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Austin, Boston, Silicon Valley, and New York: Case studies in the location choices of entrepreneurs in maintaining the Technopolis☆

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ABSTRACT

This study uses institutional theory and the "Technopolis" wheel to investigate the movement of technology entrepreneurs and why they "stick" to well-established entrepreneurial ecosystems in Silicon Valley, Austin, Boston, and New York City. We detail the historical development of the entrepreneurial ecosystem in each location, with a particular focus on the institutions and support structures that link and sustain key resources that are central to technology clusters. We operationalize key segments of the Technopolis wheel including (1) networks and connectedness, (2) investment capital, and (3) innovation and R&D. The empirical analysis specifies models testing for location-specific variation in the influence of these factors on entrepreneur location choice. We supplement this with analysis of interview data from 45 technology entrepreneurs with direct experience in these locations. We find that higher degrees of connectedness in Austin and Silicon Valley are an important factor in retaining potential entrepreneurs and several institutions were linked to facilitating tie formation and accessing key resources within the Technopolis. We also find that the frequency of funding opportunities positively influences entrepreneurs moving to Austin, Boston, and Silicon Valley to immediately start a company. In Boston, we find a positive association between patents and staying in Boston to launch a startup and we find that older entrepreneurs living in New York and Silicon Valley are less likely to remain and start a company.

1. Introduction

The literature on regional advantage offers several explanations for why particular regions have prospered. The relationship between creative environments and creative regions can be traced to the analysis of regional clustering of firms (Marshall, 1920; Porter, 1990) and the innovation-centered business clusters (Dorfman, 1983; Feldman, 2000; Hellmann, 2000; Kenney and Burg, 1999; Saxenian, 1994; Steiner, 1998). Regional advantage stems from the geographic concentration of innovative industries that constantly yield spin-offs that refuel the hub. Geographically concentrated business clusters offer several advantages to new ventures. Clusters often specialize in a particular industry or technology and in turn attract key suppliers and labor talent to the area (Sorenson and Audia, 2000). This provides new firms with lower cost access to material and human resources, providing competitive advantages that stem from economies of scale, reduction of transaction costs, and capturing spillover demand (Krugman and Obstfeld, 1997; Porter, 1990).

Research on high technology regions increasingly uses institutional theory as a guiding framework to help to explain entrepreneurial success (Foss and Gibson, 2015). Institutional theory is concerned with the resilient, lasting aspects of social structure (Blau, 1955; Merton, 1940; Parsons, 1956). The institutionalist view recognizes these clusters develop robust networks of institutional support corresponding to the cluster's industry focus. In an important conceptual work, Smilor et al. (1989) developed the framework of the Technopolis wheel (see Fig. 1), which outlined the importance of institutions in the academic, business, and government sectors and explained how institutional alliances could drive strategy and tactics for technology-based economic development (Gibson and Rogers, 1994).

Building on this foundation, the purpose of this paper is to leverage institutional theory and the Technopolis Wheel to empirically

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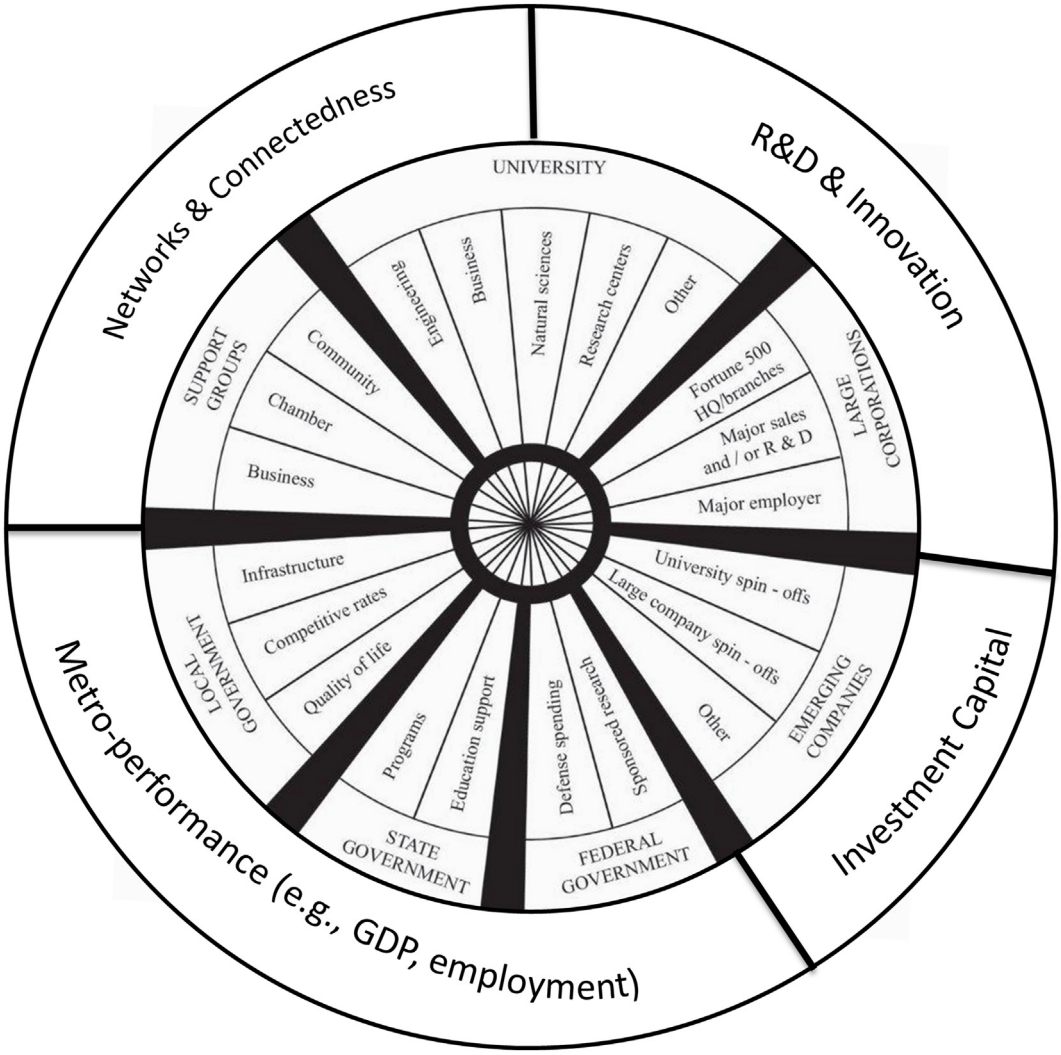

Fig. 1. Measuring components of the Technopolis wheel (outer rim measures traditional Technopolis wheel by Smilor et al., 1989).

investigate the location choice of technology entrepreneurs to better understand why they stick and refuel established entrepreneurial ecosystems. In addition to individual characteristics, we explore associations between entrepreneur movement and institutional and economic factors of four major entrepreneurial ecosystems in Austin, Silicon Valley, Boston, and New York. These locations have established themselves as technology innovation-centered business clusters and "talent magnets" with varying degrees of entrepreneurial success.

First, we detail the historical growth and key institutional features of the entrepreneurial ecosystem in each location. Next, we operationalize key segments from the Technopolis wheel including (1) networks and connectedness, (2) investment capital, and (3) innovation and R&D, and measure factors that may attract or retain entrepreneurial talent in each of the four ecosystems. For each distinct location, we model both metropolitan-level and individual-level factors influencing entrepreneur's location decisions and explore how and why these factors may vary by location. Third, we supplement the case studies descriptions and empirical analysis with interview data from technology entrepreneurs. The interview responses describe how structural and cultural factors within the ecosystems facilitate social capital formation—revealing similarities and differences between the regions and offering potential explanations for why entrepreneurs are drawn to or "stick" within each region.

1.1. Regional advantage: institutions and ecosystems

The literature on regional prosperity and the transformation of regions through technology entrepreneurship has grown significantly, detailing how some regions have prospered and others have not (Gibson and Butler, 2013; Saxenian, 1994, 1999; Venkataraman, 2004). Studies on the connection between institutional environments and creative regions can be traced to early cluster work of Alfred Marshall (1920) and Michael Porter (1990). Much of the historical literature is concerned with ecosystems of agglomeration including spin-offs and the geographic or regional clustering of firms (Fetters et al., 2010; Marshall, 1920; Moore, 1993; Porter, 1990; Saxenian, 1994; Schumpeter and Opie, 1934). The traditional literature on clustering can explain how areas specializing in an industry gain competitive advantages as a result of economies of scale, reduction of transaction costs, and capturing spillover demand (Krugman and Obstfeld, 1997). However, as noted by Engel (2015), the traditional clustering literature falls short of explaining how highly innovative clusters are able to support the continuous emergence of high-growth firms, many of which are not similar to the original business concentration of the cluster.

