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The city and high-tech startups: The spatial organization of Schumpeterian entrepreneurship

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ABSTRACT

Research on Schumpeterian entrepreneurship identifies new high-growth startup companies as key factors in technological innovation and economic growth. While economists have tended to focus on high-growth, high-tech startup firms as the unit of analysis, economic geographers and urbanists have examined the geographic dimensions of entrepreneurship, particularly the rise of entrepreneurial clusters and eco systems. We focus here on a particular type of Schumpeterian entrepreneurship associated with high-tech startup companies, or what we refer to as "tech-startup entrepreneurship." We contend that the organization of such Schumpeterian entrepreneurship occurs at two spatial scales. At the macro-geographic level, it is highly clustered and concentrated in a relatively small number of global cities or metro areas. At the micro-geographic level, it is highly concentrated in distinct districts or micro-clusters within these leading cities and metro areas. To examine the geographic dimensions of tech-startup entrepreneurship across these spatial scales, we use previously unused data on venture capital-financed startups at the metropolitan and district levels. Our findings support the hypothesis that tech-startup entrepreneurship is organized across two distinct but related spatial scales, which act on entrepreneurial activity through different mechanisms. These findings suggest that local diversity and local specialization can simultaneously potentiate innovation, and that a multi-scalar approach to the geography of entrepreneurship is prudent.

1. Introduction

The modern theory of entrepreneurship begins with the seminal contributions of Joseph Schumpeter (1934a, 1934b, 1954) who argued that not just innovation and economic growth but the ability of capitalism to overcome economic and political crises (à la Marx) comes from the efforts of entrepreneurs who drive the creation of new firms which unleash the "gales of creative destruction" which revolutionize industries and reset the economy as a whole. Economists working in the Schumpeterian vein have developed theories of entrepreneurship to empirically examine the connections between entrepreneurship and innovative activity and economic growth and development (see Griliches, 1957; Schmookler, 1966; Aghion and Howitt, 1990b; Nelson & Winter, 1982; Mowery & Rosenberg, 1991; Grossman & Helpman, 1993). Generally speaking, the economic and management literatures on entrepreneurship inspired by Schumpeter have focused on the firm as the unit of analysis.

Geographers and urbanists have brought a spatial frame to the study of Schumpeterian entrepreneurship. Their work has focused on the geographic clustering of entrepreneurial activities across space (Acs, Anselin, & Varga, 2002; Anselin, Varga, & Acs, 1997; Carlino & Kerr, 2015; Florida, Adler, & Mellander, 2017; Jaffe, Trajtenberg, & Henderson, 1993). This literature identifies the key characteristics of geographically clustered ecosystems in organizing innovation and entrepreneurial firm formation (Florida & Kenney, 1992a, 1992b; Porter, 2000; Saxenian, 1994; Scott & Storper, 2003). This broad body of research establishes that the processes of innovation and entrepreneurship are geographically concentrated in space and organized by spatially-delimited ecosystems.

Building from this literature on the geography and clustering of entrepreneurial activity, of the high-tech of Schumpeterian variety, we seek to further develop our understanding of the spatial dimensions of high-tech entrepreneurship as operating at two distinct spatial scales, a macro-geographic scale across city-regions or metropolitan areas and a micro-geographic scale within cities regions at the district or neighborhood level. We focus on entrepreneurial high-tech startups, which

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we measure as venture capital investment in start-up companies.

Our paper builds on two empirical observations about geography of high-tech entrepreneurship and from two types of mechanisms derived from literature and theory about what underpins those observed empirical patterns. Empirically speaking, high-tech startups cluster across city-regions or metropolitan areas, but they also cluster in distinct neighborhoods and districts or micro-clusters within these city-regions and metro areas. These empirical observations on the clustering of tech-based entrepreneurial activity reflect different mechanisms which operate across and between these two critical spatial scales. On the one hand, economic geographers and urban economists have noted that entrepreneurial activity, and innovative activity more generally, are conditioned by mechanisms related to urban density and economic diversity initially identified by Jane Jacobs (1969). On the other hand, there is the construct that agglomeration economies are basically economies of scale associated with specialization and co-location dating back to the work of Alfred Marshall (1890). These mechanisms – referred to as "Jacobsian" and "Marshallian" approaches – are sometimes set in opposition to each other (Beaudry & Schiffauerova, 2009; Frenken, Van Oort, & Verburg, 2007).

Our research begins from the intuition that perhaps they should not be separated and that they more likely work together as mechanisms to condition high-growth Schumpeterian entrepreneurship. In fact, we see them as operating at different spatial scales, which we label "macro-geographic" on the one hand and "micro-geographic" on the other.

The macro-geographic scale operates at the level of the city-region or metropolitan area. In terms of mechanisms, this scale works to organize and bring together the broad talent base, the wide array of firms that function as customers, end-users and suppliers; universities and knowledge institutions; and other key inputs that are required for entrepreneurial startups. In terms of spatial theory, this macro-geographic level works to organize Jacobs-type diversity – organizing inputs which relate to urban diversity and scale across a broad spatial scale. While some would operationalize Jacobsian diversity as "industry mix" (Beaudry & Schiffauerova, 2009), we concur that is perilous to try to differentiate a diverse mix from a specialized or relatedly specialized one (Kemeny & Storper, 2015). Urban size, instead, provides the best conceptual and empirical proxy for diversity. Urban size is demonstrated to be a robust marker of diversity across time and space (Bettencourt, Lobo, Helbing, Kühnert, & West, 2007a, 2007b). From the standpoint of an innovative firm in a new industry, a large city-region, represents a more hospitable environment for innovation because it is more likely to have a wider range of inputs - people, ideas, suppliers - that can be recombined to achieve breakthrough innovations (Duranton & Puga, 2001; Glaeser, Kallal, Scheinkman, & Shleifer, 1992). Over the industry life cycle, as products mature and become standardized and as costs lower, firms earn smaller premia from locating in large, diverse areas. However, there is no reason to believe that immediate diversity that is diversity at the micro-geographic scale is conducive to entrepreneurial firm. The range of neighbors *could* have severely limited the possible level of "micro-diversity", and the probability that any single input will be implicated in breakthrough innovation is very small. What matters is that agents have a diversity of inputs that they might interact with in their daily activities and the city-region is at the scale that tends to act in this range.

