



Space-time analysis of high technology entrepreneurship: A comparison of California and New England

Haifeng Qian^{a,*}, Chang Zhao^b

^a School of Urban and Regional Planning, The University of Iowa, 338 Jessup Hall, Iowa City, IA, 52242, USA

^b Department of Geographical and Sustainability Sciences, The University of Iowa, Iowa City, IA, 52242, USA

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ABSTRACT

Entrepreneurship or new firm formation has been recognized as one of the major driving forces behind regional economic development. This study focuses on high technology entrepreneurship in California and New England, two of the most entrepreneurial regions in the United States. We compare and contrast the spatial-temporal patterns of high technology entrepreneurship at the county level in these two regions. Further, we run spatial panel regressions to identify locational factors associated with high technology startup activity and find heterogeneous results between California and New England. The spatial panel regression results reported in this research are also different from cross-sectional studies in the literature, addressing the need for integrating the temporal dimension in regional studies of entrepreneurship. Policy implications are discussed based on empirical findings.

1. Introduction

It is increasingly recognized that entrepreneurship or startup activity drives economic development. As summarized in Qian and Haynes (2014), entrepreneurs or new firms contribute to regional economic performance in three ways: job creation (Haltiwanger, Jarmin, & Miranda, 2013), efficient uses of market resources (Kirzner, 1997), and knowledge commercialization (Acs, Audretsch, Braunerhjelm, & Carlsson, 2009). Numerous empirical studies report significant associations between entrepreneurship and regional economic development (e.g., Acs & Armington, 2006; Audretsch & Keilbach, 2008; Audretsch, Keilbach, & Lehmann, 2006). Realizing the importance of entrepreneurship, economic development practitioners and policy makers have been searching for ways to promote entrepreneurial activity in regional economies (Gilbert, Audretsch, & McDougall, 2004).

Regional economies do not benefit equally from entrepreneurship. Economic geographers and regional scientists provide documented evidence on regional variations in entrepreneurial activity, for instance, in the United States (Acs & Armington, 2006), Germany (Audretsch et al., 2006), Sweden (Andersson & Koster, 2011), South Korea (Hong, Lee, Sun, & Harrison, 2015), and China (Guo, He, & Li, 2016). With few exceptions (e.g., Andersson & Koster, 2011; Hong et al., 2015), regional studies of entrepreneurship are cross-sectional, and the temporal dimension of new firm formation has been rarely examined. However,

economic development is about the temporal change of the economy in nature. Therefore, how startup activity evolves along time is perhaps more important to economic development than its static regional variation from a policy perspective.

The economic success of Silicon Valley has attracted many scholars to the study of entrepreneurial activity in high technology industries (Bahrami & Evans, 2000; Oakey, 2012). Entrepreneurship is identified as one mechanism of facilitating knowledge spillovers (Acs et al., 2009; Qian & Acs, 2013). Entrepreneurial activity in knowledge-intensive, high-technology industries is often closely associated with innovation and therefore has greater and longer-term impacts on economic growth. Among areas benefitting the most from high technology development, Silicon Valley in California and Route 128 in Massachusetts stand out for their high concentration in electronics (Saxenian, 1994). Saxenian addresses the culture of networking, openness, and high mobility in Silicon Valley that makes it outperform Route 128, which is culturally characterized by independence, vertical integration, and stability. Spatially speaking, one may expect higher spatial dependence of high technology entrepreneurship in California than in Massachusetts under these cultural differences.

The objective of this research is to conduct space-time analysis of high technology entrepreneurship, addressing the understudied temporal dimension in spatial analysis of entrepreneurship. We use California and New England as two examples, enlightened by Saxenian's work (1994) that examines the performance difference

* Corresponding author.

E-mail addresses: haifeng-qian@uiowa.edu (H. Qian), chang-zhao@uiowa.edu (C. Zhao).

between these two most prominent high technology centers in the United States. Instead of her qualitative approach, we test her hypothesis in a quantitative way and examine whether there are stronger spatial dependency or spillovers of high technology startup activity across geographical units in California than in New England based on spatial statistical methods. In a spatial panel regression approach, we further explore and compare/contrast the geographically-bounded factors that may impact high technology entrepreneurship in each of the two regions. This regression analysis helps policy makers to understand the dynamic regional environments that are friendly to entrepreneurial startups.

2. Literature

This research is motivated by the influential study of AnnaLee Saxenian (1994) who compares high technology development in Silicon Valley with that in the Route 128 area of the Boston metropolitan region. These two areas were the nation's most prominent innovation and entrepreneurship centers in the field of electronics. Both benefited from federal military spending and world-class university research within their region in the 50s–70s. Since the 80s, Silicon Valley continues to be a high technology hot spot and one of the most entrepreneurial areas in the United States. In contrast, Route 128's high technology sector is lagged behind. Saxenian attributes this divergent performance to the cultural differences between these two areas. Silicon Valley's network-based industrial system is characterized by openness, dense networks, high flexibility, collective learning, risk-taking, high mobility in the labor market, and collaboration in parallel to competition. Such a decentralized system blurs “the boundaries between social life and work, between firms, between firms and local institutions, and between managers and workers” (Saxenian, 1994, p. 56). Route 128 has a very different independent firm-based industrial system, which highlights vertical integration, self-reliant large corporations, hierarchy, secrecy, stability, and lack of mobility in the labor market. The culture in Silicon Valley proves to be friendlier to knowledge spillovers, innovation, and entrepreneurship and represents one of the key components of the area's competitive advantage.