Research on high technology regions increasingly uses institutional theory as a guiding framework to help to explain entrepreneurial success (Foss and Gibson, 2015). Institutional theory is concerned with the resilient, lasting aspects of social structure, and can be traced to the work of scholars concerned with organizational science (Blau, 1955;

Merton, 1940; Parsons, 1956). It is a continuation of the intellectual revolution that introduced scholarship to open systems theory by concentrating on the importance of the wider context of the environment as it shapes, constrains, penetrates and renews the organization (Scott, 1987, 2004). Parsons (1960) notes that organizations experience normative pressure to ensure that their goals are consistent and congruent with wider societal values, which legitimate the organizations' existence. This interplay of structure and constraints is at the core of institutional theory, allows scholars of regional advantage to see how institutions and organizations adapt to regional environments, enhancing the development of business activity and creating regional economic advantage.

Some scholars of regional technology advantage have continued this institutional tradition in describing the dynamics within innovation-centered business or technology clusters (Dorfman, 1983; Feldman, 2000; Hellmann, 2000; Kenney and Burg, 1999; Saxenian, 1994; Steiner, 1998). The institutionalist view recognizes these clusters develop robust networks of institutional support corresponding to the cluster's industry focus. Some institutions linked to the development of regional advantage include universities, business accelerators, investments groups (e.g., angel networks, venture capital), large established enterprises, and legal and financial service organizations. For example, in Boston, Owen-Smith and Powell (2004) document how various public and private institutions were deeply embedded in an inter-organizational network of formal and informal relations, which encouraged information spillover and helped fuel the “Route 128” biotechnology business cluster.

In an important study, Smilor et al. (1989) developed the conceptual framework of the “Technopolis” wheel (see Fig. 1), which emphasized the key importance of academic, business, and government sectors and concentrated on how new institutional alliances could drive strategy and tactics of technology-based economic development. The study describes institutional alliances between major research universities (which anchors the “science city), policy makers at federal, state and local levels, business leaders and key support groups (e.g., venture investors, lawyers, accountants and professional services) as well as the importance of 1st and 2nd degree influencers who provide leadership within the region and help structure the networks. The Technopolis framework outlines how the connectivity of these components shaped the evolution of high-technology companies over time through both the relocation or geographic expansion of major companies and the founding of new high-technology companies. Austin was posited as the original case study for the Technopolis model, and subsequent literature has well-documented Austin's emergence as a technology business cluster (Butler, 2004; Gibson and Butler, 2013; Henton and Held, 2013)—joining the more established high tech regions of Silicon Valley and Boston.

In the U.S., Silicon Valley, Boston, and Austin are three geographically concentrated ecosystems that have yielded the most technology ventures. There is a large body of literature on each location (Butler, 2010; Etzkowitz and Dzisah, 2008; Kozmetsky et al., 1985; Owen Smith and Powell, 2005; Powell et al., 2002; Saxenian, 1994; Smilor et al., 1989). Although less examined in the literature, New York has more recently been recognized for its growing, startup-fueled high-tech industry (Kickul and Mulloth, 2015). However, this literature does not investigate regional variation in the social, economic, and structural factors that influence entrepreneurs' location choice decisions. Building on this prior work, this study focuses on four case studies and investigates institutional structures and other individual and metropolitan-level factors that shape the location choice of entrepreneurs in each region. The next section provides some background on the development of the entrepreneurial ecosystems in Silicon Valley, Austin, Boston, and New York City.

1.2. Entrepreneurial ecosystems: metro backgrounds

1.2.1. San Francisco Bay Area (Silicon Valley)

For the last several decades, Silicon Valley and the greater San Francisco Bay area has been the “800-pound gorilla” of innovation-centered business clusters and technology startups. Silicon Valley is the unquestionable global hub of entrepreneurship and innovation in a full spectrum of industries including software, information technology, Internet, social media, and biotechnology. Silicon Valley is a highly-concentrated cluster of technology firms, research institutions (e.g., Stanford, UC Berkeley), and venture capital and angel investment firms. In 2015, total venture capital investment for the greater Silicon Valley region reached $24.5 billion ($11.13 billion in Silicon Valley, and $13.34 billion in San Francisco), which is 42% of the total U.S. venture capital investment (Joint Venture Silicon Valley, 2016). Software investments comprise more than half (52%) of all Silicon Valley 2015 VC funding while smaller proportions went into other industries like biotechnology (13%), IT services (6%), and industrial/energy (5%). In 2014, total angel investment for the greater Silicon Valley region was $4.1 billion (roughly $1.8 billion in Silicon Valley, and $2.3 billion in San Francisco) (Joint Venture Silicon Valley, 2016).

Many prior studies detail the origins and development of the innovation-fueled business ecosystem in Silicon Valley (Castilla et al., 2000; Saxenian, 1994). The Silicon Valley ecosystem successfully capitalized on each new wave of creative destruction initiated by each successive technological innovation (Henton and Held, 2013; Schumpeter, 1942). Although important to each regional cluster, spin-off firms are particularly important to understanding regional advantage in Silicon Valley (Saxenian, 1994). In the 1950s, rapid growth in the semiconductor industry started in Silicon Valley with Shockley Semiconductor Laboratories (founded in 1956). Shockley Labs started attracting scientific talent, including many leading academics from STEM fields like engineering, math, and physics and their top graduate students. Fairchild Semiconductor was the key spin-off (founded in 1957).

The concentration of scientific and engineering talent in Fairchild eventually yielded many spin-offs including Intel, Advanced Micro Devices, and National Semiconductor. The invention of microprocessors at Intel in 1971 paved the way for the next technological wave in personal computers (1970s and 1980s). Bolstered by the concentration of talent, support industries, venture capital, and a culture that praised creative risk-taking (Saxenian, 1994), newly developed personal computer companies (e.g., Apple and Hewlett-Packard) made computers a home commodity. The proliferation of personal computers in every home made the Internet and World Wide Web possible. This helped spawn the next wave of spin-off firms based on the Internet and information technology (e.g., Netscape and Cisco). In turn, Internet and information technology companies fueled rapid growth in software and computer-related employment, which further helped the Silicon Valley retain and attract ambitious and entrepreneurial talent.

Finally, this wave fueled the current wave of spin-offs in Internet and social media (e.g. Google, Facebook, Twitter, Airbnb, and Uber). Silicon Valley ecosystem also supports starts biotechnology (e.g., 23andMe) and clean-technology (e.g., Tesla). Throughout this process, the spin-offs founded the new ventures near the parent organization (for the economic and social benefits discussed above) (see Sorenson and Audia, 2000), which further attracted key resources like talent, support industries, and venture capital. Strong regional growth in Silicon Valley (in 2015, 4.3% employment growth rate and 3.6% unemployment rate) has led to a geographic expansion from the region's core in Santa Clara County (e.g., Palo Alto, Cupertino, San Jose) to adjacent parts of San Mateo, Alameda and Santa Cruz counties (e.g., San Francisco, Fremont, Gilroy). This expanded area covers 1845 sq. miles and, in 2015, reported a large, diverse population of 3 million with strong foreign immigration (net +14,338) (Joint Venture Silicon Valley, 2016).

Beyond the concentration of resources, Saxenian (1994) emphasized the role of an innovative risk-taking culture in Silicon Valley as well as the critical role of research universities. Venture capital firms (VCs) in Silicon Valley had distinct financing objectives that strongly encouraged aggressive risk-taking (Saxenian, 1994). Venture capital and angel networks are important to innovation clusters because they finance most new technology ventures and facilitate interactions and the creation of new ties between key players in the entrepreneur ecosystem. In Silicon Valley, VCs are central to the innovation clusters because they fund most successful new ventures (Ferrary and Granovetter, 2009).

1.2.2. Austin, Texas

Austin is the capital of Texas and home to The University of Texas at Austin, and other private and public colleges and universities. Historically, employment opportunities in Austin revolved around the state government, colleges and universities, and small private firms. In contrast to the emergence of the high-tech business cluster in Silicon Valley, the Austin technology cluster was more the consequence of strategically planning. The transformation of Austin into a technology hub for innovation and entrepreneurship began with the vision of George Kozmetsky, who created a strategy to transform the city into a high-tech region to augment opportunities in other parts of the state mostly centered on the oil and gas industry. Kozmetsky created the Institute for Constructive Capitalism (IC2), and its laboratory the Austin Technology Incubator, to be institutional catalysts for transforming Austin into an innovation-centered business cluster. One of the first companies in the Austin Technology Incubator was Pencom Software, which was admitted in 1989. Since its inception, IC2 has launched over 150 companies, raised over $750 million dollars in investor funds for member companies, created initial public offerings, and had many companies acquired (Butler, 2010).