The second and related level is at the district or neighborhood level, or what we refer to as the "micro-geographic" scale. At this scale, the process of Schumpeterian entrepreneurship is organized into much denser and more compact micro-clusters that operate at the district or neighborhood level. The mechanism at work here is that these micro-clusters work to harness the Marshallian (as opposed to Jacobsian) benefits of a deeper spatial division of labor. This is due to the nature of knowledge in highly innovative areas of the economy, which is more tacit in character and thus highly distance-sensitive. By organizing themselves into specialized innovation districts, likely collaborators can maintain regular face-to-face access to each other (Storper & Venables, 2004) and dramatically lower search costs for inputs like labor and intermediate suppliers (Duranton & Puga, 2004; Rosenthal & Strange, 2008; 2004). If a larger and more diverse city-region potentiates interaction with a diverse range of inputs, a more specialized district ensures that transactions costs are lowest among regular and more immediate collaborators.

We contend that these two scales work together and that these Marshallian and Jacobsian mechanisms mutually reinforce each other. To get at this, we explore the interplay of these macro- and micro-level geographic mechanisms as they effect and shape a particular type of entrepreneurial activity: venture capital investment in high-tech startup firms.

This remainder of this paper proceeds in four main parts. We begin by contextualizing our contribution in light of the extensive literatures on innovation and entrepreneurship. We then describe our data, variables and methodology. After that, we turn to our findings: first describing our findings on the macro-geography of high-techstartup entrepreneurship across cities and metro areas, and then turning to the micro-geography of high-tech startup entrepreneurship within metro areas. The concluding section highlights our key takeaways and relevance for research and theorizing on innovation and entrepreneurship.

2. Theory and concepts

The theory of entrepreneurship originally advanced by Schumpeter (1934a, 1934b, 1954) focusses on the revolutionary impact of the entrepreneur and entrepreneurial firm. The Schumpeterian entrepreneur recognizes opportunities not just to create new firms but to bring to life new technological innovations and business models which shape new industries and restructure the economy. There is a huge literature in economics and management which advances and seeks to formalize these basic Schumpeterian insights, including Solow's (1956) theory of technological change and economic growth; Griliches (1957) and Schmookler's (1966) research on the economics of innovation; Arrow (1971) and Nelson (1986) on the internalization of industry R&D; Nelson and Winter (1982) on evolutionary models of economic growth; Mowery and Rosenberg (1991) on the role of technology and entrepreneurship in economic development; Aghion and Howitt (1990a) and Grossman and Helpman (1993) who more formally model economic growth as an outcome of firm innovations; Vernon (1966) and Klepper (1996); and Cohen and Levinthal (1990) on the absorptive capacities of firms. Generally speaking, these economic and management approaches to Schumpeterian entrepreneurship focus on the firm as the unit of analysis.

Economic geographers and urban economists have shed important light on the spatial organization of entrepreneurship and innovative activity more broadly (Feldman & Kogler, 2010). Empirical research into the regional geography of innovation shows that it is considerably more clustered than manufacturing (Audretsch & Feldman, 1996; Feldman & Florida, 1994; Feldman & Kogler, 2010) and considerably more so than population or economic output (Bettencourt et al., 2007a, 2007b; Chatterji, Glaeser, & Kerr, 2014; Florida, 2005). This uneven geography of innovation has been documented in studies using a wide range of variables and indicators, including patents (Acs, Audretsch, & Feldman, 1994; Jaffe et al., 1993), new product innovations (Acs et al., 2002; Feldman & Audretsch, 1999), venture capital (Chen, Gompers, Kovner, & Lerner, 2010; Florida & Kenney, 1988) and research and development laboratories (Carlino, Carr, Hunt, & Smith, 2012).

There are several key mechanisms that underlie the geographic clustering of entrepreneurial activity and innovation. Such activities cluster because entrepreneurs and innovators derive economic benefits from clustering, and these benefits derive from local economies of scale that attend to industrial activity. Duranton and Puga (2004) note that local scale allows firms to share resources, to improve the match between inputs and outputs and to learn from each other. On each of these scores, entrepreneurial and innovative activity is advantaged, relative to other activities, by agglomeration. Entrepreneurial firms also benefit from the dense supplier networks found in industrial clusters (Helsley & Strange, 2002). Such clustering has also been shown to improve the quality of input matching, particularly in the labor market (Helsley & Strange, 2002; Huber, 2011). Job mobility between firms in places like Silicon Valley enables better matching of employees to firms (Fallick, Fleischman, & Rebitzer, 2006; Gerlach, Rønde, & Stahl, 2009; Saxenian, 1994). Geographic clustering also raises worker incentives to acquire industry-specific human capital (Rotemberg & Saloner, 2000), thereby, lowering adverse selection problems for employers with regard to skill. These effects are more pronounced in skill-intensive, innovative sectors.

Geographic concentration and clustering are further premised on knowledge spillovers between and among firms. Knowledge is not fully excludable and is subject to increasing returns in the aggregate (Lucas, 1988; Romer, 1990). Knowledge also has a tacit dimension, so that only the most codified knowledge can be instantaneously transmitted across distance without incurring significant transactions costs (Cohen & Levinthal, 1989) Thus, clustering is required to mobilize this knowledge between and among firms. So-called "MAR" externalities, named for the contributions of Marshall, Arrow and Romer, highlight how proximity in physical space is required to facilitate more and better sharing of complex knowledge. Indeed, there is ample empirical evidence that similar firms co-produce a common stock of knowledge and know-how when they agglomerate and that this provides a key foundation of innovative and entrepreneurial clusters. Firms in clusters tend to cite local knowledge at much higher rates when they apply for patents (Jaffe et al., 1993; Thomson & Fox-Kean, 2005). A raft of empirical studies has established a relationship between urban diversity and knowledge spillovers, based on various measures of industrial composition (Feldman & Audretsch, 1999), urban size (Ó Huallicháin, 1999), cultural diversity (Florida & Gates, 2001) and density (Carlino, Chatterjee, & Hunt, 2007).

Generally speaking, research identifies two main drivers for the clustering of entrepreneurial activity and innovation more broadly: specialization à la Marshall and diversity à la Jacobs. Kemeny and Storper (2015) contend that further progress on this issue appears to have been held back by a lack of conceptual precision around what constitutes diversity and specialization. We agree with this assessment, and simply suggest that greater clarity can be achieved by seeing specialization and diversity as mechanisms that mainly (though not exclusively) operate at different spatial scales.

