries using the number and employment of existing firms within an industry cluster in a city. Entrepreneurial culture is difficult to distill from the city-level data as culture in most cases would be captured by region-specific fixed effects (Guerrero and Sero 1997). Nevertheless, we attempt to measure *Culture* using two proxies: the ratio of self-employment in total population to reflect local preference for self-employment and therefore entrepreneurs' propensity to create businesses (Chua, Roth, and Lemoine 2015); an index of trust which is an important dimension of social capital to promote new firm formation (Sabatini 2009). Restricted by data availability at the regional level, we have to acknowledge that our measure of culture is indirect and incomplete. We will further discuss the results and limitations using this measure in the following sections of this paper.

It may be argued that the sample period that we study is very dynamic with unequal regional development and a rapid industrial transition. This would imply that policies to support entrepreneurship should be differentiated across time, industries, and regions in China. To shed more light on these issues, we construct four dummies to capture nonlinear effects through interaction variables. First, we break the series into an early period (1998–2003) and a later period (2004–2009) to investigate the longitudinal effects of entrepreneurial ecosystems. Second, considering the emphasis of government policies on productivity improvement during the sample period, we divide the industry clusters into low- and high-tech

groups based on research intensity so that we capture the different effects of ecosystems on entrepreneurship activity in industries with low and high productivity. Third, we break between high- and low-income regions. It is widely acknowledged that there is large variation in income across regions in China. As entrepreneurship, especially productive entrepreneurship plays a crucial role in promoting economic development, analysing how ecosystems shape young and fast-growing firms in regions with different income levels can be important for reducing income inequality. In fact, the overall regional disparity of China can be mostly attributed to the development gap between Eastern and Western China (Cai, Wang, and Du 2002). Reducing the income gap between the eastern and western regions is therefore the main rationale behind China's western development program. Given the policy relevance, we also break between Eastern and Western China to analyse how the effects of entrepreneurship are moderated by geography.

Lastly, we aim to measure the multilateral interdependence of the components of entrepreneurial ecosystems. We need to find a balance between the tools of a large quantitative study using public data, as we do with our research data, and the much more nuanced concept of complexity of entrepreneurial ecosystems developed in social studies. There are currently three empirical strategies to capture complexity more fully in smaller cross-sectional studies than we do in this panel data analysis. The first method coming from complexity theory is the use of fuzzy set QCA approaches to assess the interdependence of entrepreneurial ecosystems (Berger and Kuckertz 2016; Vedula and Fitza 2019). This approach tries to assess which sets of ecosystem components best match the regional entrepreneurial results. A second method uses latent variable analysis to shed light on the effects of entrepreneurial ecosystems on regional economic results (Content et al. 2019), in which the regional outcomes are regressed on a set of economic variables to create an error term for regional economic performance. A third approach is to include individual ecosystem components in a structural equation model, which provides many cross-sectional insights into the way individual ecosystem components work together.

The main measure used in this paper to capture system strength as in Stam (2018) is based on interaction terms between the individual ecosystem components. What is new in our empirical approach is that we add interaction on top of the individual components to isolate the additional effects of interdependence and analyse how the system effect evolves. In addition, we generate a measure by performing the factor analysis on the underlying components. We compare these measures for consistency and report the estimation results using the alternative measures in the results section. The results show that the factor-based construct

**Table 1a:** Data summary of the main variables.

Variable	No. of obs.	Mean	Std. Dev.	Min	Max
<i>New_Business</i>	16814	0	1	−0.402	9.631
<i>Gazelle</i>	9961	0	1	−0.439	3.835
<i>Finance</i>	16818	0	1	−2.880	1.394
<i>Knowledge</i>	16229	0	1	−2.984	2.714
<i>Marketization</i>	16839	0	1	−2.853	2.487
<i>Demand</i>	16839	0	1	−2.043	3.281
<i>Culture</i>	15827	0	1	−1.210	3.215
<i>Agglomeration</i>	16814	0	1	−2.624	4.069
<i>Manufacturing/GDP</i>	16408	0	1	−7.810	3.201
<i>Service/GDP</i>	16408	0	1	−3.906	3.657

Note: *New\_Business* is the number of newly established private firms at the city and industry cluster level, scaled by the total number of firms. *Gazelle* is the number of firms established less than five years and with growth rate of sales above 20% in each of the last three years at the city and industry cluster level, scaled by the total number of firms. All the variables are standardized.

correlates to the dependent variables in a qualitatively similar way as the interaction-based ecosystem construct.<sup>3</sup>

As for control variables, we include employment of all firms in a city to capture agglomeration at the city level as well as the shares of manufacturing and service sectors in GDP to show the industry structure of a city. In all regressions, we include year dummies to control for time fixed effects. Appendix II shows definitions of the main variables and Table 1a and 1b provides descriptive statistics.

We use a fixed effects panel estimation setting to control for unobserved time-invariant city-industry characteristics. We are mainly interested in how changes in the time-variant elements of an entrepreneurial ecosystem at the city level affect productive entrepreneurship at the city-industry level. We have performed a Hausman test supporting the fixed effects model. We report robust standard errors clustered at the city and industry cluster level since entrepreneurship activity within the same city and industry cluster may be correlated.

## 4 Descriptive Statistics

The aim of this section is to provide some stylized facts about the data, which supports the claims in later chapters that use advanced econometric methods. As a

<sup>3</sup> However, a variable that rolls out of the factor analysis cannot be added in addition to the individual components in a regression, as it is predicted by the underlying components and there is perfect multicollinearity.

**Table 1b:** Correlations between the main variables.

Variable	1	2	3	4	5	6	7	8	9	10
<i>New_Business</i>	1.000									
<i>Gazelle</i>	0.264	1.000								
<i>Finance</i>	0.126	0.228	1.000							
<i>Knowledge</i>	0.112	0.258	0.298	1.000						
<i>Marketization</i>	0.178	0.281	0.077	-0.113	1.000					
<i>Demand</i>	0.085	0.079	0.102	-0.028	0.514	1.000				
<i>Culture</i>	0.071	0.232	0.407	0.374	0.099	0.050	1.000			
<i>Agglomeration</i>	0.112	0.257	0.203	0.608	0.215	0.128	0.363	1.000		
<i>Manufacturing/GDP</i>	0.024	0.057	0.079	0.153	0.087	0.141	0.077	0.256	1.000	
<i>Service/GDP</i>	-0.029	0.018	-0.059	0.235	-0.156	-0.154	0.012	0.078	-0.746	1.000

first crude eyeballing exercise, in Tables 2a and 2b, we compare cities that have similar starting positions but different trajectories. We make pairs of cities that are in the same province and have similar levels of per capita income but differ substantially in elements of entrepreneurial ecosystems. Though there are many examples, we have selected the pairs with the largest distance in the growth of entrepreneurial activities in the same province. Clearly, this is a very crude way of looking and potentially opens up to some cherry-picking and selection on the dependent, but it simply serves to give the first intuition. The results are quite consistent in that cities with stronger ecosystem components have higher average levels of new productive business formation (Table 2a) and more scale-ups (Table 2b).