Smilor et al. (1989) developed the Technopolis wheel framework to explain the emergence of the high-tech cluster in Austin (see Fig. 1). The Technopolis wheel is composed of distinct institutional spokes including major research universities (e.g., UT Austin), technology companies and spin-offs (e.g., Tracor), federal, state, and local government, and support groups (e.g., angel networks, chamber of commerce). The institutional resources can be in place, but the cluster does not self-assemble. In this framework, networks of key influencers embedded in each institutional segment interact with other key influencers to form important institutional alliances, which in turn promoted the high-tech economic development of the Austin cluster (Smilor et al., 1989, Gibson and Rogers, 1994). Austin's ecosystem changed quickly as the Technopolis framework helped spur partnerships with the chamber of commerce, wealthy investors, industry, and universities/research laboratories. A Harvard-Business case study of the Austin Technopolis model reported that this introduced a paradigm of technology-driven economic development driven by interlocking relationships between academia, business and government (Butler, 2010).

In the 1990s Austin was one of the hubs for high-tech firms. The early business face of Austin, Dell Computers (whom Kozmetsky helped to mentor as Chairman of the Board). Other companies included Motorola, IBM, Applied Materials and Tracor (an early company founded as early as 1955). Kozmetsky's Technopolis was given a boost in 1983 when Austin won a very competitive national competition that included over 50 localities, to bring the Microelectronics and Computer Technology Corporation (MCC) to the city (Smilor et al., 1989). Today, many of the Fortune 500 companies that are located in Austin include Apple, ARM holdings, eBay, Cisco, General Motors, Google, Intel, Texas Instruments, 3 M, and Oracle Corporation. During the past few decades, Austin has produced firms like National Instruments, Dell Computers, Whole foods, Evolutionary Technologies, FreeScale (originally Metrowerks), and Golfsmith. Other homegrown companies include Uship, HotSchedules, Golden Frog, Alchemy, and Glofish. Austin is also celebrated for its lively culture—nicknamed the Live Music Capital of the World and home to Austin City Limits and SXSW Music Festival.

Today the Austin ranks highest (1st) on the Kauffman Foundation's Startup Activity Index, derived from the number of new entrepreneurs, startup density, and percent of entrepreneurs starting companies because of perceived market opportunities (Morelix et al., 2015). There is robust institutional support for startups in the Austin ecosystem. As of June 2017, we identified 39 entrepreneurial support “spaces” (e.g., incubators, accelerators, and co-working spaces) in greater Austin. From 2005 to 2016, thirteen “incubators” and 25 co-working spaces were launched in Austin. The culture, structure, amenities, and impact of these recently established entities has yet to be determined, but they have clearly provided increased visibility and support for Austin entrepreneurs. In 2015, angel network investors in greater Austin invested over $13 million in 43 companies (Central Texas Angel Network, 2016). Venture capitalists infused $740 million in 99 Austin-area companies in 2015, far outpacing larger Texas cities like Dallas ($214 million) and Houston ($160 million) (MoneyTree™ Report from Pricewaterhouse-Coopers and the National Venture Capital Association based on data provided by Thomson Reuters).

1.2.3. Boston

The greater Boston area (including Cambridge) has a robust technology startup ecosystem and central to one the largest geographic agglomerations of biotechnology firms in the world. In 2015, venture capitalists invested in 486 VC deals totaling $6.7 billion, which is roughly 5.3% of global VC investment (PitchBook, 2016). In Boston, biotechnology is the largest sector of VC investment, receiving $2.9 billion in 91 biotechnology startups, second only to Silicon Valley and vastly outpaces all other regions. Software is the second largest sector with 160 Boston-based software startups receiving $1.6 billion in VC funding. While Silicon Valley slightly edges Boston in aggregate VC investment, Boston has an unparalleled concentration of elite public and private research institutions, including research universities (e.g., Harvard, MIT, Tufts, Northeastern), research hospitals (Brigham and Women's, Massachusetts General), medical research institutes (Dana Farber Cancer Center), and international leaders in the Human Genome Project (Whitehead Institute for Biomedical Research). Boston is also the R&D headquarters for major multinational pharmaceutical firms (e.g., Pfizer, Novartis) and Amgen (the largest biotech firm in annual sales).

Prior research traces the origins of Boston's biotech startup boom to the late 1970s and early 1980s with the founding of two major biotech pharmaceutical ventures, Biogen and Genzyme. Both firms were founded by leading scientists from nearby universities, which sparked other researchers and academics to launch their own startups. Largely fueled by public research funding, the Boston area eventually developed a robust venture capital sector during the 1990s, which further fueled the number of new biotech startups (Powell et al., 2002). To get a sense of the diverse and rich biotech ecosystem in Boston, between 1988 and 1999, Owen-Smith and Powell (2004) report that greater Boston had a total of 57 independent biotech firms, 19 public research organizations, and 37 venture capital firms. These organizations were deeply embedded through a dense network of formal and informal relationships (Owen-Smith and Powell, 2004).

Other research contends that the strong public research presence in the Boston ecosystem has left an institutional imprint on Boston-based biotech firms. Owen Smith and Powell (2005) document how Boston-based biotech companies often focus their R&D on orphan medicines and therapeutic treatments for well-known patient groups. In contrast, R&D at Silicon Valley biotech firms often swing for “home-runs”, that is, pioneering first-ever medicines aimed at large global markets.

1.2.4. New York

With a population of 22,000,000 New York City (NYC) is the largest metropolis in the US. NYC has historically thrived on competition, innovative ideas, diversity, resilience, and determination, which make it a breeding ground for entrepreneurial activity (Stringer, 2012). The high-

tech industry's young, creative talent is attracted to NYC because of the education and career opportunities, ethnic diversity, creative and entertainment industries, and NYC's distinct urban lifestyle.

One key advantage of NYC's technology industry is its cultural and ethnic diversity. The continued influx of skilled immigrants is important to expanding the talent base sought by high-tech firms. A 2013 report from the Office of the State of New York Comptroller showed that immigrants played a significant role in the high tech economy. Immigrants were employed in over one-third of many of the high-playing technology jobs (e.g., computer systems design, software publishing, and data processing and hosting services) (DiNapoli and Bleiwas, 2014). Forty percent of the city's tech employees are women and a fifth are people of color. Part of the reason New York has more diverse tech workers is because the companies in NYC offer a wide range of technology jobs. Many non-American startups use NYC as their American or North American headquarters, bringing in talented workers with international perspectives.

As of late 2013, NYC was home to 6970 high-tech firms and high-tech employment was one of the fastest growing industries (DiNapoli and Bleiwas, 2014). More than half of the high-tech sector jobs in NYC (56,000 jobs) were related to designing, managing and operating computer systems and digital media (such as Internet publishing and broadcasting). While software accounted for only 2% of high-tech jobs, it had the fastest rate of growth (58%). In addition, new digital and mobile technologies bolstered new ventures in NYC's advertising, publishing, media, design and entertainment industries (Bloomberg Technology Summit, 2013).

In NYC, the public and private sectors have launched many initiatives to help support entrepreneurship and the emerging high-tech industry by nurturing a skilled workforce. In 2011, Cornell University and Technion (Israel Institute of Technology) made significant infrastructure investments towards expanding their applied sciences and engineering campuses based on a land grant on Roosevelt Island. In another initiative, New York University (NYU), the City of New York, and several large tech firms partnered to launch NYU's Center for Urban Science and Progress (NYU CUSP)—a research center and graduate school focused on leveraging “big data” for creative enterprises and addressing major urban problems around the globe (Kickul and Mulloth, 2015).

In another public-private partnership, the Polytechnic Institute (NYU Poly) and the New York City Economic Development Corporation (NYCEDC) worked together to launch several initiatives geared towards supporting local technology entrepreneurship. For example, the Varick Street Incubator provides affordable office space and business supplies/services in prime real estate in lower Manhattan. Other initiatives include the NYC Accelerator, the DUMBO Incubator, and most recently a Clean Technology Entrepreneur Center. Moreover, Columbia University established the Institute for Data Sciences and Engineering in Morningside Heights and Carnegie Mellon University invested in an Integrative Media Program at the Brooklyn Navy Yard (Kickul and Mulloth, 2015).

Furthermore, with its proximity to Wall Street and a growing venture capital community, NYC-based technology firms have access to large and diverse funding opportunities. In 2013, venture capital firms invested $1.3 billion in 222 high-tech companies in the NYC metropolitan region, according to the MoneyTree™ Report PricewaterhouseCoopers and the National Venture Capital Association, with Thomson Reuters' data. This ranked third among the nation's regions, following Silicon Valley and New England. Since the end of the last recession, high-tech venture capital investment in the NYC metropolitan region has doubled, growing at the same rate as in Silicon Valley and more than twice the rate of growth in New England. However, despite a population roughly eight times as large as San Francisco and being the global financial hub for the world's largest banks, NYC tech firms raised just 5% of the VC funds while Silicon Valley area companies received roughly 15% of the world's venture capital.

1.3. Entrepreneur mobility

Research has noted that the key to developing regional economies lies not only in the development of institutional structures but also the attraction and retention of individual entrepreneurs (Florida, 2005). However, despite widespread interest in entrepreneurship and the importance of entrepreneurs to the local and regional economy (Shane and Ulrich, 2004), social scientists have an incomplete understanding of why entrepreneurs move to, or stay within, particular regions. Prior work has shown that many high performance individuals are motivated by and attracted to economic opportunity (Agarwal et al., 2004; Campbell et al., 2012). Thus structural advantages of technology clusters and other location-specific factors in the “Technopolis” framework might play an important role in entrepreneurs' location decisions.