A sizeable chunk of the literature on the geography of entrepreneurship and innovation tends to focus on the distribution and organization of these activities across city-regions or metropolitan regions, at a level that we refer to as the "macro-geographic scale." This scale is useful because the metropolitan region is a scale that corresponds with the broad organization of economic activity in space, notably the size of the geographic market or commuting shed for the labor market and not administrative boundaries which are often arbitrary designations of where economic activity takes place.

Economic geographers and urban economists have also long recognized that the metropolitan region is not the only meaningful scale at which innovative and entrepreneurial activity occur. The seminal contributions Marshall (1890) and Jacobs (1969, 1984) as well posed entrepreneurship and innovation as being organized at a much smaller, fine-grained scale, such as the district or neighborhood level. This can be thought of as the micro-geography of innovation, and while important, it is an area where considerably less empirical research has been done, largely because of difficulty in obtaining data on entrepreneurial activity at this scale. Ellison and Glaeser (1997) point out that the tendency of firms and networks to bunch themselves within in urban regions may lead some observers to exaggerate the benefits of regional agglomeration.

A growing body of empirical studies finds that the geography of entrepreneurial and innovative activity occurs and benefits from clustering at smaller scales. Rosenthal and Strange (2008) show that human capital spillovers tend to decay after just five miles. High-tech sectors like software tend to exhibit even greater sensitivity to such clustering (Rosenthal & Strange, 2004). Experimental research finds clear evidence that productive collaboration is much more fruitful when participants are within thirty meters of one another (Olson & Olson, 2003). The San Francisco Bay Area technology complex has been found to be made up of several distinctive technology spillover zones which only somewhat overlap (Kerr & Kominers, 2015). Research on the location of R&D laboratories finds that labs are located in a series of nested clusters across the Bay Area and Boston-New York-Washington corridor with laboratories clustered in tightly networked districts which do not exceed five miles (Carlino & Kerr, 2015). Guzman and Stern (2015) find high-quality entrepreneurial activity to be highly clustered and increasingly concentrated in urban districts in San Francisco and Boston, two areas with among the highest innovation and entrepreneurial activity.

While the literature on the geography of entrepreneurship and innovation has dealt with both the macro-geography of these activities at the metropolitan scale and the micro-geography at the district or neighborhood scale – it does not fully integrate the two, or more precisely, distinguish their roles, and how the two scales work together to shape the processes of innovation and entrepreneurship. This also leads to ambiguity over whether spatial diversity or specialization is the more important mechanism at work in the clustering of entrepreneurial and innovative activity. This paper seeks to provide clarity around these issues, by identifying the roles and mechanisms at work in these two spatial scales.

Our research is organized around the idea that clustering at different scales is the product of different underling spatial mechanisms. At the macro-geographic scale, the city-region or broad metropolitan level brings together and organizes the labor market and talent; a wide array of firms that function as customers, end-users and suppliers; universities and knowledge institutions; and other key inputs. These are Jacobs-type diversity inputs which relate to urban diversity and scale. At the micro-geographic scale, local economies of scale and specialization reward innovators engaged in similar domains.

The revelation that innovative activity was highly clustered among regions and randomly dispersed within them falsifies our theory. On the other hand, the incidence of innovation clusters in non-metropolitan or non-urban regions, would suggest that urbanization economies were less important.

3. Methods and variables

To examine the interaction of these macro- and micro-level scales of spatial organization, we use unique data on a specific type of entrepreneurial activity – venture capital financed high-tech startups. These data enable us to focus on firms which reflect dimensions of Schumpeterian entrepreneurship. Much data on entrepreneurship considers all firm formation across various high-tech, low-tech, manufacturing and service industries. Using data on venture capital investment in startups enables us to focus on high-growth, high-potential firms in leading-edge industries like software, biotechnology, advanced electronics, robotics, artificial intelligence, social media and the like. Many, if not most, of the leading-edge startups of the past several decades -companies like Intel, Apple, Genentech, Google, Facebook, Twitter, Uber, Airbnb, and WeWork – have been funded by venture capital investment. These kinds of data are far less commonly employed in studies of the geography of innovation and entrepreneurship which tend to rely on government statistics for input measures like R&D funding or output measures like patents. Venture capital investors provide financing in exchange for equity in a venture. For startup firms, such venture financing is often a more promising route to market than traditional bank financing, because it allows for firms to generate resources without making a profit. Venture capital investment provides more than money; a critical dimension of it is the validation and management assistance venture investors provide to startups. For our purposes, venture capital investment provides not just a numeric count of entrepreneurial startups, but it places a market value on tech startup companies. It thus enables us to compare the total volume of venture capital investment across as well as within cities and metro areas.

These data provide a useful addition to the literature on the geography of entrepreneurship. While venture capital data has been used by economists and management scientists to look at the characteristics of tech startups or technology-based industries (Lerner, 1995; Mason, 2007), it is far less commonly employed in geographic analyses. Geographic studies tend to use two key measures for innovation and entrepreneurial activities, patents and concentrations of high-tech or newly established firms. Both types of indicators tend to be collected nationally and thus do not lend themselves to cross-national comparisons. They are also broad proxy measures of commercially relevant entrepreneurial or startup activity. A few previous geographic studies do make use of venture capital data. Florida and Kenney (1988, 1992a, 1992b) used venture capital data to document the geographic patterns of high-tech entrepreneurship and the social structures of innovation anchored by venture capitalist that underpin such geographically organized social structures of innovation. However, the data they used was much less detailed and only covered major US centers for venture capital backed startups.

Our data on venture capital investment in high-tech companies overcome many of these limitations and provide a robust measure of high-tech startup entrepreneurship. These data cover the entire universe of venture capital-backed high-tech startup across the world and can be organized and compared across each and every geographic scale of interest to the geography of innovation – the nation, the metropolitan area and the neighborhood or district level.

That said, there are challenges that come from using venture capital data to measure entrepreneurial high-tech startups (Kaplan & Lerner, 2016). For one, some kinds of technologies and firms lend themselves to venture capital funding. Patentable or otherwise excludable technologies where intellectual property can be protected are more likely to get financing from venture capitalists. Moreover, venture capital financing is more strongly established in some nations (like the United States) than others, particularly in the developing world (Bruton, Ahlstrom, & Yeh, 2004; Çetindamar, 2003; Le, Venkatesh, & Nguyen, 2006). In spite of these limitations, venture capital investment in startups provides a useful, reliable and credible, if underutilized, measure of entrepreneurial activity (Kaplan & Lerner, 2010; Kortum & Lerner, 2000). Venture capital is also a means of connecting technologists in some industries to capital that would not be available from more conservative institutions like banks and governments. There are no financing arrangements that can fully substitute for venture capital.