Certainly, this exercise may not be very convincing, but we can take the comparison one step further and systematically compare like cities. To do this, in Table 3 we use the intuition of propensity score matching. In this method, using underlying parameters we make a prediction of which cities should have a similar outcome with respect to having the same entrepreneurial ecosystem. We compare cities that have the same probability but in practice are different with respect to their entrepreneurial ecosystem. To find such “treatment” effects, we split each ecosystem component index around the median to create a dummy variable with high and low values of the index. We then use the same variables of initial GDP per capita and province dummies to pair cities on their propensity to have a high or low value of the ecosystem index. The treatment effect arises by assessing the differences in entrepreneurial outcomes for pairs with the same propensity score but of which in practice one city has a high value for the ecosystem (a “1”) and the other a low value (a “0”). In Table 3, we first observe that there is a substantial difference in

Table 2a: Compare the growth of new businesses for cities with similar initial conditions.

City	Province	Initial GDPPC	Growth no. New firms	Growth of <i>Finance</i>	Growth of <i>Knowledge</i>	Growth of <i>Marketization</i>	Growth of <i>Demand</i>	Growth of <i>Culture</i>
Eastern cities								
Linyi	Shandong	4643	2.965	0.103	0.139	0.337	0.204	0.355
Liaocheng	Shandong	4274	0.697	0.015	−0.178	0.061	0.449	0.073
Wenzhou	Zhejiang	9431	2.405	0.280	0.494	0.367	0.153	0.123
Zhoushan	Zhejiang	9495	−0.024	−0.895	−0.420	0.209	0.132	0.414
Huizhou	Guangdong	13407	1.191	0.120	0.327	1.193	0.112	0.167
Dongguan	Guangdong	13362	−0.600	−0.018	0.041	−6.530	−0.226	0.386
Western cities								
Xinyang	Henan	2984	2.468	0.190	0.093	0.098	0.408	0.039
Shangqiu	Henan	2588	−0.229	0.099	−0.210	−0.617	0.951	−0.154
Xianning	Hubei	4534	2.850	0.008	0.271	0.366	0.252	0.171
Huanggang	Hubei	4796	0.057	−0.697	−0.153	0.372	0.917	−0.605
Huainan	Anhui	6187	2.750	0.148	1.983	0.466	−0.141	0.041
Hefei	Anhui	6349	0.834	−1.020	0.199	0.224	0.643	0.274

Table 2b: Compare the growth of gazelles for cities with similar initial conditions.

City	Province	Initial GDPPC	Growth no. gazelles	Growth of <i>Finance</i>	Growth of <i>Knowledge</i>	Growth of <i>Marketization</i>	Growth of <i>Demand</i>	Growth of <i>Culture</i>
Eastern cities								
Zhanjiang	Guangdong	5645	1.375	1.708	0.011	0.160	0.086	0.208
Shanwei	Guangdong	5896	0.453	−0.081	−0.016	0.040	0.283	0.114
Weifang	Shandong	9261	4.112	0.245	0.316	0.078	0.015	0.331
Laiwu	Shandong	8723	−1.000	−0.070	0.022	−0.069	−0.356	0.162
Jinhua	Zhejiang	10937	1.030	0.702	0.222	0.068	−0.073	0.179
Huzhou	Zhejiang	12737	−0.267	0.179	−0.013	0.057	0.028	0.159
Western cities								
Meishan	Sichuan	3724	1.379	0.246	0.084	0.427	0.109	0.205
Luzhou	Sichuan	3396	−0.333	−0.791	−0.093	−2.618	0.356	0.066
Pingxiang	Jiangxi	4735	1.905	0.543	−0.200	1.718	0.320	0.684
Xinyu	Jiangxi	5272	−0.275	−0.155	0.129	0.319	0.512	0.006
Wuhu	Anhui	8683	1.778	0.344	0.221	0.634	0.201	0.081
Tongling	Anhui	9507	−0.500	−0.229	−0.306	0.396	0.209	0.047

significance between new productive business formation and scale-up activity: the significance of entrepreneurial ecosystems is much more prominent for new productive business formation when compared to scale-ups. For new productive business formation, the average value is higher for the Treated group (that has high ecosystem values) than for the Control group (that has low ecosystem values). These differences are statistically significant, though we have to be careful with significance in such a crude test. For gazelles, entrepreneurial ecosystem components seem to have a less significant effect. In Table 4, we explore the mean values of new productive businesses and gazelles across the ecosystem values using the dummies. Again, the pattern is clear: cities with high values for ecosystem components have higher values of new productive business formation and scale-ups.

## 5 Econometric Results

### 5.1 New Productive Business Formation

We start with new business formation at the city-industry level as the dependent variable. In Column (1) of Table 5, we present the baseline results which show that the *Finance*, *Knowledge*, *Marketization*, and *Demand* components are all significantly positively related to the formation of new productive businesses. As both the dependent and independent variables are standardized, the estimated coefficients are interpreted as the change in standard deviation units. Holding other factors constant, the standardized measure of new business formation on average increases by 0.035 standard deviation when the standardized *Finance* index increases by 1 standard deviation. Similarly, a 1 standard deviation rise in values of the *Knowledge*, *Marketization*, and *Demand* indices are associated with a 0.161, 0.053, and 0.082 increases in standard deviation of the measure of new business formation, respectively. However, on average the measure of *Culture* has a statistically insignificant effect on new productive business formation for the whole sample. We will further test the effect of *Culture* in different sub-samples from Columns (2) to (5). All in all, there is substantial support that the ecosystem components matter.