However, individuals also value social connections and we sometimes underestimate the degree of influence social networks have on our career choices (Dahl and Sorenson, 2010). We expect that social structures and networks influence an individual's migrating pattern (Massey, 1990). It has been shown that an individual's decision to move is influenced by localized concentration of their social network ties (Dahl and Sorenson, 2010, 2012; White and Green, 2010). Research has also shown that the size and strength of one's local social network negatively impacts the individual's propensity to move to a new location (Dahl and Sorenson, 2010; Sjaastad, 1962), even after controlling for wage and cost of living differentials between metropolitan areas (Michaelides, 2011).

Some prior research indicates entrepreneurs have a propensity to start a company in the same location where they previously worked because this choice enables them to use their existing local networks (Rogers, 1995; Romanelli and Feldman, 2004; Sorenson, 2003). The literature shows that entrepreneurs tend to start their businesses in locations in which they have more family and friends or “deep roots”, and thus providing them a rich but geographically concentrated supply of social capital (Dahl and Sorenson, 2009). However, this research examines founders of non-tech companies in Denmark, focused on traditional industries like hospitality, food, business services, and construction. This group of entrepreneurs is likely distinct from founders of technology ventures that were launched in prominent technology clusters like San Francisco Bay Area, Boston, Austin, and New York.

Moreover, this earlier work primarily conceptualized social networks as family and friend connections (Dahl and Sorenson, 2009), which is perhaps more appropriate for successfully launching new non-tech businesses serving local clientele. In the technology sector, especially with the increasing digital reach of online social networks, entrepreneurs can now more easily identify and connect with individuals and resources needed to grow a successful startup. Thus, a more expansive measure of professional connectivity is more appropriate for examining founders of technology startups, which need links to more specialized resources, technological expertise, and tacit knowledge required for startup success (Sorenson and Audia, 2000).

1.4. Technopolis and entrepreneur movement

In addition to detailing the resilient, lasting aspects of institutional structures, a more comprehensive understanding of the heterogeneous economic growth among metropolitan areas requires one to place entrepreneur movement at the center of the analysis. Leveraging the “Technopolis” wheel framework, we investigate the factors that influence entrepreneur location choices. The Technopolis wheel (see Fig. 1) shows the interaction of key segments in the institutional make-up of innovation-centered business clusters. This offers a clear framework for conceptualizing the economic and institutional factors influencing startup development and thus impacting entrepreneurs' location decisions.

As shown in Fig. 1, we overlay several indicators on this Technopolis framework to empirically measure the factors that influence entrepreneurship decisions regarding startup location. As we further detail in the next section, we measure an entrepreneur's (1) social network or tie-density as a proxy of one's level of connectedness to a location—capturing an entrepreneur's integration into the broader network of support groups and alliances specific to a location. Since technology startups are largely started with angel and venture capital investments, we capture the emerging companies segment as of the Technopolis wheel as the (2) number of funding rounds per year and average funding amount per year in a location.

We measure (3) innovation (number of patents) to capture R&D and research-related sections of the wheel. Prior work suggests patents is a suitable measure for innovation, R&D, and spin-offs. Research on economic output of metropolitan areas have reported an association between higher patent rates and higher levels of innovation and productivity gains (Rothwell et al., 2013). Literature has also shown the importance of patents in creating geographically concentrated spin-off clusters (Butler and Gibson, 2011). Lastly, we measure and control for infrastructure, government, and more macro characteristics of the Technopolis using a metro-performance index, which is a useful proxy for the overall economic strength and high-tech industry growth of a metropolitan area. We also include some individual-level control variables that may impact entrepreneur movement.

Our case studies of Silicon Valley, Austin, Boston, and New York City brings the measurement of institutional structures into an analysis of the movement of entrepreneurs and what makes them "stick" within a region. More specifically, following Butler et al. (forthcoming), we compare the variables that are important when an entrepreneur 1) starts a company in a region, 2) moves and then starts a company, or 3) moves, and enters the job market in a region, and then launches a startup after a short delay (less than one year).

2. Methods

2.1. Data and variable specification

For our analysis of entrepreneur movement, we focus on within-country (United States) migration of technology entrepreneurs within 4 established entrepreneurial ecosystems: Silicon Valley, Austin, Boston, and New York City. We created a database of entrepreneurs' employment histories using individual LinkedIn profiles and startup investment data from CrunchBase—a self-reported database for startup funding and activity—and the MoneyTree™ Report from PricewaterhouseCoopers and the National Venture Capital Association based on data provided by Thomson Reuters. The CrunchBase and PwC databases included company names of 31,615 technology startups that received at least one infusion of venture or angel capital between 1995 and 2014-Q1 (data collected 2014-Q3).[1]

Based on this startup investment databased, we randomly sampled 2000 technology startups. We then used LinkedIn public profiles to identify the startup founder/co-founder of these startups. (1765 startups). Of these startups, we selected the 551 entrepreneurs[2] that started their first startup in either Austin, Silicon Valley, Boston, or New York (the 4 highest frequency locations for launching startups in our database). Using LinkedIn public profiles, we identified the startup founders/co-founders of these startups and accessed the complete LinkedIn profile web pages for these startups. The profiles pages contained self-reported education and job histories including titles, dates, locations, as well as the entrepreneurs' endorsement network. We standardized the self-reported job locations by geocoding and mapping onto metropolitan statistical areas (MSAs).

We selected 68 large MSAs[3] and then collapsed all geocoded locations (latitude/longitude coordinates) listed by entrepreneurs and endorsers to the nearest metropolitan area within 100 miles. We used aggregate city-level investment data from CrunchBase, a comprehensive self-reported database for startup funding and activity, to compute the MSA-level investment information. For patent data at the metropolitan level, we used the Strumsky Patent Database (Strumsky, 2014) that contains annual counts for patents granted by the US Patent and Trademark office between 1975 and 2013 (Bearman, 1997).

We also acquired social network data from LinkedIn but since much of the online social networks are comprised of weak ties (De Meo et al., 2014), we used endorsement ties because they can provide a reasonable proxy for number of ties in one's social network. A skill endorsement tie is established on LinkedIn when a member of an entrepreneur's first-degree network endorses him/her for a specific work-related skill or attribute (e.g., leadership, creativity). These skill endorsements are generated voluntarily at any time by individuals in one's network. These endorsements are not solicited by the receiver and endorsements can be removed by either the giver or receiver at any time. The specific motivation of each individual endorsement is well outside the scope of this analysis. To further mitigate the risk of over- or under-estimating the role of local social networks we consider tie-density in a location (percentage of social ties in a location relative to total social ties) for empirical analysis. Thus, endorsement social tie density provides a robust proxy for one's social network density in a location. The median number of endorsement ties for entrepreneurs is 89 and the tie distribution is skewed with few entrepreneurs having > 130 ties.

Our analysis focuses on the subset of entrepreneurs who launched a startup in one of four major technology startup hubs (Austin, Silicon Valley, Boston, New York) to better understand how the Technopolis measures influence the geographic movement of entrepreneurs.

2.2. Variable specifications

2.2.1. Individual-level variables

We use three individual level variables in the analysis 1) education, 2) local tie-density, and 3) location stickiness. *Graduate education* is a binary indicator variable that has a value of one if the entrepreneur has a graduate degree. *Tie-density* measures the percentage of endorsement ties in the location of current job. For each entrepreneur, this measure is simply the ratio of the number of endorsement ties in a given location divided by the total number of endorsement ties. We measure current location stickiness as the *cumulative work experience in the current location*. For entrepreneurs that change locations from their previous job and start a company (either immediately or after a short-term job (duration < 1 year), we measure previous location stickiness as the *cumulative work experience in previous location*.

2.2.2. Metro-level variables

Average funding averages the investment-funding amount per year for the 68 metropolitan areas. *Total funding rounds* count the number of funding rounds per year in each metropolitan area. *Patents* equal the total number of patents per year in a given metropolitan area. Table 1 presents descriptive statistics for the variables specified in our models.

Among the entrepreneurs in our dataset, 551 launched their first

[1] All data for the database was collected Fall 2014.

[2] These are first time entrepreneurs starting their first company. They are sometimes called "nascent entrepreneurs" in the literature. We decided to focus on this subset of entrepreneurs because there is good reason to suspect that serial entrepreneurs (launching their *N*th startup) are distinct in terms of their existing connections to key resources within entrepreneurial ecosystems. Thus the factors and constraints in their location choice decision is likely to be different than first time entrepreneurs.

[3] These are the primary metropolitan statistical areas (MSAs) for which the U.S. Bureau of Labor Statistics (BLS) collects data on the economic indicators and employment, which we used as controls in the models.