The data we use are from Thomson Reuters and cover the entire universe of venture capital investment in high-tech companies. Most companies are in the software, biotechnology, media and entertainment, medical devices and equipment and information technology services sectors. We code the data at the zip code or postal code level using this dataset to examine the geographic distribution and clustering of venture capital investment across the world. We aggregate these venture investments by zip or postal code and assigned them to locations according to defined global metro boundaries based on global boundary shape files provided by the Brookings Institution.

The data are for the years 2012 (and 2013 in the Swedish case) and cover more than $35 billion in venture capital investments in metro areas across the world. This data includes the name of the recipient company, the total dollar value of the investment, the number of deals completed, and geographic location information, including metro, city and postal code. These data are also coded by broad industry sector and we use these data to examine the patterns of macro- and micro-level geographic clustering for all venture capital-backed startups.

Table 1
Leading global metros for venture capital investment.

Rank	Metro	All venture capital[a]	
		Amount	Share of total
1	San Francisco	$6471	15.4%
2	San Jose	$4175	9.9%
3	Boston	$3144	7.5%
4	New York	$2106	5.0%
5	Los Angeles	$1450	3.4%
6	San Diego	$1410	3.3%
7	London	$842	2.0%
8	Washington	$834	2.0%
9	Beijing	$758	1.8%
10	Seattle	$727	1.7%
11	Chicago	$688	1.6%
12	Toronto	$628	1.5%
13	Austin	$626	1.5%
14	Shanghai	$510	1.2%
15	Mumbai	$497	1.2%
16	Paris	$449	1.1%
17	Bangalore	$419	1.0%
18	Philadelphia	$413	1.0%
19	Phoenix	$325	0.8%
20	Moscow	$318	0.8%
	Top 10 Metros	$21,917	52.0%
	Top 20 Metros	$26,790	63.6%

Source: Thomson Reuters, 2010.
[a] Millions of US dollars.

4. Findings

We begin with our findings for the macro-geography of high-tech startup entrepreneurship. Table 1 charts the distribution of venture capital investment in startup companies across the world's leading cities or metropolitan areas. Our data identify 170 global metropolitan areas that had venture capital investment in high-tech startups in 2012.

San Francisco tops the list with nearly a fifth of the global total. And nearby, San Jose in the heart of Silicon Valley is second with more than 10%. Boston is third with 8.6%; New York is fourth (5.8%); and Los Angeles is fifth (3.9%). San Diego, London, Washington, D.C. Beijing, and Seattle round out the top ten.

High-tech startup entrepreneurship as measured by venture capital investment, is considerably more concentrated and clustered on a global scale than is population or economic output. The five leading global metros for venture capital investment account for nearly half (47.6%) of such investment compared to 3.3% of global economic output and just 0.8% of population. The top ten leading global metros for venture capital investment account for 56% of the global venture investment compared to 5% of global economic output and just 1.4% of population. And the top twenty global metros for venture capital investment account for roughly three quarters (73.5%) of such investment compared to roughly 8% of global economic output and just 3% of population.

There is some overlap with venture capital investment centers and broader rankings of global cities, though the connection is not one to one (Florida & King, 2016). New York, the world's most economically powerful global city, is fourth for venture-capital investment. London, the world's second leading global city has the seventh largest amount of venture capital investment. And, Paris, which is the fifth leading global city ranks 16th for venture capital investment. But, Greater San Francisco—which is far and away the world's leading venture-capital center—only ranks as the world's 23rd leading global city. Furthermore, Tokyo which is the third leading global city ranks just 54th in venture capital investment, while Hong Kong which is the fourth most significant global city ranks 107th in venture capital investment. Overall, 12 of the world's 25 leading cities rank among the top 25 centers for venture capital investment; and 15 of the top 25 global cities rank among the world's top 60 venture-capital centers. The global leaders in innovation and entrepreneurship benefit from a combination of size, significant knowledge-based institutions, and dense innovative and entrepreneurial ecosystems. The San Francisco Bay Area's venture capital cluster is even more striking when compared to the US city system.

We now turn to the second scale of the geography of entrepreneurial activity, its micro-geography. Indeed, entrepreneurial activity not only requires the spatial organization of inputs at the broad metropolitan level, but sharable inputs the more local level as well. As we have seen, unban theory dating back to Marshall and Jacobs notes that it occurs in denser, more tightly linked and connected micro-clusters of entrepreneurial activity.

To understand this, we examine the distribution of venture capital investment in high-tech startup companies across US zip codes. Our data identify such venture capital investment in less than 4% (3.9%) of all US zip codes (1339 of 33,144 zip codes). Zip codes delineate neighborhoods or districts that encompass clusters of business, industrial, commercial and residential activity, and as such provide the best available unit of analysis for examining the micro-clustering of innovative and entrepreneurial activity.

Table 2 lists the location of capital investment by zip code across the United States in 2013. Large levels of investment are in the San Francisco Bay Area, around Los Angeles and San Diego in Southern California, and in the East Coast along the New York-Boston-Washington Corridor.

Venture capital-backed startup activity is highly concentrated in a relatively small number of zip codes across the United States. Overall, the top 20 zip codes for venture investment account for nearly a third of the total, while just the top 10 accounts for roughly a fifth of total venture investment.

Fig. 1 maps the micro-clustering of venture capital investment within the three metros which account for the largest shares of venture capital investment in the United States: the San Francisco Bay Area, the New York metro and the Boston-Cambridge metro. Note the significant micro-level clustering of innovative and entrepreneurial activity within each of these metros.

Table 2
Leading US Metros for Venture Capital.