In Column (2), we introduce the interaction variables of the ecosystem components with the dummy for the early and later period of the sample. In the upper plane, we show the results for the baseline early period and the interaction variables. In the lower plane, we present the results for the later period which basically combine the results for the baseline group and the interaction effect. We find that the influence of the *Finance* component has over time become more significant for



**Table 3:** Compare the growth of entrepreneurial activities based on matched cities.

Variable	Treated	Controls	Diff	Bootstrap S.E.	Z-stat
ATT conditional on <i>Finance</i>					
Growth of number of new businesses	0.890	0.408	0.482	0.158	3.05
Growth of number of gazelles	0.125	0.076	0.048	0.152	0.32
ATT conditional on <i>Knowledge</i>					
Growth of number of new businesses	0.757	0.337	0.420	0.231	1.82
Growth of number of gazelles	-0.162	0.018	-0.180	0.197	-0.91
ATT conditional on <i>Marketization</i>					
Growth of number of new businesses	0.876	0.472	0.404	0.188	2.14
Growth of number of gazelles	0.092	-0.052	0.144	0.141	1.02
ATT conditional on <i>Demand</i>					
Growth of number of new businesses	1.042	0.271	0.771	0.169	4.56
Growth of number of gazelles	0.054	0.051	0.003	0.130	0.00
ATT conditional on <i>Culture</i>					
Growth of number of new businesses	0.958	0.455	0.503	0.196	2.57
Growth of number of gazelles	0.285	-0.031	0.316	0.163	1.94

Note: ATT is the average effect of the treatment on the treated. The variables included for the matching process are initial GDPPC in our sample and province dummies.

new productive business formation. However, the positive effect of *Knowledge* has decreased over time, with the size of the coefficient declining from 0.202 in the early period to 0.081 in the later period. The effects of *Marketization* and *Demand* are statistically of equal importance for both early and later time periods. The next split in Column (3) is for the high- and low-tech industries. The results show that the *Finance* component is significantly positive for the low-tech industries but not significant for the high-tech industries. Also, the *Knowledge*, *Marketization*, and *Demand* components are important for new productive business formation in both the low- and high-tech industry clusters. Columns (4) and (5) extend by looking at different city income levels and spatial divisions. The results show that the *Finance* factor only seems to matter in relatively low-income cities, while the positive effect of *Demand* is statistically larger in high-income cities. Interestingly, the *Culture* index has a significant positive effect on new productive business formation only in low-income cities. The East-West divide in Column (5) should to some extent mirror the income division of Column (4) – which it indeed does.

Regarding new business formation, the following conclusions stand out. The first is supporting **Hypothesis 1** as we see an especially significant role of *Finance*, *Knowledge*, *Marketization*, and *Demand* in promoting the creation of new productive businesses. The second conclusion is that the relative importance of ecosystem components changes over time. When regions develop, the effects of some ecosystem components become larger and more significant, while some others

**Table 4:** Compare the growth of entrepreneurial activities based on data summary.

Variable	Number of obs.	Mean	Std. Dev.	Min	Max
Growth of number of new businesses	286	0.654	1.280	−0.846	9.117
Growth of number of gazelles	286	0.084	0.311	−0.375	2.467
<i>Finance</i>					
High					
Growth of number of new businesses	134	0.963	1.530	−0.429	9.117
Growth of number of gazelles	134	0.102	0.354	−0.375	2.467
Low					
Growth of number of new businesses	134	0.394	0.968	−0.846	8.112
Growth of number of gazelles	134	0.041	0.219	−0.341	1.212
<i>Knowledge</i>					
High					
Growth of number of new businesses	134	0.930	1.504	−0.500	9.117
Growth of number of gazelles	134	0.094	0.329	−0.375	2.467
Low					
Growth of number of new businesses	134	0.426	1.026	−0.846	8.112
Growth of number of gazelles	134	0.049	0.258	−0.333	1.318
<i>Marketization</i>					
High					
Growth of number of new businesses	143	0.805	1.450	−0.667	9.117
Growth of number of gazelles	143	0.129	0.365	−0.375	2.467
Low					
Growth of number of new businesses	143	0.502	1.074	−0.846	8.112
Growth of number of gazelles	143	0.037	0.237	−0.375	1.212
<i>Demand</i>					
High					
Growth of number of new businesses	141	1.121	1.868	−0.667	9.117
Growth of number of gazelles	141	0.116	0.845	−0.375	2.467
Low					
Growth of number of new businesses	141	0.191	0.775	−0.846	8.112
Growth of number of gazelles	141	0.048	0.916	−0.341	1.212
<i>Culture</i>					
High					
Growth of number of new businesses	133	0.983	1.595	−0.916	9.117
Growth of number of gazelles	133	0.125	0.898	−0.375	2.467
Low					
Growth of number of new businesses	134	0.373	1.409	−0.846	8.112
Growth of number of gazelles	134	0.035	0.787	−0.333	1.212

Note: Each ecosystem component is split into the high and low groups based on its median value.