Table 1
Descriptive statistics for entrepreneurs ($N = 551$).

Variables	Austin		Boston		Silicon Valley		New York	
	Mean	sd	Mean	sd	Mean	sd	Mean	sd
Individual-level								
Tie-density	0.40	0.28	0.35	0.25	0.39	0.27	0.38	0.26
Cumulative tenure at location of last job (yrs.)	6.46	5.94	5.42	5.41	6.28	6.15	5.02	4.92
Cumulative work experience (yrs.)	8.32	7.98	6.94	7.15	7.33	7.43	6.00	6.06
Metro-level								
Funding-rounds per year (1-yr lag)	101.65	177.78	287.55	323.66	794.84	828.89	407.29	410.21
Avg. funding per year ($-millions) (1-yr lag)	6.57	7.26	7.94	5.01	7.91	5.79	8.30	6.47
Patents(1-yr lag)	2912.22	2382.54	5241.99	3988.24	1035.94	1835.28	874.32	2012.95
Total # of entrepreneurs	160		46		248		97	
# of entrepreneurs with graduate degree	76		23		141		45	
Total jobs in work histories	763		197		1063		461	

startup in one of the four major technology startup hubs (Austin, Silicon Valley, Boston, New York). The 551 entrepreneurs in our analysis reported 2484 total jobs throughout their career. In our sample, 309 entrepreneurs (56%) did not move and founded a startup in their existing MSA, 165 entrepreneurs (30%) moved and immediately founded a startup, and 77 entrepreneurs (14%) moved and worked a short-term job before starting a startup.

2.3. Empirical specification

Entrepreneurs face two decision choices 1) to continue working or start a new company or 2) to stay in existing location or move to a new location. We currently estimate and present our results for the conditional choice mixed model (Boskin, 1974). Thus, we estimate the following mixed logistic regression model:

$$D_{ijt}(X_{ijt}, Z_{jt-1} \mid f, j) = \beta_0 + \beta_1 X_{ijt} + \beta_2 Z_{jt-1} + \delta_i + \gamma_j + \varepsilon_{ij} \quad (1)$$

Where D is the observed binary decision of entrepreneur i to start a company in location j at time t that is a function of observable user (X) and location (Z) characteristics, which is conditional on user moving to a different location. X are the observable entrepreneur characteristics – including social network densities in location j, Z are the location specific time-varying characteristics – including the investments available in the region, and ε is the unobserved iid stochastic error assumed to have extreme value type I distribution. Prior research suggests that regional factors such as population, income and wealth, and employment within a region influence and individual's intent to become an entrepreneur (Kibler, 2013). These metropolitan-level economic variables are included (Z) in the model. Thus, we classify these three group of entrepreneurs as 1) entrepreneurs that don't move and create a startup, 2) entrepreneurs that move and create a startup immediately, and 3) entrepreneurs that move and create a startup after a short delay (less than one year). Thus, we estimate three separate models with three different binary outcomes.[4]

As a robustness check, we also specified models using the Milken Institute Best-Performing Cities Index,[5] which includes a variety of measures of metro-performance including job, wage, and GDP growth and high-tech industry growth. This metro-performance index is a useful proxy for the overall economic strength of the greater metropolitan area. Metro-performance index is a suitable proxy because it is positively correlated with patents and negatively correlated with the unemployment rate while removing multicollinearity. The beta estimates did not significantly change, reinforcing our results.

2.4. Interview data

We supplement the descriptive and empirical analyses with an analysis of interview data from technology entrepreneurs with direct experience in these locations. The interview data was collected as part of a larger research project on digital and mobile media entrepreneurship. One research objective of the project aimed to better understand networking activity and social capital formation among digital technology entrepreneurs. The research team[6] conducted 45 semi-structured, in-depth interviews with technology entrepreneurs, collected between 2015 and 2017. The interviews lasted 1–2 h (on average) and included a section of questions about the role of social networks and network activity in the process of launching a startup. The research team also completed > 70 h of ethnographic fieldwork, observing entrepreneurs at various startup-related meetups and networking events. We used purposive sampling to attain variation in entrepreneur perspective, considering venture location, development stage (early stage to more mature ventures), type of business (creative content, professional or technical services etc.), genre (e.g., gaming, education, entertainment, health, productivity, social, etc.).

Table 2 reports the geographic and demographic characteristics of the entrepreneurs that were interviewed. Due to availability and scheduling and budget constraints, over half of the entrepreneurs were from Austin, but many were located in other metropolitan areas such as Silicon Valley/San Francisco, New York City, Chicago, Washington D.C., and St. Louis. Although none of the entrepreneurs currently live in Boston, two of the entrepreneurs we interviewed had lived in Boston and were involved in Boston's startup scene. Moreover, many of the entrepreneurs had lived in multiple locations and were quite familiar with the entrepreneurial ecosystems in each location. Pseudonyms of entrepreneurs and their ventures are used throughout to assure privacy and confidentiality.

Based on analysis of all 45 interviews, the responses captured important descriptions about structural and cultural factors of local ecosystems and how they facilitate interaction and networking among entrepreneurs. The entrepreneur responses were particularly valuable in comparing the structures and culture within different ecosystems—offering potential explanations for some of the observed

[4] The logit model is appropriate here because we model and interpret each outcome separately (independently). To minimize concerns about correlated errors terms across the models, we segmented the entrepreneurs based on the founder location choice path they selected during their career and then we modeled each path independently without overlap. While most individuals were distinctly categorized in path 1, path 2, or path 3, some of the serial entrepreneurs had selected multiple paths (e.g. founded a startup in their current location (path 1) and founded a second startup in a new location (path 2)). For these overlapping cases, we categorized the entrepreneur based on the path of the founder job with the longest duration (i.e., the most successful startup).

[5] http://www.milkeninstitute.org/publications/view/897

[6] In addition to the lead author, the research team also included Dr. Wenhong Chen (PI) and other graduate student RAs.

Table 2
Demographic distribution of entrepreneur interviewees ($N = 45$).

		Count	Percentage
Location	Austin	31	69%
	Silicon Valley/SF Bay Area	5	11%
	Washington DC	3	7%
	New York City	3	7%
	Chicago	2	4%
	St. Louis	1	2%
Gender	Male	34	76%
	Female	11	24%
Race/ethnicity	White	35	78%
	Asian	6	13%
	Black	3	7%
	Latino	1	2%
Age	30–39	20	44%
	40 +	16	36%
	20–29	9	20%
Total		45	100%

variation between regions. We analyze the entrepreneur interviews and report findings on the important structural elements of the ecosystems more generally, as well as location-specific characteristics of the ecosystems for the selected case studies (Austin, San Francisco, Boston, and New York).

3. Results

Based on the Technopolis wheel framework for understanding technology-based economic development, we teased out key indicators derived from key segments of the wheel. These segments include: (1) networks and connectedness, (2) investment capital, and (3) innovation and R&D. We focus the results and our interpretations on these three segments.

Table 3 presents the estimated beta coefficients of logistic regressions for entrepreneurs in Austin, Silicon Valley, Boston, and New York who decided to remain in the same location and start a company. To facilitate the interpretations in the text below, we report the odds ratios (exponentiated coefficients). For each of four locations in our analysis, we separated entrepreneurs by where they launched a startup and fit a separate logistic regression model. We picked separate logit models because each entrepreneur in the group could be intrinsically different and thus the coefficients could have different significance. The dependent variable in columns 1–4 is a binary indicator of entrepreneur starting a company in the same location. In all of the models, we control for the metro-performance in each region.[7]

Table 3
Logistic regression estimates for entrepreneurs who started companies in same location (non-movers) by region.

	Dependent variable			
	Non-move and Founder			
	(1) Austin	(2) Boston	(3) S.V.	(4) New York
Grad degree*	−0.137	−0.481	−0.141	0.038
	(0.253)	(0.501)	(0.202)	(0.320)
Cumulative work experience (yrs.)	−0.013	−0.046	−0.072***	−0.110***
	(0.021)	(0.047)	(0.022)	(0.043)
Tie-density (current location)	1.789***	−1.320	1.042**	1.072
	(0.552)	(1.042)	(0.432)	(0.681)
Cumulative work experience in current location	0.087***	0.142***	0.115***	0.193***
	(0.025)	(0.055)	(0.024)	(0.045)
ln(Funding-Rounds Per Year)(1-yr lag)	0.697***	0.170	0.486***	0.052
	(0.170)	(0.176)	(0.088)	(0.150)
ln(Avg. Funding Per Year) (1-yr lag)	−0.067	1.212	−0.014	0.119
	(0.063)	(0.814)	(0.057)	(0.088)
ln(Number of Patents)(1-yr lag)	0.311	1.037***	−0.389	−1.158
	(0.193)	(0.351)	(0.187)	(0.511)
Constant	−7.601***	−30.437**	−2.708**	1.214
	(1.621)	(14.188)	(1.284)	(3.351)
Economic Controls (metro-performance index)	yes	yes	yes	yes
Observations	709	178	922	414

Note: (odds ratios reported in text).
* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

The tie-density estimates for entrepreneurs in Austin and Silicon Valley (in Table 3, models 1 and 3) are positive and significant for entrepreneurs who start a company in their current location. For persons in Austin and Silicon Valley, this indicates that entrepreneurs are more likely to start a company in their present location if their tie-density in that location is high, suggesting that ties play an important role in supporting entrepreneurs. Interpreting the model for Austin, for a 0.1 increase in the tie-density in a location, ceteris paribus, the odds of an entrepreneur starting a company increase by a factor of 1.20 and this estimate is statistically significant ($p < 0.001$). Interpreting the model for Silicon Valley, for a 0.1 increase in the tie-density in a location, ceteris paribus, the odds of an entrepreneur starting a company increase by a factor of 1.11 and this estimate is statistically significant ($p < 0.001$). This suggests that social networks in Austin and Silicon Valley are an important factor in retaining potential entrepreneurs to start a company in the near future. Entrepreneurs embedded or "plugged-in" the Austin and Silicon Valley ecosystems are more likely to stay in that location when launching a startup. Although positive, the estimates for entrepreneurs in Boston and New York were not statistically significant.