Rank	Metro[a]	All venture capital[a]		Digital venture capital[a]		
		Amount	Share of total	Amount	Share of metro	Share of all digital
1	San Francisco	$8468	25.3%	$5083	60.0%	29.7%
2	San Jose	$4865	14.5%	$2983	61.3%	17.5%
3	New York	$3335	10.0%	$1780	53.4%	10.4%
4	Boston	$3199	9.5%	$1063	33.2%	6.2%
5	Los Angeles	$1695	5.1%	$918	54.2%	5.4%
6	Washington DC	$1268	3.8%	$597	47.1%	3.5%
7	Seattle	$873	2.6%	$499	57.1%	2.9%
8	Atlanta	$514	1.5%	$412	80.2%	2.4%
9	Austin	$475	1.4%	$295	62.0%	1.7%
10	Miami	$329	1.0%	$271	82.4%	1.6%
11	Chicago	$650	1.9%	$269	41.3%	1.6%
12	Philadelphia	$495	1.5%	$190	38.4%	1.1%
13	San Diego	$944	2.8%	$189	20.0%	1.1%
14	Denver	$380	1.1%	$189	49.6%	1.1%
15	Dallas	$734	2.2%	$183	25.0%	1.1%
16	Santa Barbara	$250	0.8%	$178	71.1%	1.0%
17	Phoenix	$147	0.4%	$127	86.3%	0.7%
18	Baltimore	$237	0.7%	$106	44.8%	0.6%
19	Portland	$177	0.5%	$103	58.4%	0.6%
20	Minneapolis-St. Paul	$309	0.9%	$93	30.1%	0.5%
	Top 10 metros	$25,021	74.6%	$13,901	55.6%	81.3%
	Top 20 metros	$29,344	87.5%	$15,527	52.9%	90.8%

Notes: Metro names are abbreviated.
Source: Thomson Reuters, 2013.
[a] Millions of US dollars.

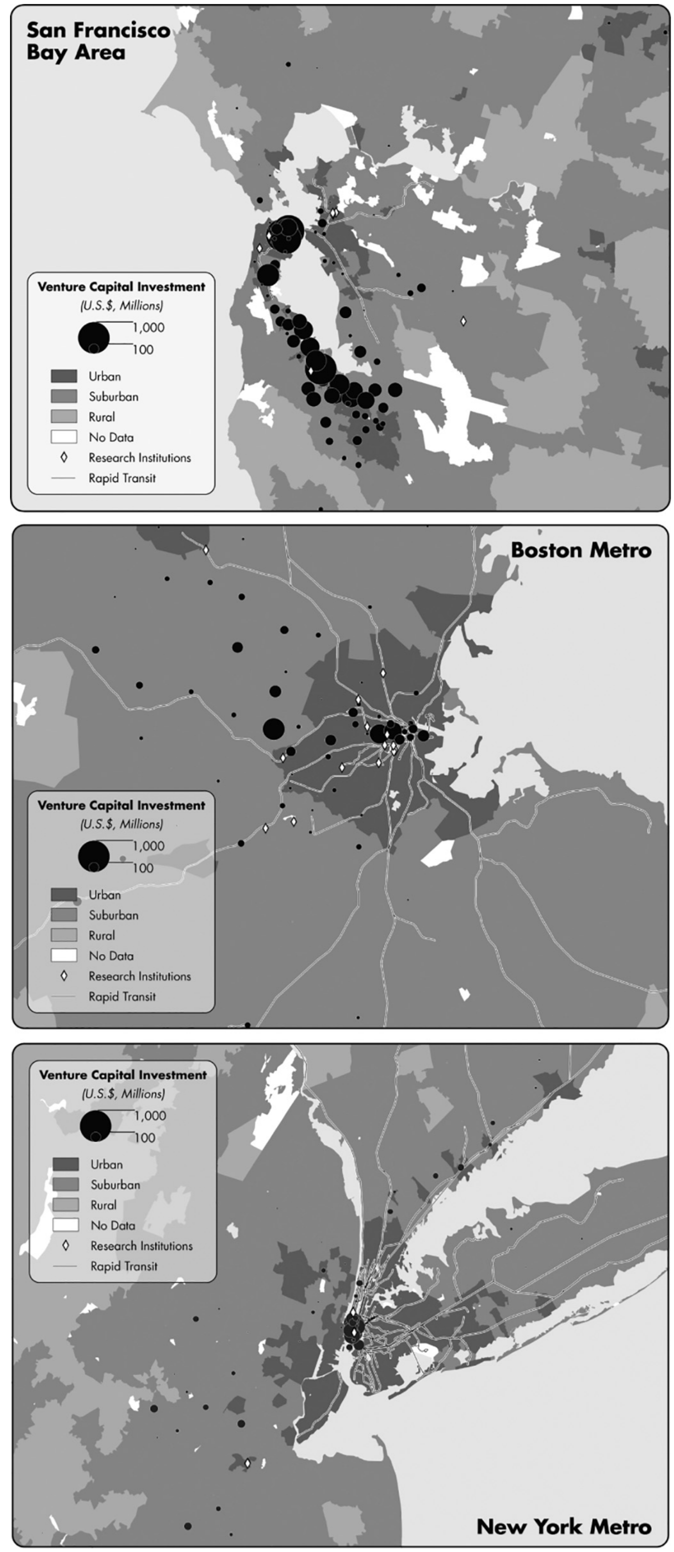

Fig. 1. Venture capital investment within America's largest venture capital sheds.

In the San Francisco Bay Area, there are distinct clusters of venture capital investment in and around downtown San Francisco and around the University of California San Francisco and in Silicon Valley, particularly in and around Palo Alto, close to Stanford University. In the Boston-Cambridge metro there are significant clusters of venture capital investment in and around downtown Boston and in Cambridge in close proximity to MIT and Harvard. In the New York metro, we find substantial clustering of venture capital investment and startup activity around Lower Manhattan.

We also compare the locations of venture capital investment to two measures of urbanity– household density and commute to work. While these measures are complementary, we use both to measure the level of urbanity. Urbanity is measured categorically as urban, suburban, or rural with household density. We classify zip codes using household density based on a methodology devised by Kolko (2015) which classifies urban areas as those with 2213.2 households per square mile; suburban areas have between 101.6 and 2213.2 households per square mile and rural areas have less than 101.6 households per square mile.

We find that venture capital-backed startups are split between urban and suburban zip codes. Of the 1301 zip codes that receive venture capital investment roughly 40% (38.6% or 501) are urban, 44.3% (718) are suburban, and just 4% (49) are rural. The differences between zip codes with venture capital investment and those without are statistically significant based on *t*-tests.