**Table 5:** FE estimation results for new businesses (dependent: *New\_Business*).

Variable	(1) Baseline	(2) Time: early, late	(3) Tech: low, high	(4) Income: low, high	(5) Region: west, east
<i>Finance</i>	0.035** (0.017)	−0.011 (0.029)	0.035* (0.019)	0.052** (0.022)	0.083** (0.037)
<i>Knowledge</i>	0.161*** (0.038)	0.202*** (0.038)	0.153*** (0.039)	0.174*** (0.046)	0.132*** (0.037)
<i>Marketization</i>	0.053*** (0.020)	0.065*** (0.025)	0.055*** (0.020)	0.164*** (0.035)	−0.023 (0.033)
<i>Demand</i>	0.082*** (0.014)	0.040* (0.022)	0.087*** (0.015)	0.076*** (0.025)	0.064*** (0.020)
<i>Culture</i>	0.045 (0.030)	−0.015 (0.036)	0.043 (0.031)	0.096* (0.052)	0.111** (0.050)
<b>Interaction</b>		<b>*Late</b>	<b>*High-tech</b>	<b>*High-income</b>	<b>*Eastern</b>
<i>Finance</i>		0.069** (0.033)	0.001 (0.036)	−0.035 (0.031)	−0.086*** (0.029)
<i>Knowledge</i>		−0.121*** (0.022)	0.039 (0.028)	0.003 (0.052)	0.067 (0.050)
<i>Marketization</i>		−0.018 (0.023)	−0.009 (0.018)	−0.126*** (0.033)	0.094*** (0.032)
<i>Demand</i>		0.030 (0.020)	−0.017 (0.016)	0.365*** (0.093)	0.179*** (0.043)
<i>Culture</i>		0.067*** (0.024)	0.010 (0.026)	−0.097* (0.052)	−0.119** (0.053)
<b>Control</b>					
<i>Agglomeration</i>	0.349*** (0.117)	0.353*** (0.121)	0.347*** (0.117)	0.357*** (0.118)	0.358*** (0.120)
<i>Manufacturing/ GDP</i>	0.172*** (0.047)	0.136*** (0.044)	0.172*** (0.046)	0.139*** (0.046)	0.168*** (0.048)
<i>Service/GDP</i>	0.115*** (0.036)	0.099*** (0.035)	0.116*** (0.036)	0.089** (0.036)	0.115*** (0.037)
<i>Year dummies</i>	Yes	Yes	Yes	Yes	Yes
<b>Calculated effects for specific groups</b>					
		<b>Late</b>	<b>High-tech</b>	<b>High-income</b>	<b>Eastern</b>
<i>Finance</i>		0.057** (0.027)	0.037 (0.038)	0.017 (0.029)	−0.002 (0.023)
<i>Knowledge</i>		0.081* (0.044)	0.193*** (0.051)	0.177*** (0.068)	0.199** (0.078)
<i>Marketization</i>		0.047** (0.020)	0.046** (0.022)	0.038** (0.015)	0.071*** (0.019)
<i>Demand</i>		0.070** (0.028)	0.070*** (0.024)	0.441*** (0.093)	0.243*** (0.041)

Table 5: (continued)

Variable	(1) Baseline	(2) Time: early, late	(3) Tech: low, high	(4) Income: low, high	(5) Region: west, east
<i>Culture</i>		0.052 (0.045)	0.053 (0.039)	−0.001 (0.026)	−0.008 (0.030)
<i>N</i>	15234	15234	15234	15234	15234

Note: \*denotes  $p < 0.1$ , \*\* $p < 0.05$ , and \*\*\* $p < 0.01$ . Standard errors are robust and clustered at the city and industry cluster level.

become less important in promoting new productive businesses. Specifically, there is a shift in the later period away from a smaller effect of *Knowledge* towards a higher significance of *Finance*, while the effects of bank finance and entrepreneurial culture are becoming less significant for high-income regions especially in the Eastern part of China. Therefore, we find mixed evidence for **Hypothesis 2**.

## 5.2 Gazelles

Table 6 presents the results for the effects of the ecosystem components on scale-up activity. The baseline results in Column (1) show that *Finance*, *Knowledge*, *Marketization*, and *Demand* are important for scale-up activity, thus supporting **Hypothesis 1**. Keeping other variables constant, a 1 standard deviation increase in the *Marketization* index is associated with a 0.230 standard deviation increase in the standardized measure of scale-up activity. The corresponding effects of the *Finance*, *Knowledge*, and *Demand* components are 0.037, 0.088, and 0.065, respectively. Compared to the new productive business formation regressions in Table 5, the *Knowledge* component on average is a less important factor while the *Marketization* index is a more significant driver for scale-ups. In addition, the *Culture* index shows no significant effect on scale-up activity for the whole sample and we will check its effect in different sub-samples.

In Column (2), access to finance and the market-supporting institutional context have become more important for scale-ups over time. The *Demand* component is important for the fast-growing young firms in the early and later time periods, while the *Culture* index has an insignificant effect on scale-ups for both time periods. Column (3) shows that the *Finance* index is not significant for high-tech industries. By contrast, the significance of the *Knowledge* component is larger in high-tech industries than in low-tech industries. The *Marketization* and *Demand* components have a significantly positive effect on gazelles in both low- and high-tech industry clusters. In Columns (4) and (5), interestingly, in contrast to new business formation,

**Table 6:** FE estimation results for gazelles (dependent: *Gazelle*).

Variable	(1) Baseline	(2) Time: early, late	(3) Tech: low, high	(4) Income: low, high	(5) Region: west, east
<i>Finance</i>	0.037** (0.017)	−0.005 (0.023)	0.082*** (0.030)	0.041 (0.025)	0.015 (0.019)
<i>Knowledge</i>	0.088** (0.037)	0.013 (0.035)	0.072* (0.038)	−0.076* (0.045)	−0.027 (0.043)
<i>Marketization</i>	0.230*** (0.037)	0.024 (0.027)	0.245*** (0.034)	0.205*** (0.036)	0.296*** (0.042)
<i>Demand</i>	0.065*** (0.021)	0.130** (0.052)	0.059*** (0.021)	0.023 (0.052)	0.039 (0.045)
<i>Culture</i>	0.023 (0.034)	−0.025 (0.038)	−0.003 (0.032)	0.139*** (0.034)	0.114*** (0.041)
<b>Interaction</b>		<b>*Late</b>	<b>*High-tech</b>	<b>*High-income</b>	<b>*Eastern</b>
<i>Finance</i>		0.083*** (0.027)	−0.064** (0.029)	0.001 (0.032)	0.077** (0.035)
<i>Knowledge</i>		0.046 (0.031)	0.053 (0.037)	0.293*** (0.061)	0.293*** (0.069)
<i>Marketization</i>		0.220*** (0.053)	−0.067** (0.030)	0.018 (0.058)	−0.115** (0.059)
<i>Demand</i>		−0.051 (0.037)	−0.027 (0.030)	0.056 (0.056)	0.046 (0.051)
<i>Culture</i>		0.037 (0.032)	0.089** (0.042)	−0.227*** (0.058)	−0.181*** (0.065)
<b>Control</b>					
<i>Agglomeration</i>	0.148*** (0.031)	0.137*** (0.030)	0.146*** (0.031)	0.133*** (0.031)	0.121*** (0.031)
<i>Manufacturing/ GDP</i>	0.084 (0.056)	0.072 (0.054)	0.091 (0.056)	0.078 (0.056)	0.082 (0.055)
<i>Service/GDP</i>	0.051 (0.053)	0.051 (0.051)	0.055 (0.053)	0.047 (0.053)	0.049 (0.053)
<i>Year dummies</i>	Yes	Yes	Yes	Yes	Yes
<b>Calculated effects for specific groups</b>					
		<b>Late</b>	<b>High-tech</b>	<b>High-income</b>	<b>Eastern</b>
<i>Finance</i>		0.079*** (0.016)	0.018 (0.019)	0.041** (0.019)	0.092*** (0.032)
<i>Knowledge</i>		0.059 (0.049)	0.125** (0.063)	0.217*** (0.048)	0.266*** (0.080)
<i>Marketization</i>		0.243*** (0.048)	0.178*** (0.033)	0.223*** (0.038)	0.181*** (0.020)
<i>Demand</i>		0.080** (0.035)	0.032* (0.018)	0.079*** (0.027)	0.085*** (0.027)