The institutionalist view reflected in the networks and alliances components of the Technopolis wheel offers one explanation for this pattern. Austin and Silicon Valley have multiple institutional structures and entrepreneurial environments that promote social tie formation and embeddedness in these locations. In one of the interviews, Yaser Masoudnia, an entrepreneur who moved from Washington D.C. to Silicon Valley, spoke about the environment being an important factor in building a support network and growing their business.

> *"We were based in DC area. And we realized very soon—I think it was about six or seven months into the business—that we are in the wrong place, despite the fact that a lot of part of the business that we were doing was basically security space and cyber security. We realized that if we want to make progress and make this business happening, we have to be in an environment with a network that nourished the start-ups and small businesses. That was the reason both of us moved from DC to basically Silicon Valley, and we start living here, working on the idea, going to different events, finding different people."*
>
> (Yaser Masoudnia)

Descriptive indicators of the entrepreneurial ecosystems in Austin and Silicon Valley also lend support to this argument. Both Austin and Silicon Valley have a large number of incubators, accelerators, co-working spaces, social groups, and networking events targeting individuals with entrepreneurial ambitions. These formal organizations and informal groups frequently host networking events and activities on a weekly if not daily basis, thus increasing opportunities to interact (Startup Digest, 2016). Frequency of interaction facilitates production

[7] We use the Milken Institute Best-Performing Cities Index, which includes a variety of measures of metro-performance including job, wage, and GDP growth and high-tech industry growth. This metro-performance index is a useful proxy for the overall economic strength of the greater metropolitan area. We also specified using broader economic measures from the Bureau of Labor Statistics (e.g., GDP, unemployment rate, employment), but the results did not meaningfully change.

and maintenance of close-knit networks (Blau, 1964; Homans, 1964). For example, Silicon Valley has dozens of well-known incubators including Y Combinator, Silicon Valley Innovation Center, 500 Startups, and Founders Space among many others.

In our interviews with entrepreneurs, many reported that meetups facilitated tie formation. Meetup is a platform that enables local individuals to organize events around certain topics, ideas, activities, or groups. Although some entrepreneurs reported that they attend meetups for all types of activities and interests, many were characterizing their participation in meetups focused around startups and entrepreneurs. As Joseph Dreyfus suggested that Meetups help entrepreneurs "find a community of people who have like interests and similar kind of expectations and ambitions."

The meetups can be geared towards entrepreneurs in general, but many are targeted towards specific subgroups based on interest or industry. For example, during fieldwork for the analysis in this chapter, we attended meetups specifically targeting entrepreneurs interested in 3D printing, maker's spaces, and crowdfunding on Kickstarter. Another entrepreneur interviewee, Alec Olsson, suggested that it can be challenging building ties in the San Francisco Bay area (Silicon Valley) where seemingly everybody is an entrepreneur or has ambitions of launching a startup. In this context, Alec reported that these specialized meetups can helpful in connecting with individuals that are more relevant to your needs and interests.

> *"San Francisco is crazy, because it seems like everyone and their brother in this city is involved in a start-up. And it's probably the one city I've been in in the world where when somebody asks you what you do for a living, if you say, 'I work for a start-up,' it's not of particular interest, and it's completely cliché. And so networking becomes challenging because there is no novelty associated with it. It's 100% expected to be associated with a start-up, and you have to find other ways and reasons to connect with people. So that can be industry specific. There are a bunch of industry specific meet-ups. There's the 3D printing meet-up. There's the advanced manufacturing meet-up. There's hardware start-up meet-ups, you know, where you can sort of form a cadre of like-minded, or at least like-focused companies or start-up founders."*
>
> (Alec Olsson)

A critical part of the networks and connectedness aspect of the Technopolis wheel is the role institutions play in establishing and sustaining bridges and alliances between key support structures and resources. Incubators are structures within startup ecosystems that can facilitate entrepreneur social capital formation. Some incubators aim to develop new products or technologies, but the typical aim of these organizations is to nurture and develop entrepreneurial talent and to encourage startups. Most incubators offer many services such as office space, business supplies/services, entrepreneurship courses, advisor/mentors, consultants, and access to labs and equipment (Allen and McCluskey, 1991; Mian, 1996). Some incubators offer small amounts of capital upon acceptance into the incubator. Also there are a few studies that suggest incubators help broker ties between entrepreneurs and key financial, technical, and social resources (Bøllingtoft and Ulhøi, 2005; Totterman and Sten, 2005). Some entrepreneurs we interviewed describe incubators as an alumni network of past members, who facilitated tie formation. Describing his experience in the Techstars incubator, Silicon Valley entrepreneur Devin Norris said:

> *"It's been this kind of ever long fraternity, alumni, however you want to call it and we think very highly of the Techstars program. … We joined Techstars, which is now an international network of entrepreneurs and founders and mentors and while we completed that program in June of 2013 – or, sorry, we started it in June. I think we 'graduated' in September or October for the – ever since we moved on, we still have – it's like an alumni network. It's like a modern day college in a sense and we still get a ton of value out of both helping other entrepreneurs and getting help ourselves."*
>
> *(Devin Norris)*

Several entrepreneurs that had experience with incubators indicated that incubator personnel had established networks with first degree connections to key resources, particularly early seed capital investors. Alec Olsson reported:

> *"First of all, from a fundraising perspective, you really—the only way you can effectively fundraise for venture capital is to have a good number of people in your network that know a good number of VCs and to get very strong personal introductions from the people in your network. And when we started the company in Madison, we literally knew nobody. So one of, you know, we paid—through our participation in Techstars—with a significant amount of equity in the company, and the thing we were buying with that equity was first and foremost access to the Techstars network … that would give us access to introductions to venture capitalists."*
>
> (Alec Olsson)

In general, the responses suggested that participation in incubators was valuable to very early stage entrepreneurs with small stocks of social capital, particularly entrepreneurs that recently arrived in a new location. For example, Joshua Serrano describes his experience arriving in Austin:

> *"So when I first came here, I didn't know anybody and all I had was the Capital Factory [incubator] basically as a place to kind of start plugging into different places. But I was – you know, within six months to a year, I was connected to a lot of very useful, successful, and cool people in Austin. And it didn't – all it took was like me making them feel like I was really trying to do something positive for them to be like willing to help me and wanting to help me."*
>
> (Joshua Serrano)

In addition, Stanford University, an early champion of technology transfer and commercialization towards entrepreneurship, plays a big role in fostering the Silicon Valley startup ecosystem (Colyvas and Powell, 2006). Similarly, in Austin, prominent incubators—including Capital factory, TechRanch, Techstars, Austin Technology Incubator, and Thinktiv—and The University of Texas at Austin also hosts many events in support of the Austin startup entrepreneur, which provide forums for potential entrepreneurs to engage the networks and support structures for launching new ventures. As emphasized by Smilor et al. (1989) in developing the Technopolis wheel, these institutions and institutional alliances are central in structuring and sustaining the network of key resources (e.g., mentors, support groups, venture funding, and intellectual property lawyers).

We find that "location stickiness", meaning the cumulative time spent in a location, significantly influences entrepreneurs when choosing a startup location. In all four locations, the results show that the more time potential entrepreneurs remain in a location increases the likelihood that they will launch a startup in that same location. For entrepreneurs in Austin, Boston, Silicon Valley, and New York (Table 3, models 1, 2, 3, and 4), we find a one-year increase in cumulative time spent in a location increased the odds of starting a company in that location by 1.15, 1.12, and 1.21, respectively (all estimates statistically significant at 99% level).