But, when we look at the leading neighborhoods for venture capital investments, we find that venture capital-backed startups are even more concentrated in urban areas. Table 3 lists the top twenty zip codes for venture capital-backed startups in the United States and shows how they compare on our household density and commuting measures. Of these top twenty leading venture capital neighborhoods, eleven are urban and nine are suburban based on our density measure. Seven of these zip codes have densities greater than 5000 people per square mile. The two leading zip codes for venture capital-backed startups are dense, highly urbanized neighborhoods of San Francisco.

Many of these top venture capital receiving zip codes are located in very close proximity to universities. In particular, zip code 94301, which received the third highest amount of venture capital, is in Palo Alto which is home to Stanford University, a leading research institute in the United States. In addition, five of the top twenty zip codes in California are in close proximity to Stanford University, including zip 94,025 Menlo Park, 94,043 Mountain View, 94,041 Old Mountain View, 94,063 Redwood and 94,085 Sunnyvale. Zip code 95054 Santa Clara is in close proximity to University of California Santa Cruz while zip code 94111 is in close proximity to University of California San Francisco as well as the University of San Francisco and San Francisco State University. Both Boston zip codes of 02139 and 02142 with a total of almost $700 million in venture capital investment are in close proximity to the leading research universities of MIT and Harvard. New York University is located in zip code 10012 which received $310 million.

Many commentators have suggested that digital industries – those based on the internet and other digital technologies would be more spread out and less geographically rooted (Friedman, 2005). But, venture capital-backed startups in digital industries are even more concentrated at the zip code or neighborhood level, in a manner consistent with the ‘flat earth’ skeptics like Leamer (2007). Table 4 lists the leading zip codes for digital venture capital investment across the United States in 2013. Top ten zip codes for digital venture capital account for 30% of investment (compared to 20% for the top ten zip codes for overall venture capital investment); the top twenty zip codes for digital venture capital investment account for more than 40% of the total (compared to less than a third for the top twenty for all venture capital investment). Indeed, ten of the top twenty zip codes for digital venture capital startups are urban neighborhoods, with six mainly in around downtown San Francisco, and three in neighborhoods in New York City's Lower Manhattan. Our data on venture capital investment in digitally related industries suggest that it is even more concentrated in micro-clusters in and around dense urban areas. Digital technologies may flatten the earth for most consumers of these technologies, they do not do the same for producers.

The commuting data provide an additional lens into urbanity, by showing the share of workers who drive to work versus those who walk, bike or use transit to get to work. Zip codes where more people walk or bike to work are by definition located closer to central business districts and commercial areas, while zip codes where more people use transit to get to work are located around transit hubs, which also by definition require greater density. Conversely, zip codes where people use cars to get to work are less dense, more sprawling and more suburban. These data are from the American Community Survey's 2013 five-year estimate (U.S. Census, 2013). The conventional wisdom about high-tech location suggests that a preponderance of high-tech, venture capital-backed startups locate in suburban areas where workers drive to work.

Table 3
Leading zip codes for venture capital investment.

Rank	Zip code	Neighborhood/city	Metro[a]	Venture capital investment[b]	Urban vs. suburban	Density[c]	Walk, bike or transit
1	94,103	South of Market/Mission District	San Francisco	$1063	Urban	9659	61.2%
2	94,105	Rincon Hill	San Francisco	$1004	Urban	9718	59.6%
3	94,301	Palo Alto	San Jose	$998	Urban	3194	21.3%
4	94,107	Potrero Hill/Dogpatch/South Beach	San Francisco	$885	Urban	7665	46.8%
5	92,121	Sorrento Valley	San Diego	$568	Suburban	137	10.0%
6	94,080	South San Francisco	San Francisco	$501	Suburban	2049	14.8%
7	2451	Waltham	Boston	$484	Suburban	1359	11.1%
8	94,104	Financial District	San Francisco	$481	Urban	2654	92.1%
9	94,025	Menlo Park	San Francisco	$430	Suburban	1309	12.7%
10	94,043	Mountain View	San Jose	$416	Suburban	1158	9.5%
11	94,041	Old Mountain View	San Jose	$392	Urban	3899	15.9%
12	94,063	Redwood City	San Francisco	$378	Urban	1281	14.6%
13	2139	Cambridge/MIT	Boston	$377	Urban	9331	64.3%
14	94,065	Redwood Shores	San Francisco	$369	Suburban	1946	5.9%
15	75,034	Frisco	Dallas-	$368	Suburban	498	0.9%
16	94,085	Sunnyvale	San Jose	$351	Suburban	2199	7.2%
17	2142	MIT	Boston	$320	Urban	5300	65.0%
18	95,054	Santa Clara	San Jose	$313	Suburban	1348	5.6%
19	10,012	SOHO/NYU	New York	$310	Urban	41,294	83.8%
20	94,111	Financial District/Embarcadero	San Francisco	$306	Urban	6875	60.3%
		Top 10 metros		$6830			
		Top 20 metros		$10,315			

Source: Thomson Reuters, 2013.
[a] Metro names are abbreviated.
[b] Millions of US dollars.
[c] In households per square mile.

Table 4
Leading zip codes for digital venture capital investment.

Rank	Zip code	Neighborhood[a]	Metro[b]	Density[c]	Digital venture capital investment		
					Amount[d]	As share of all venture capital in zip code	As share of all digital venture capital
1	94,105	Rincon Hill	San Francisco	9718	$904	90.1%	5.3%
2	94,103	South of Market/Mission District	San Francisco	9659	$899	85.1%	5.3%
3	94,301	Palo Alto	San Jose	3194	$881	88.2%	5.2%
4	94,107	Potrero Hill/Dogpatch/South Beach	San Francisco	7665	$707	79.9%	4.1%
5	94,104	Financial District	San Francisco	2654	$357	74.3%	2.1%
6	2451	Waltham	Boston-Cambridge	1359	$333	68.8%	2.0%
7	94,108	Chinatown	San Francisco	28,252	$261	100.0%	1.5%
8	94,111	Embarcadero/Financial District	San Francisco	6875	$236	77.0%	1.4%
9	94,041	Old Mountain View	San Jose	3899	$230	58.5%	1.3%
10	10,010	Gramercy/Flatiron	New York	42,343	$211	80.8%	1.2%
11	94,022	Los Altos Hills	San Jose	405	$211	94.8%	1.2%
12	94,065	Redwood Shores	San Francisco	1946	$210	56.8%	1.2%
13	94,085	Sunnyvale	San Jose	2199	$206	58.8%	1.2%
14	94,043	Mountain View	San Jose	1158	$206	51.2%	1.2%
15	10,012	SoHo/NYU	New York	41,294	$205	66.0%	1.2%
16	10,001	Chelsea	New York	17,763	$204	83.6%	1.2%
17	94,404	Foster City	San Francisco	3223	$204	91.8%	1.2%
18	94,040	Cuesta Park/Blossom Valley	San Jose	3735	$189	75.8%	1.1%
19	95,054	Santa Clara (North)	San Jose	1348	$187	59.7%	1.10%
20	30,338	Dunwoody	Atlanta	1463	$179	100.0%	1.1%
		Top 10 zip codes			$5018		29.4%
		Top 20 zip codes			$7019		41.1%

Source: Thomson Reuters, 2013.
[a] Neighborhoods in italics are suburban based on household density.
[b] Metro names are abbreviated.
[c] In households per square mile.
[d] Millions of US dollars.