Table 6: (continued)

Variable	(1) Baseline	(2) Time: early, late	(3) Tech: low, high	(4) Income: low, high	(5) Region: west, east
<i>Culture</i>		0.011 (0.050)	0.086 (0.066)	−0.087 (0.063)	−0.066 (0.087)
<i>N</i>	9323	9323	9323	9323	9323

Note: \*denotes  $p < 0.1$ , \*\* $p < 0.05$ , and \*\*\* $p < 0.01$ . Standard errors are robust and clustered at the city and industry cluster level.

especially in high-income regions and Eastern cities, access to finance has a significantly positive effect on scale-ups. In low-income cities and Western cities, the *Knowledge* and *Demand* components show an insignificant or even negative effect on scale-ups, in contrast to their significantly positive effect in high-income cities and Eastern cities. In addition, the *Culture* component is only significantly positively associated with scale-ups in low-income cities and Western cities. As in Table 5, the results show that the relative importance of ecosystem components in influencing scale-up activity changes over time when regions develop, with some (*Finance*, *Knowledge*, *Marketization*, and *Demand*) increasing while others (*Culture*) decrease. Therefore, the results provide mixed evidence for **Hypothesis 2**.

### 5.3 System Effects

A central question is which ecosystem components work in tandem to foster new productive businesses and gazelles. Table 7 and Table 8 look at the interaction

Table 7: Interactions between the ecosystem components for new business formation.

	<i>Finance</i>	<i>Knowledge</i>	<i>Marketization</i>	<i>Demand</i>
<i>Knowledge</i>	−0.027*** (0.010)			
<i>Marketization</i>	0.023* (0.013)	0.056*** (0.013)		
<i>Demand</i>	0.023** (0.011)	0.162*** (0.034)	0.027** (0.011)	
<i>Culture</i>	0.005 (0.019)	−0.016 (0.016)	0.045*** (0.016)	0.069*** (0.018)

Note: \*denotes  $p < 0.1$ , \*\* $p < 0.05$ , and \*\*\* $p < 0.01$ . Standard errors are robust and clustered at the city and industry cluster level. The individual ecosystem components are included but not reported. The control variables for *New\_Business* are the same as those in Table 5.

**Table 8:** Interactions between the ecosystem components for gazelles.

	<i>Finance</i>	<i>Knowledge</i>	<i>Marketization</i>	<i>Demand</i>
<i>Knowledge</i>	0.038*** (0.015)			
<i>Marketization</i>	0.065** (0.028)	−0.018 (0.044)		
<i>Demand</i>	−0.004 (0.013)	0.014 (0.021)	0.024 (0.020)	
<i>Culture</i>	0.045** (0.019)	−0.026 (0.028)	0.138*** (0.036)	0.020 (0.022)

Note: \*denotes  $p < 0.1$ , \*\* $p < 0.05$ , and \*\*\* $p < 0.01$ . Standard errors are robust and clustered at the city and industry cluster level. The individual ecosystem components are included but not reported. The control variables for *Gazelle* are the same as those in Table 6.

effects of individual ecosystem components added to the baseline results. We may argue that positive interaction implies that the components are complements, whereas negative interaction shows the components to be substitutes. In Table 7 for new productive business formation, broadly speaking, the individual ecosystem components turn out to be significant complements, except that *Finance* and *Knowledge* behave as substitutes. The results are more or less mirrored for scale-ups in Table 8 with one significant difference: for scale-ups *Finance* and *Knowledge* are complements. In addition, for scale-ups, there are few complementary effects between the individual ecosystem components.

To dig one level deeper, we construct an ecosystem index by multiplying the five individual components (*Ecosystem*). Alternatively, we also create an ecosystem index by applying the factor analysis based on the individual components (*Ecosystem\_fac*). In Table 9, Columns (1) and (2) show that both the factor analysis-based and interaction-based ecosystem indices are significantly positive for new business formation. In Column (3), we add the system index on top of the individual components and observe that the ecosystem index is still significantly positive. Similar results can be found for scale-ups in Columns (4)–(6). In Table 10, we further split the data into two time periods to see the system effect over time. The results show that, for both new productive businesses and gazelles, the system effect is especially important in the later period and such effect has substantially increased over time, indicated by the statistically significant and positive interaction variables between the measures of the system effect and the dummy for the later period. The results in this subsection provide confirmation of **Hypothesis 3** that the interaction between ecosystem components plays an important role in entrepreneurial activity and becomes more important over time.

**Table 9:** FE estimation results of the ecosystem variables.

	New_Business			Gazelle		
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Ecosystem_fac</i>	0.182*** (0.025)			0.133*** (0.040)		
<i>Ecosystem</i>		0.019*** (0.007)	0.016* (0.009)		0.036*** (0.013)	0.029* (0.016)
<i>Finance</i>			0.036** (0.017)			0.039** (0.017)
<i>Knowledge</i>			0.166*** (0.038)			0.088** (0.037)
<i>Marketization</i>			0.077*** (0.027)			0.241*** (0.035)
<i>Demand</i>			0.090*** (0.014)			0.073*** (0.023)
<i>Culture</i>			0.049 (0.030)			0.025 (0.034)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
<i>N</i>	15234	15234	15234	9323	9323	9323

Note: \*denotes  $p < 0.1$ , \*\* $p < 0.05$ , and \*\*\* $p < 0.01$ . Standard errors are robust and clustered at the city and industry cluster level. The control variables are the same as those in Tables 5 and 6.