Given there is little variation across the regions, this suggest that local stickiness may be a general tendency for entrepreneurs to develop a personal/emotional affinity to a place the longer they live there. The more time an entrepreneur spends in a place, the more personally attached they become to that community because they develop a comfort, a sense of trust and security, and a personal connection to the history of a place (Hite, 2005). Attachment to place can also be an emotional affinity derived from preferences to be near friends/family in a secure and enjoyable community (Dahl and Sorenson, 2009).

Regarding estimates for other individual-level factors, we find no statistically significant association between having a graduate degree

and starting a company in the same location. In Silicon Valley and New York, we find a negative and significant association between overall cumulative work experience and entrepreneurs starting a company in the same location. As shown in Table 3 (models 3 and 4), for Silicon Valley and New York, a one-year increase in the cumulative work experience reduces the odds of starting a company in the same location by 0.069 and 0.104, respectively (estimates statistically significant at 99% level). Since cumulative work experience can serve proxy for age, this finding is consistent with some public accusations of "ageism" among VC firms targeting technology startups, especially in Silicon Valley (Scheiber, 2014). Some prominent venture capitalists have even publically listed youth as an important criteria for investments (Wadhwa, 2011). This is also in line with findings from Azoulay et al. (2017), which found that the average entrepreneur age was lowest among VC-backed technology ventures and the youngest entrepreneurs were founders of VC-backed startups in New York.

Next, we move to discuss the investment capital section of the operationalized Technopolis wheel. Reporting findings for the metropolitan-level factors, we find a positive and significant association between number of funding opportunities for startups in Austin and Silicon Valley and entrepreneurs remaining in the location to start companies. For Austin and Silicon Valley (models 1 and 3 in Table 3), a 10% increase in the number of ln(funding rounds per year) increases the odds that entrepreneurs will stay in the same locations and start their companies by a factor of 1.07 and 1.05, respectively. Our models also include a measure for the average funding amount per year, but the beta estimates were not statistically significant. This finding might stem from the type of industry prevalent in each location. Austin and Silicon Valley produce a lot of information technology and software startups that have lower initial costs, thus large funding amounts may not be a primary concern at the initial stages when entrepreneurs are deciding where to launch their company. Moreover, although average funding amount and number of funding rounds are not strongly correlated (which is why they are simultaneously included in the model specifications), we tried removing funding rounds and leaving average funding rounds in the specification, but the results did not significantly change.

Moreover, this finding is consistent with our expectations based on numerous discussions with entrepreneurs and angel investors. In the interviews, entrepreneurs reported that they primarily seek small-to-medium sized investments from angel investors towards the beginning of the process and very few startups are equipped to appropriately utilize massive investment fusions that often come with steep growth targets that must be reached in a short period of time. Targeting large investment amounts is not a priority in the earliest phases of launching a company, although they might be relevant at a more mature phase. Thus during the startups' nascent phase, potential entrepreneurs are likely to be attracted to a location that provides more opportunities for funding when compared to the amount of funding. As a result, entrepreneurs believe that the larger number of funding rounds in a location is an indicator of more opportunity for securing funding for their startup. Additionally, because startups are typically funded in stages (Gompers and Lerner, 2010), entrepreneurs likely associate more funding rounds in a location with a higher likelihood that their startup will continue to receive additional funding rounds beyond any initial investment capital. In short, for Austin and Silicon Valley, our findings suggest entrepreneurs tend to gravitate towards places where they have more opportunity for rounds of funding.

For New York and Boston, although the models indicate a positive association between frequency of funding opportunities and likelihood of starting a company in the same location, the estimates were not statistically significant. This finding was somewhat surprising. However, a couple entrepreneurs we interviewed help shed some light on a potential explanation. In several interviews, entrepreneurs spoke about their frustrations with the slow speed of the "due diligence" among New York and Boston investors', when it came to evaluating whether or not to invest in their startup. Describing his experience, entrepreneur Chris Block said,

> *"San Francisco by far was the easiest place to raise money. And it's not just because there's more capital. People move a lot quicker, actually like a lot quicker—compared to like New York and also Boston. So like in our early fundraising rounds, we had investors from Boston, New York, and San Francisco primarily. Boston was slow and New York was by far the slowest. They would take eight to ten weeks to do due diligence. And San Francisco, they would make decisions in two to three weeks, which was great. Boston was somewhere in the middle… we ended up just going to the [SF] Bay for all the later rounds."*
>
> (Chris Block)

In another interview comparing New York City and Austin, entrepreneur Zac White lamented about the overall difficultly of getting the attention of investors in New York:

> "*I think that's why it was easier here [Austin], because it's smaller, to be like a larger fish in a smaller pond. It was just so difficult to get connected to the right people in New York, it's just too big, too many hoops to jump through just to get like 10 minutes [of investor's time].*"
>
> (Zac White)

Altogether, given the pace of the technology industry, the short time-frame in which technology startups must scale, and the risks associated with delaying, these findings suggest it is plausible that the investment networks are perhaps more organized and accessible in Silicon Valley and Austin relative to New York and Boston. These results also suggest the need for more in depth exploration of the investment networks in different ecosystems to better understand the underlying mechanisms for this association. We leave this for future research.

Next, we examine the innovation and R&D dimension of the Technopolis and its influence on entrepreneur movement. In Boston, we find a positive and statistically significant association between higher innovation (patents) and founding a startup in Boston. For Boston entrepreneurs, a 10% increase in the ln(number of patents per year) increases the odds ratio of entrepreneurs staying in the same locations and starting companies by a factor of 1.11, and this estimate is statistically significant ($p < 0.01$). Again, we suspect the industry type might offer an explanation because Boston has many startups in the biotechnology sector, which require large upfront investments for new entrants (Owen-Smith and Powell, 2004). Patents are important in the biotechnology sector for potential entrepreneurs and investors due to the large startup costs. This finding is also consistent with the institutional legacy left by the large public research presence on Boston's biotech-based ecosystem (Owen Smith and Powell, 2005). The estimates for the other locations are not statistically significant. This could be the case because technologically advanced firms may want to distance themselves from competitors (Alcacer and Chung, 2007).

Next, we report estimates from Table 4 that present the estimated beta coefficients of logistic regressions for entrepreneurs who chose to change locations and start a company. In Table 4, the dependent variable is whether or not the entrepreneur moved to a different location and immediately started a company. The model specification is the same across all the models, except for the location stickiness variable. In Table 4, entrepreneurs change locations and the stickiness variable measures the cumulative work experience in the previous location (prior to the startup location). For the models in Table 4, this is the location of the previous job.

As shown in Table 4, the tie-density estimates are negative and significant for entrepreneurs changing locations and immediately starting companies in Austin, Boston, and Silicon Valley. If an entrepreneur's tie-density in their previous metropolitan area is high, the entrepreneur is less likely to immediately start a company after moving to a different location. This finding is consistent with our expectations from prior research on the mobilization of social capital (Lin, 2001).

Table 4
Logistic regression estimates for entrepreneurs who started companies in different location (move and immediately started company) by region.

	Dependent variable:			
	Move and Immediately Founder			
	(1) Austin	(2) Boston	(3) S.V.	(4) New York
Grad Degree	−0.115	−1.953	−0.286	−0.521
	(0.327)	(0.848)	(0.324)	(0.539)
Cumulative Work Experience (Yrs.)	0.056***	0.150***	0.090***	0.161***
	(0.020)	(0.053)	(0.027)	(0.050)
Tie-Density in Previous Location	−2.272***	−3.388**	−4.624***	−0.739
	(0.701)	(1.586)	(0.864)	(1.088)
Cumulative Work Experience in Previous Location	−0.029	−0.173**	−0.043	−0.099*
	(0.030)	(0.082)	(0.031)	(0.060)
ln(Funding-Rounds Per Year)(1-yr lag)	0.344**	0.640**	1.096***	−0.164
	(0.166)	(0.343)	(0.237)	(0.197)
ln(Avg. Funding Per Year) (1-yr lag)	−0.035	−0.332**	1.655**	0.156
	(0.059)	(0.155)	(0.725)	(0.203)
ln(Number of Patents)(1-yr lag)	0.783***	1.459***	0.054	−0.856
	(0.208)	(0.545)	(0.228)	(0.546)
Constant	−8.995***	−11.489**	−35.773***	−0.302
	(1.770)	(4.652)	(12.576)	(4.671)
Economic controls (metro-performance index)	yes	yes	yes	yes
Observations	709	178	922	414

Note: (odds ratios reported in text).
* p < 0.1.
** p < 0.05.
*** p < 0.01.

Table 5
Logistic regression estimates for entrepreneurs who started companies in different location (move, work other job, then started company) by region.