Although not using the term *spatial dependency*, the network-based knowledge economy described by Saxenian (1994) implies the spatially-interdependent innovative and entrepreneurial activities across geographically proximate areas in the Bay Area. Geographical proximity may facilitate face-to-face interactions, learning by observing and imitating, and sharing of geographically-bounded common resources, infrastructure, and business practices. However, these roles of geography are expected to be weakened when the regional economy is characterized by the independent firm-based industrial system, exemplified by the Boston area.

Saxenian's work also implies the *temporal dependency* of industrial systems in her account of the history of the two high technology centers. The founding of Hewlett-Packard (HP) in 1937 is typically considered as the beginning of Silicon Valley (Saxenian, 1994, p. 20). HP's co-founders William Hewlett and David Packard “pioneered management styles based on teamwork, openness, and participation” (Saxenian, 1994, p. 50). Other iconic entrepreneurs in the area, such as Intel co-founders Robert Noyce, Andy Grove, and Gordon Moore, similarly adopted organizational or management structures that “facilitate the exchange of ideas and information” (Saxenian, 1994, p. 53). Another major figure in the early years of Silicon Valley, Frederick Terman who was then the engineering school dean at Stanford University, made extensive efforts to build collaborative relationships between the university and local industries. These business and university pioneers formed a network-based cultural environment that propelled the rise of Silicon Valley and helped it survive the fierce competition from Japanese semiconductor manufacturers in the 80s. In contrast, the open, network-based, and risk-taking culture that consistently characterizes Silicon Valley was never prevalent in Route 128. The most

visible business leader in Route 128, Ken Olsen of Digital Equipment Corporation (DEC), mentioned the enormous influence of New England's “Puritan traditions of self-reliance and self-reflection” on business operations in the area (Saxenian, 1994, p. 62). Saxenian (1994) summarizes in her concluding chapter that “regional institutions and culture are difficult to change. An industrial system is the product of historical processes that are not easily imitated or altered” (p.162).

Saxenian (1994) relies primarily on case studies in her book to explain the differences in entrepreneurial activity between these two areas. For instance, she tells a number of Silicon Valley stories in which an engineer/manager/founder left an incumbent firm and created her/his own firm. This type of entrepreneurship is termed as “knowledge spillover entrepreneurship” by Acs et al. (2009) or “spinoffs” by Klepper and Sleeper (2005). Along with this line of research, knowledge spillovers and high technology entrepreneurship have been built into an integrative framework of regional development, e.g., in Qian, Acs, and Stough (2013). The spatial dimension of knowledge spillovers has long gained attention (Marshall, 1920), but it was not until the work of Anselin, Varga, and Acs (1997) that rigorous spatial analytical methods (e.g., spatial econometrics) were used to study the spatial interactions of knowledge-intensive economic activity. The spatial econometric approach to knowledge spillovers has been flourishing in recent years (Acs, Anselin, & Varga, 2002; Autant-Bernard & Lesage, 2011) and also extended to high technology entrepreneurship (Audretsch, Dohse, & Niebuhr, 2010; Qian & Haynes, 2014). Plummer (2010) discusses why entrepreneurial activity in general can be spatially dependent and why spatial econometric methods should be considered in entrepreneurship research. He notes that new firms in the same sector tend to be geographically clustered and rely more on regional environments or nearby resources.

While spatial dependency has been widely considered in entrepreneurship research, integrating the temporal dimension at the same time is very rare. An exception is Hong et al. (2015), who have studied the space-time dynamics of new manufacturing firms in South Korea. But a spatial-temporal data analysis approach to *high technology* entrepreneurship is missing in the literature.

In this research, Saxenian's theory is tested in spatial-temporal data analysis. We examine the spatial-temporal patterns of high technology entrepreneurship and compare/contrast the “West Coast pattern” with the “East Coast pattern.” This research adopts a very different approach from the qualitative analysis of Saxenian (1994). Built on the population data of new firm formation and using the newest spatial-temporal analytical tools, this research provides solid and scientific evidence on the spillover effects of high technology entrepreneurship with a consideration of the temporal dimension. Further, this research expands Silicon Valley to California and Route 128 to New England, which allows it to have a greater geographical impact. New England as a whole has its unique history, identity, and culture associated with its economic development (Innes, 1995). Therefore, it is reasonable to consider the entire New England instead of simply the Commonwealth of Massachusetts. The new firm formation data available to us allow for using counties as the geographical unit for analysis. California and New England are also comparable in the number of counties within each region (58 and 67, respectively). One hypothesis is that California exhibits a higher level of spillover effects of high technology entrepreneurship than New England does. Given their cultural differences, spatial heterogeneity between these two regions in terms of the associations between quantifiable regional factors and high technology entrepreneurship is also expected.

3. Methodology

3.1. Research scope

This study analyzes the spatial-temporal dynamics of high technology startup activity in California and New England. A special

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