## 6 Discussion

The overall conclusion is that empirically entrepreneurial ecosystems matter for productive entrepreneurship (large new and fast-growing firms) in manufacturing industries at the city-industry level in China. In discussing the effects of ecosystems, we refer to ambitious forms of entrepreneurship and leave out private necessity-driven entrepreneurship. Clearly, this is a big debate in entrepreneurship. Though most policies specifically aim at ambitious entrepreneurship, the rest of society is moving towards self-employment, and such movements are of crucial importance for future economic welfare. In addition, following Baumol (1990) it may be argued that it is especially the combination of ambitious entrepreneurship and high-growth firms together with self-employment and also social entrepreneurship important for a vibrant entrepreneurial ecosystem. Having said that, the current definitions of most of the leading entrepreneurial ecosystem scholars specifically target the entrepreneurial ecosystem components like risk capital that are necessary for productive entrepreneurship.

We start by discussing the results in the context of what they imply for the individual entrepreneurial ecosystem components and the ecosystem dynamics,



**Table 10:** FE estimation results of the ecosystem variables for two time periods.

	New_Business			Gazelle		
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Ecosystem_fac</i>	0.128*** (0.026)			−0.029 (0.045)		
<i>Ecosystem_fac*Late</i>	0.060* (0.032)			0.155*** (0.034)		
<i>Ecosystem</i>		−0.061** (0.025)	0.016 (0.022)		0.138 (0.122)	−0.219* (0.126)
<i>Ecosystem*Late</i>		0.079*** (0.023)	0.054** (0.024)		−0.171 (0.122)	0.250* (0.132)
<i>Finance</i>			0.036** (0.017)			0.039** (0.017)
<i>Knowledge</i>			0.166*** (0.038)			0.086** (0.037)
<i>Marketization</i>			0.077*** (0.027)			0.244*** (0.035)
<i>Demand</i>			0.089*** (0.014)			0.064*** (0.022)
<i>Culture</i>			0.049 (0.030)			0.025 (0.034)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
<i>N</i>	15234	15234	15234	9323	9323	9323

Note: \*denotes  $p < 0.1$ , \*\* $p < 0.05$ , and \*\*\* $p < 0.01$ . Standard errors are robust and clustered at the city and industry cluster level. The control variables are the same as those in Tables 5 and 6.

in line with **Hypothesis 1** and **2**. When talking to entrepreneurs about the barriers to starting a company, the perceived lack of access to finance often stands out. A novel finding in our analysis is that new productive business formation relies stronger on bank credit in low-income regions when compared to high income regions. By contrast, high-income regions have firms of skill-intensive entrepreneurship making use of intangible assets and may rely on different forms of finance that are not captured by the bank financing variable. For instance, in high-income regions, entrepreneurs can rely on network effects of high-income individuals and angel investors for financing their businesses. A policy implication of the finding is that improving access to finance should be especially important for entrepreneurship in low-income regions, as improved financial services aimed at low-income groups and regions – like support for microfinance for small scale firms and traders – are more efficient than a focus on bank credit countrywide. For scale-ups, access to finance matters more in high-income cities than in low-income cities, as these cities have already gone through the startup phase so that

improving access to finance stimulates the increase in scale-up activity more than it does for new business formation.

One of the other interesting results that stand out is the significant effect of knowledge capital on entrepreneurial activity. As we have observed, knowledge capital is especially important for scale-ups in high-tech industries as well as in the Eastern and thus coastal regions of China. However, high levels of knowledge capital do not seem to spur scale-up activity in low-income regions and in the Western part of China. This result may well reflect the position of China as the world factory in the supply chains of multinational firms. Over time, the high-income regions may specialize in value-adding activities in which scale-ups play an important role. As these value-adding activities climb up in the supply chain, we may expect that knowledge capital starts to play a more important role in explaining the growth of domestic firms in high-income regions and in the East of China. By contrast, in the West of China, there is an emphasis on production facilities that serve multinational firms and are more driven by efficiency concerns. These efficiency concerns result in a business model that predominantly floats on low-cost workers and high levels of physical capital intensity. This implies that scale-ups that serve multinational firms make less use of knowledge capital and are driven more by a large pool of low-skilled labor.

Another interesting individual effect is the increased importance of local market demand for new productive business formation and scale-up activity in high-income cities and in the Eastern cities of China. Our results map to the transformation of China as an economy mostly driven by domestic demand instead of by foreign direct investment (FDI). As our results show, an important side effect of this shift is that large domestic firms in high-income regions have an important effect on entrepreneurship in the form of startups and scale-ups. If we combine this finding with the effects of knowledge capital, it may seem that the role of multinational firms in steering entrepreneurial activity is restricted to the low-income regions and to the Western part of China. By contrast, high-income regions rely on domestic demand. In the future, this may change when multinational firms start to shift high value-adding activities to China with a focus on the coastal regions, especially in the field of research and development.

For both new business formation and scale-ups, entrepreneurial culture, measured by trust and the ratio of self-employment, plays a significant role only in low-income and Western cities but not in high-income and Eastern cities. By contrast, the degree of marketization (the dominance of the private sector in business) seems important for entrepreneurial activity in both low- and high-income cities. These observations may suggest a substitution effect between formal and informal institutions on entrepreneurship when regions develop. In low-income and Western cities with relatively weak formal regulatory institutions such as contracting enforcement and property rights protection, enterprise

trustworthiness and the preference for self-employment are critical for stimulating entrepreneurial activity. By contrast, the effect of culture is limited in high-income cities where market-supporting formal institutions are better developed and play a predominant role in entrepreneurship.

When we move from the individual components to the system effects (**Hypothesis 3**), the components are shown to be complements and generate system effects. This is the case for the *Finance*, *Marketization*, and *Demand* indices which strengthen each other in explaining regional variation in new productive business formation. The same applies to the interaction between local knowledge, marketization, and local demand. By contrast, we find a substitution effect between finance and knowledge capital. Framed like this, the results make sense as finance and knowledge capital may create different kinds of resources for new businesses. For scale-up activity finance and knowledge are complements, which suggests that the finance and knowledge components work together to have a relatively large effect on scale-up activity. These results make us return to the analysis that includes the system effect as an add-on to the individual components in Tables 9 and 10. The results show that the system effect becomes more important over time. One may argue that entrepreneurial ecosystems need time to have an impact as component complementarity cannot be created overnight. Another way of looking at this is that there is some merit in the opinion of policymakers in developing countries that ecosystems are an elite policy preoccupation for advanced economies and are less of a priority than getting the components themselves right.