Our data enable us not just to identify the density of locations of venture capital backed startups but to identity the shares of workers in these locations who drive a car to work versus those who take transit or walk or bike to work.

We find a relatively larger share of venture capital backed startups that are located in zip codes where workers take transit or walk or bike to work. In neighborhoods with venture capital investment, 16.6% of commuters walk, bike, or use transit to get to work, compared to 8.4% in all zip codes and 4.9% in zip codes without venture capital. In the top 20 zip codes for venture capital backed startups, roughly three times as large a share of commuters walk, bike, or use transit to get to work compared to the national average – 25.9% versus 8.4%. In 16 of these top twenty zip codes, the share of commuters who walk, bike or take transit to work exceeds the national average. In the top fifty zip codes with venture capital, 17.9% of commuters walk, bike or take transit to work. In the top ten, 33.9% do so.

We now look at the micro-clustering of venture capital investment in Sweden. Sweden has a high level of innovative and entrepreneurial activity, ranking second on the Global Innovation Index (World Intellectual Property Organization, 2017). In total, 100 registered venture capital investments were made in Swedish firms distributed across 91 companies (in nine of the cases, the company received an investment both in 2012 and 2013). The primary industry of investment was software publishers which accounted for approximately 57% of the investments.

We track Swedish venture capital investments across three geographic scales: (1) 72 metro areas based on labor market areas, (2) 290 municipalities which are essentially subdivisions within these metro areas, and (3) 9700 postal codes across the 290 municipalities. Out of the 72 metros, only 19 were home to a company that received venture capital investment. Table 5 shows the breakdown of venture capital investment across Swedish metro areas.

Stockholm is the leading center for venture capital investment by far, accounting for more than three-fourths of all investments compared to just 26% of the population. Stockholm is home to several globally successful digital startups, including Skype, Minecraft and Candy Crush. Stockholm is also home to Kista – the number one ICT cluster in Sweden. The Malmö-Lund region is second with 9.3% of venture capital investment, which is smaller than its share of the population (11.5%). The core of the Malmö region is closely connected by a bridge to the Copenhagen region, which is approximately is two thirds of the size of Stockholm.

Table 5
Venture capital investment in Swedish metros.

Metro	Venture capital investment		Digital venture capital investment	
	Amount[a]	Share	Amount[a]	Share
Stockholm	$572.04	75.9%	$493.15	83.2%
Malmö/Lund	$70.13	9.3%	$47.12	7.9%
Göteborg	$40.99	5.4%	$6.33	1.1%
Total for 3 metros	$683.16	90.6%	$546.60	92.2%
Total	$754.21	100%	$593.01	100%

Source: Thomson Reuters, 2013.
[a] Millions of US dollars.

These three regions account for 90% of venture capital investment in Sweden compared to 57% of economic output or GDP, and 48% of the population. The remaining 16 labor metros account for less than 10% of venture capital investment, while being home to the remaining 52% of the population. Roughly 80% of all Swedish venture capital investment was in digital industries. Two regions – Stockholm and Malmö-Lund - account for more than 90% of venture capital investment in digital startups in Sweden, Stockholm with more than 80% and Malmö-Lund with roughly 8%.

Venture capital investment is even more concentrated within metros at the city or municipal levels. Table 6 shows the distribution of venture capital investments in municipalities for the Stockholm and Malmö-

Table 6
Venture capital investment municipalities in the Stockholm and Malmö/Lund Metros.

Metro	Municipality	Venture capital investment		Digital venture capital investment	
		Amount[a]	Share	Amount[a]	Share
Stockholm	Stockholm	$515.47	90.1%	$463.92	94.1%
	Danderyd	$21.00	3.7%	$21.00	4.3%
	Solna	$17.95	3.1%	$0	0%
	Uppsala	$13.64	2.4%	$4.25	0.9%
	Täby	$2.14	0.4%	$2.14	0.4%
	Lidingö	$1.84	0.3%	$1.84	0.4%
	Total	$572.04	100%	$493.15	100%
Malmö/Lund	Lund	$58.57	83.5%	$40.79	86.6%
	Malmö	$6.33	9.0%	$6.33	13.4%
	Eslöv	$3.86	5.5%	$0	0%
	Helsingborg	$1.37	2.0%	$0	0%
	Total	$70.13	100%	$47.12	100%

Source: Thomson Reuters, 2013.
[a] In millions of US dollars.

Table 7
Venture capital investment by postal codes in Stockholm and Lund.

Municipality	Postal code	Venture capital investment		Digital venture capital investment	
		Amount[a]	Share	Amount[a]	Share
Stockholm	11,356	$350.00	67.9%	$350.00	75.6%
	11,143	$37.80	7.3%	$37.80	8.2%
	11,426	$20.10	3.9%	$0.00	0%
	11,123	$19.30	3.7%	$19.30	4.2%
	16,440	$15.80	3.1%	$10.30	2.20%
	11,130	$8.70	1.7%	$8.70	1.9%
	11,144	$6.70	1.3%	$0.0	0%
	Total of 7 postal codes	$458.40	89.0%	$426.10	92.0%
	Total	$515.50	100%	$463.20	100%
Lund	22,363	$57.56	98.3%	$40.79	100%
	22,362	$1.01	1.7%	$0	0%
	Total	58.57	100%	$40.79	100%

Source: Thomson Reuters, 2013.
[a] Millions of US dollars.

Lund metros. Stockholm and Lund municipality together account for 10% of the population but more than three-quarters of venture capital investment in Sweden.