Related to **Hypothesis 4**, entrepreneurial ecosystem components, their interdependence, and evolution show different effects on new business formation and on scale-ups. Overall, local knowledge and demand are the most important individual ecosystem components for new business formation (significant in all sub-samples), while marketization plays a key role in stimulating scale-up activity. Compared to new business formation, for scale-ups, most ecosystem components are not significant in the early period and become to play a more important role over time. Also, the results in Tables 9 and 10 shows that there is a larger system effect on scale-ups than on new business formation, especially over time. We can also observe in Table 8 that the system effect on scale-ups mainly comes from the complementary related to finance and culture components. These findings imply that the ecosystem components need to work as a system to play a larger role in scale-ups.

## 7 Conclusion

This paper is one of the first to analyse the effects of entrepreneurial ecosystems on entrepreneurial activity using a large pool of data and panel techniques at the city-

industry level. By covering 29 industries (6 clusters) and more than 280 cities over 12 years, these data have substantial cross-sectional variance as well as dynamic differences over time. Overall, we find substantial effects of ecosystem components on new productive business formation and scale-up activity in line with theoretical predictions. We also find substantial system effects for both new businesses and gazelles. In addition, the importance of entrepreneurial ecosystem effects at the margin has increased over time, consistent with popular intuition.

## 7.1 Implications for Theory

The results are rich in detail and tell an interesting story about China's economic development. In terms of theory formation, this paper has two valuable lessons. First, we have shown that the time component and dynamics of entrepreneurial ecosystems matter. Many of the empirical contributions compare ecosystems, especially when it comes to creating indices and rankings. Our analysis shows that ecosystems change over time and that what is needed in the beginning is not necessarily a critical component later in the evolution. When comparing ecosystems, therefore, the time component should be taken more explicitly into account. A second significant contribution to theory is that the complexity of the elements of entrepreneurial ecosystems is a key explanatory driver for entrepreneurship. Although such complexity has often been argued to be important in the conceptual literature, analysis on the interaction between the ecosystem components and especially the system effect over time was not present until now.

## 7.2 Implications for Policy and Practice

We like to stress three implications for economic policy that supports entrepreneurship. The first is that supporting entrepreneurial ecosystems is especially important in low-income regions. Often a critique on the ecosystem approach is that it is quite lofty and applies most to advanced regions. However, this study shows that there are strong effects of ecosystem components on new productive business formation and scale-up activity in developing countries like China. The results seem to suggest that the creation of ecosystems to support entrepreneurial activity needs to be proactive, which is to some extent connected to Florida's creative class argument that cities invest in amenities that later will result in new business formation (Florida 2003).

A second implication of our analysis is that with respect to policy focus the difference between new firm formation and scale-ups matters. This feeds into the

recent policy discussion on moving more towards the support of scale-up firms as job creators and to focus less on startup support. As an overall finding, the individual ecosystem components show different effects across industries, years, and regions on scale-up activity when compared to startup activity. In the West, a dominant sentiment is the fatigue and sometimes disappointment with the startup revolution in terms of creating a job-creating society. Clearly, this may all be different in a developing context, but a similar argument in these regions can be made for necessity-driven entrepreneurship. Hence, systematically reflecting on the differences between new business and scale-up ecosystems may provide some clues for policy evolution.

The third overall conclusion is that it is important to look at system effects. Our study shows that such system effects are not trivial if we take account of the complementary and substitute forces among the individual ecosystem components. The implication for policy is that when building entrepreneurial ecosystems, it is essential to make a comprehensive long-term plan in which a strategy should be developed for the accumulation and interplay of the individual components. Another important lesson is that if ecosystems do not make a sufficient contribution to entrepreneurial activity in a region, it may be necessary to investigate which component is missing and how the lack of this specific component in the system holds back economic development. Such an analysis of 'weakest links' that undermine the overall system can lead policymakers to identify factors that are crucial in the complexity of entrepreneurial ecosystems.

### 7.3 Limitations and Future Research

This part of the paper is also the place to reflect on conceptual cautions. The first is the limitation of the current setup to address causality. Although the fixed effects setup partly takes account of omitted variables that are invariant over time, endogeneity of the variables clearly is an issue.<sup>4</sup> We may also expect reverse causality to be an issue, as entrepreneurial activity is likely to trigger the strengthening of the ecosystem components. Clearly, the ecosystem components are endogenous and there is really no point of hiding this other than stressing the correlation itself: things go together. One way to "solve" this is with a bit of make-up to take the lagged independent variables. However, for slow-moving factors, this does not really address the issue. Also, we may think of using instruments for the components, but this for the moment takes a lot of conceptual thinking not yet

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<sup>4</sup> As robustness checks we have run the random effects estimation of which the results qualitatively match the fixed effects estimation results.

there. Using the internal instruments of Arellano–Bond type of setups would stretch the data beyond their limits.<sup>5</sup>

Second, the measurement of culture in our study entails a number of weaknesses. The first problem is that our measure is incomplete. In our study we capture two dimensions of entrepreneurial culture, local preference for creating new business and social trust, but we lack city-level data on dimensions like the attitudes towards risk-taking, individual responsibility, incentives for entrepreneurial effort, and so on. The second problem is that our measure of culture is indirect. The operationalization of our culture index is based on secondary data and may have low face validity in reflecting entrepreneurial value differences. These problems may lead to the overall low significance of our culture index and a fruitful way forward is to develop more complete and direct measures of entrepreneurial culture.

Third, the lighthouse role of China as a generalizable case as used in this paper may also trigger critical reflection. China in the period of study is dominated by two forces that are not that general for economic development. First, many of the companies arise out of former collectivist structures, like the privatization of township firms. One may argue that the dynamics of Chinese capitalist development towards an entrepreneurial society has a strong grounding in an existing production structure that was already highly institutionalized, which feeds into the importance and effectiveness of entrepreneurial ecosystems as supporting institutions. Second, for a long time China has been the factory of the world, relying much on FDI and outsourcing for economic development. Clearly, this gives a specific color to China's entrepreneurial ecosystems that will not be replicated easily elsewhere.

We have chosen a single country because regional ecosystems can relatively easy be compared given similar macro and institutional variables across sub-national regions. However, how we have included interaction effects can be applied to draw comparisons across countries if we can eliminate country-specific factors and keep a focus on the local spatial dimension (region and city) that matters to entrepreneurs. For example, with the integration of the European market and the abundance of data on ecosystems for this region, our approach seems suited to analyse the effects of entrepreneurial ecosystems over time in this market. Also, with the increase in regional data in large developing countries, such as India, Indonesia, and across Africa, ecosystems in these regions may be mapped out. In addition, it is particularly important for future policy to focus on supporting developing countries in building entrepreneurial ecosystems to eradicate poverty.

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<sup>5</sup> We have done so with some success, but the results are highly vulnerable to specific time-structure specifications of the lags.

The second direction of future research is to enrich the analysis of the complexity of entrepreneurial ecosystems. We have worked with interaction effects and also explored the underlying coherence of the ecosystem components. But we also made references to literature that presents a more nuanced view of the ecosystem complexity and uses methods like fuzzy sets to analyse how these components are interrelated. A similar approach is to make use of new micro-economic insights and models, for instance CES functions, to capture the complexity and heterogeneity of ecosystems. Such studies with a richer analysis of the interaction of ecosystem components can then benefit from the inclusion of time dimension, which we have shown to be important in understanding the contribution of ecosystems to economic development through the support for entrepreneurship.

## Appendix I

Industry cluster	Manufacturing industry
Machinery and equipment	Processing of petroleum, coking, processing of nuclear fuel Smelting and pressing of ferrous metals Smelting and pressing of non-ferrous metals Metal products General purpose machinery Special purpose machinery Transport equipment Electrical machinery and equipment
Chemicals and rubber	Raw chemical materials and chemical products Medicines Chemical fibers Rubber Plastics Non-metallic mineral products
Textile and leather goods	Textile Textile wearing apparel, footwear and caps Leather, Fur, feather and related products Artwork and other manufacturing
Electronics and computers	Communication equipment, computers and other electronic equipment Machinery for cultural activity and office work
Wood products	Processing of timber, wood, bamboo and others Furniture Paper and paper products

(continued)

Industry cluster	Manufacturing industry
Food, tobacco, beverages	Printing, reproduction of recording media
	Articles for culture, education and sport activities
	Processing and food from agricultural products
	Foods
	Beverages
	Tobacco

Note: The industry clusters are identified using the approach proposed by Feser and Bergman (2000). Based on the Chinese input-output table in 2004 released by the National Bureau of Statistics of China, we first calculate four coefficients:  $x_{ij}$  and  $x_{ji}$ , intermediate good purchases by  $j$  ( $i$ ) from  $i$  ( $j$ ) as a proportion of  $j$ 's ( $i$ 's) total intermediate good purchases;  $y_{ij}$  and  $y_{ji}$ , intermediate good sales from  $i$  ( $j$ ) to  $j$  ( $i$ ) as a proportion of  $i$ 's ( $j$ 's) total intermediate good sales. This gives us one matrix of  $x$ 's on the intermediate input purchasing pattern and one matrix of  $y$ 's on the intermediate output sales pattern. We then run correlation analysis between pairs of industries based on these patterns and calculate four correlation coefficients for each pair of industries to capture the similarities in their input-output structure. Finally, we conduct a principal components factor analysis using these correlation coefficients for each sector as variables of the factor analysis. Industries for a given cluster (factor) are identified when their factor loadings on that factor are larger than 0.60.

## Appendix II

Variable	Definition
<i>New_Business</i>	The number of newly established private firms, scaled by the total number of firms, in a specific industry cluster, city, and year, standardized
<i>Gazelle</i>	The number of firms established less than five years and with growth rate of sales above 20 percent in each of the last three years, scaled by the total number of firms, in a specific industry cluster, city, and year, standardized
<i>Finance</i>	The ratio of interest payments of private firms in total interest payments of all firms in a city, relative to the share of private firms in the local economy, standardized
<i>Knowledge</i>	Based on two variables: <ol style="list-style-type: none"><li>1. The share of college students in total population in a city, standardized</li><li>2. The number of approved patent applications per capita in a city, standardized</li></ol> The index is created by taking the average of the two variables, standardized
<i>Marketization</i>	Based on four variables: <ol style="list-style-type: none"><li>1. The number of total private firms per capita in a city, standardized</li><li>2. Government spending as a share of GDP in a city, standardized</li><li>3. The share of government subsidies to state-owned firms relative to the share of state-owned firms in the local economy, standardized</li><li>4. The share of public sector employment in total population in a city, standardized</li></ol>



(continued)

Variable	Definition
<i>Demand</i>	<p>The index is created by taking the average of the first variable and the negative values of the last three variables, standardized</p> <p>Based on four variables:</p> <ol style="list-style-type: none"><li>1. The number of incumbent firms within an industry cluster in a city, standardized</li><li>2. Employment of incumbent firms within an industry cluster in a city, standardized</li><li>3. Average wage of households in a city, standardized</li><li>4. The deposit balance of households in a city at the year-end, standardized</li></ol> <p>The index is created by taking the average of the four variables, standardized</p>
<i>Culture</i>	<p>Based on four variables:</p> <ol style="list-style-type: none"><li>1. The trust measure from the China General Social Survey in 2003, standardized</li><li>2. The ratio of self-employment in total population in a city, standardized</li></ol> <p>The index is created by taking the average of the two variables, standardized</p>
<i>Ecosystem</i>	<i>Finance*Knowledge*Marketization*Demand*Culture</i> , standardized
<i>Ecosystem_fac</i>	An index constructed using the principal component analysis based on <i>Finance, Knowledge, Marketization, Demand</i> and <i>Culture</i>
Control variables	
<i>Agglomeration</i>	The total number of employees in all firms in a city, standardized
<i>Manufacturing/GDP</i>	The share of manufacturing industry in GDP in a city, standardized
<i>Service/GDP</i>	The share of service industry in GDP in a city, standardized
<i>Year</i>	Year dummies

Note: We use the simple average method instead of the factor analysis to create our ecosystem indices for two reasons. The main reason is that our ecosystem construct is derived from a large body of literature and do not follow from the underlying data. In addition, we consider the variables to be of equal importance in constructing the index. The results are not sensitive to weights used.

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