It is reasonable to believe that there are spillover effects from the Copenhagen region on the Malmö-Lund region. While our analysis for Sweden is based on the years 2012 to 2013, comparable data for Copenhagen for the year 2012 suggests that the greater region received $227 millions in venture capital investments, a significantly larger amount than Malmö-Lund. The number of deals in Copenhagen was about the same in Malmö-Lund but the amounts invested were on average larger in Copenhagen.

Venture capital investment is not only concentrated in Stockholm and Malmö-Lund, it is concentrated within them. Across the two metros, just 10 of a total of 64 municipalities are home to firms that received venture capital investment. In Stockholm, just six of 36 municipalities have venture capital investment; and Malmö-Lund has four in 28 municipalities.

Venture capital investment is organized in micro-clusters within these two regions. Ninety percent of all venture capital investment in the Stockholm metro went to the city of Stockholm. More than 80% of venture capital investment in the Malmö-Lund metro are concentrated in Lund while 9% goes to Malmö.

Again, we find the pattern to be even more clustered and concentrated for digital startups. In the Stockholm metro, nearly 95% of venture capital investments in digitally related startups went to the city of Stockholm; and Malmö-Lund region, almost 85% went to Lund.

Venture capital investment is very highly concentrated in distinct micro-clusters in these two cities. Table 7 shows the distribution of venture capital in the municipalities of Stockholm and Lund. Venture capital investment is concentrated in just 3% of all postal codes in Stockholm (24 of 779 total postal codes). The dominant postal code in Stockholm is 11,356 which accounts for more than two-thirds of all venture capital investment in the city of Stockholm. This postal code is in central Stockholm a few blocks to the Stockholm School of Economics, the Royal Institute of Technology and Stockholm University. All of the investments made in this postal code went to digital startups. Postal code 11143, also located in the city center, accounts for another 7% of venture capital investment and a similar percentage of venture investment in digitally related startups. In Lund municipality, just one postal code accounts for more than 98% of investment, and all of venture capital investment in digital industries. The postal code covers strong research hubs: Lund University, IDEON Science Park, and Sony Mobil Communications. The micro-clustering in both Stockholm and Lund-Malmö is occurring nearby leading academic institutions. While this may be a necessary condition for venture capital micro-clustering it may not a sufficient one, since there are other major universities in for example, Gothenburg and Uppsala where we do not find the same venture capital concentration.

5. Discussion and conclusion

Our research has examined the spatial organization of Schumpetarian entrepreneurship, a process which has been said to be fundamental to technological innovation and economic growth. We started from the basic contention that the geographic organization or clustering of high-techstartup entrepreneurship can be best understood as occurring across two key spatial scales – a macro-geographic scale which occurs across city-regions or metropolitan areas and reflects Jacobs'-like mechanisms and a micro-geographic scale with occurs within city-regions at the neighborhood or district level reflects Marshallian mechanisms.

Our research identified the role and interplay of these two spatial scales and attendant mechanisms via an empirical examination of venture capital-financed startup companies, the kind of enterprises noted in the literature as most reflective of Schumpeterian entrepreneurships. We find evidence of startup entrepreneurship being organized at both of these scales. At the macro-geographic scale, tech-startup entrepreneurship (measured here as venture capital-financed startups) is heavily concentrated in a relatively small group of metros that provide assets and capacity in the form of diverse pools of talent, diverse groups of firms, leading-edge research universities and knowledge institutions and other factors. At the micro-geographic scale, within these leading city-regions or metro areas, tech-startup entrepreneurship is also clustered and concentrated in considerably denser and more tightly-woven micro-clusters at the district or neighborhood scale.

Our results findings find evidence of the clustering of entrepreneurial tech startups at both scales, across a relatively small set of global cities and metro areas, and within a relatively small set of districts of neighborhoods within those global metros. At the macro-geographic level, certain subset of metros provides more of the key inputs, like talent, research universities and knowledge institutions, global gateway airports that connect to other key global cities, a diverse array of end-user, related and supplier companies, and other factors, that are broadly required for innovative and entrepreneurial activities. At the micro-geographic level, entrepreneurial activities are extremely clustered and concentrated in particular neighborhoods or districts that enable the proximity, density, knowledge-sharing, networking, face-to-face communication, combination and recombination of knowledge, and talent and ideas, which are required for innovation. Indeed, our findings point to the key role of such micro-level clustering, which is in line with economic and urban theorizing, but which has not been the subject of a great deal of previous empirical research, which has focused mainly on metro-level patterns. As Jacobs and Marshall long ago theorized and as Kerr and Kominers (2015) more recently point out, the actual mechanism that motivate and shape clustering operate at a far smaller and more localized scales than the city-region or metropolitan area.

Our work suggests that these two spatial mechanisms are not opposed, but that they work together and in conjunction to shape the geography of entrepreneurial activity. Rather than emphasize one over the other, the two seem to work together across these two geographic scales. It can ultimately be said that the macro-geographic level clustering of tech startups reflects Jacobs-like mechanisms such as the benefits of scale and diversity, while micro-geographic clustering reflects Marshallian mechanisms notably the benefits of specialized knowledge, labor, and inputs. These are complimentary scales and mechanisms, according to our research. There is no "dual" between diversity and specialization; rather they can best be conceived of as reinforcing processes operating at different geographic scales. Thus, in addition to conceptual ambiguity surrounding the benefits of diversity for growth (Kemeny & Storper, 2015) a lack of geographical clarity, may be stymying the field.

Of course, this is not to say that all entrepreneurial or innovative activities are the province of large dense cities. Firms themselves remain innovative actors. And innovative and entrepreneurial activity can and does take place in small and medium size cities, in suburbs even in rural areas (Rodríguez-Pose and Wilkie (2018); Grabher, 2018; Shearmur, 2012). That said, the preponderance of entrepreneurial tech startups (measured as venture capital investment in high-tech startups) occurs in dense urban neighborhoods in significant global cities. For these reasons, we conclude that tech-startup entrepreneurship is by definition a spatial phenomenon, and that the city itself is a key factor in and a key platform for the organization of startup entrepreneurship.

Ultimately, this research is just a start. We encourage more and further research to look at the centrality of space and place in innovative and entrepreneurial activity and the ways that different scales of geography act on and condition innovation and entrepreneurship. In particular, we encourage more research into the micro-geography of innovation and entrepreneurship focusing on the factors and mechanisms that stand behind and shape their continued clustering in distinct, spatially-delimited districts of cities.

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