	Dependent variable:			
	Move and Other-Job, Then Founder			
	(1) Austin	(2) Boston	(3) S.V.	(4) New York
Grad degree	0.010	20.263	0.031	−0.400
	(0.412)	(750.499)	(0.383)	(0.749)
Cumulative work experience (yrs.)	0.060**	−0.001	0.098***	0.200***
	(0.024)	(0.106)	(0.025)	(0.062)
Tie-density (new location)	1.802**	−0.871	−0.942	−3.081
	(0.859)	(2.472)	(0.805)	(1.759)
Cumulative work experience in previous location	−0.155***	−0.066	−0.173***	−0.123*
	(0.052)	(0.144)	(0.049)	(0.074)
ln(Funding-Rounds Per Year) (1-yr lag)	0.826**	1.027	1.530***	1.177
	(0.335)	(1.028)	(0.467)	(0.827)
ln(Avg. Funding Per Year)(1-yr lag)	−0.168	2.190	−0.452	0.144
	(0.113)	(4.812)	(0.353)	(1.055)
ln(Number of Patents)(1-yr lag)	0.507	0.894	−0.527	−1.002
	(0.330)	(1.021)	(0.427)	(0.979)
Constant	−8.851***	−71.199	−3.277	−8.452
	(2.857)	(748.095)	(4.817)	(17.286)
Economic controls (metro-performance index)	yes	yes	yes	yes
Observations	709	178	922	414

Note: (Odds Ratios reported in text)t.
* p < 0.1.
** p < 0.05.
*** p < 0.01.

Social networks are important to launching startups because social capital allows the entrepreneurs to locate and mobilize important resources (e.g., initial seed funding, labor and human capital, strategic or technical counsel). Establishing professional connections and locating bridges to key resources takes time, often requiring repeated face-to-face interactions to build a reputation and establish mutual trust (Feldman, 2000). Many of our entrepreneur interviewees described this well when discussing the difficulty of building rich/meaningful professional connections in a new ecosystem. To pick one example, Joshua Serrano stated:

> *"When you move, it's easy to meet a lot of people. But building the relationships that will actually help you is hard. It takes work and persistence. Even with a connection, it is very hard to just call someone up. … It's finding the reasons, finding the time to like actually continue to spend time with those people that really matters. It's hard to build a group of people who you know and trust and can relate to and who you meet with on a regular basis, who you share ideas with and problems with and things like that – that when the right opportunity presents itself for whatever it is you need at that moment, you're one of their people that they trust and would potentially plug you into that opportunity."*
>
> (David Kaufmann)

Thus for entrepreneurs who are heavily connected and socially embedded in their prior location, it is unlikely they can launch new venture in a new location where they sparsely connected to individuals and support structures in a new local community.

In all four locations we find a positive and significant association between cumulative work experience in a location and entrepreneurs starting a company after changing locations. For Austin, Boston, Silicon Valley, and New York, a one-year increase in cumulative time in a location increases the odds of starting a company immediately after changing locations by 1.06, 1.16, 1.09, and 1.17, respectively. This finding is consistent with the literature on commitment. The longer someone spends working in a career field, the more committed they become to a particular career ladder and less open to disruptive ideas (Dietrich and Srinivasan, 2007; Planck, 1949). Consequently, they are less likely to sacrifice their gains and lifestyle towards a highly risky venture as an entrepreneur. This could suggest why many entrepreneurs are young, often recent college graduates. However, the situation is different for individuals who change locations. Some individuals work quickly up the career ladder, often achieving positions of status experience, yet remain professionally unfulfilled or experience a personal shock (e.g., divorce, death in family). Thus, they seek large changes like moving regions and seeking new experience, including risker career changes like starting their own company.

For Austin, Boston, and Silicon Valley (models 1 and 3 in Table 4), a 10% increase in the ln(number of funding rounds per year) increases the odds ratio of the entrepreneur changing locations and starting a company immediately by 1.03, 1.07, and 1.12, respectively ($p < 0.05$). Regarding patents, in Austin and Boston, we find a 10% increase in the ln(number of patents per year) increases the odds ratio of the entrepreneur changing locations and immediately starting a company in Austin and Boston by 1.08 and 1.16, respectively, and these estimate are statistically significant ($p < 0.001$).

Lastly, we report estimates from Table 5 that present the estimated beta coefficients of logistic regressions for entrepreneurs who chose to change locations and start a company after working a short-term job. The dependent variable for Table 5 is whether or not the entrepreneur moved to different location and started a company after a short delay (worked as an employee for a duration of one year or less before starting a company). To reiterate, the model specification is the same across all the models, except for the location stickiness variable. For the models in Table 5, this is the location of the job before the short-term job (because the short-term job is in the same location as the startup).

The main reason for specifying this third entrepreneur path—separate from path 2 (move and immediately launch startup)—is exploring in influence of the social connectedness component of the Technopolis, given a short period of time to build network ties in the new location. We find that tie-density is important for entrepreneurs moving to Austin to start a company after working short-term in

another job. For persons moving from another region to Austin, we find the higher the person's tie-density in Austin the more likely the person will start a company in Austin after a short duration working as employee. Interpreting model 1 in Table 5, for a 0.1 increase in the tie-density in a location, the odds of an entrepreneur starting a company in the new location after working for a short while increase by a factor of 1.20. This estimate is also statistically significant ($p < 0.05$). However, this association was not significant for entrepreneurs moving to Silicon Valley, Boston, or New York.

One potential explanation for this finding is the estimate suggests the ease or pace at which newcomers can get plugged into crucial networks within the startup ecosystem in Austin. Based on our interview responses from several entrepreneurs, this may stem from some of the local characteristics of Austin's ecosystem. In our interviews, Austin's startup ecosystem was often described as much smaller and more decentralized with more accessible channels to key players and influencers, relative to the ecosystems in Silicon Valley and New York City. Describing her experience in different ecosystems, entrepreneur Mary Haskett said,

> *"I've lived in New York, Seattle, and some other places. And then I came here [Austin]… Austin has the friendliest entrepreneur group that I've seen. Just, I mean – not just that they're friendly. They are. But they're willing to help each other, even if they're competing. You know, it's like, 'Hey, I am having trouble because I've never sold anything outside of the country. What do I need to know? Because somebody from France is thinking about buying [her product].' You know, people – everybody will just jump in and go, 'Hey, you know, this happened to me. Here's how I handled it, you know. And here's the person who helped me. Here's her phone number. You know, call her. She's great.' Without any expectation of anything. And that can be a stranger. And people will just help just because it's sort of the culture – we help each other. And I think that's really cool. And I think that is special to Austin. I mean, everyone's nice. But in the other communities I've been in, I haven't seen people willing to go to quite that extent, you know, without some reason."*
>
> (Mary Haskett)

As indicated by this response, the culture of Austin's startup scene was often described as distinct, friendly, and collaborative. This is supported across multiple interviews with Austin entrepreneurs who have spent time in Silicon Valley, Boston, and other key cities. As one Austin entrepreneur moving from Silicon Valley puts it:

> *"I think that in Austin, I mean – like compared to Silicon Valley, Austin startup culture has a very laid-back feel to it. Whereas I think you could look at the startup culture in Silicon Valley as very well defined, very, you know, 'This is what a startup is supposed to look like'—everyone trying to be more disruptive to the industry. I don't know how you translate that necessarily. I just think [Austin] has a little bit more collaborative culture. For example, we try very hard to collaborate with other industry providers in Austin."*
>
> (Jeff Smith)

We find the estimates for location stickiness were negative and significant for all locations among entrepreneurs who move to a new location, work as an employee for a short while and then start a company. For Austin, Silicon Valley, and New York, a one-year increase in cumulative time in a location reduces the odds of moving to another location by 0.14, 0.16, and 0.12, respectively. These estimates align with expectations from prior research suggesting some degree of geographic inertia or stickiness. Entrepreneurs' tend to become more attached to a location as their tenure in that location increases and therefore are less likely to move elsewhere to start a company (Dahl and Sorenson, 2012).

4. Discussion

Technology clusters are continually being transformed by entrepreneurship. Using institutional theory as a guiding framework, this study operationalized the "Technopolis" wheel, an innovative framework for understanding the factors and institutional structures and connections that are critical to developing and sustaining geographically concentrated technology clusters. We analyzed four established ecosystems (Silicon Valley, Austin, Boston, and New York) for technology entrepreneurship as case studies, using indicators derived from the core segments of the Technopolis wheel to better understand how (1) networks and connectedness, (2) investment capital, and (3) innovation and R&D influence entrepreneur movement in different regions. The analysis in this study makes several important contributions to the literature on technology clusters, regional advantage, and entrepreneur movement. To our knowledge, this is the first study to operationalize the key segments of the Technopolis. This approach captures both individual and metropolitan-level factors, which have primarily been investigated separately and not with respect to our variable of interest—entrepreneur's choice to launch a startup in a location.

This study also extends past research in several important ways. Prior work on entrepreneur movement investigated non-tech companies in traditional industries (e.g., hospitality, food, business services) (Dahl and Sorenson, 2009), which have much different cost structures and resource requirements than technology startups in major entrepreneurial hubs (Ferrary and Granovetter, 2009). Moreover, this earlier research on geography and entrepreneurship measured social networks primarily as family and friend connections—a measure perhaps better suited for non-tech small businesses serving local customers. However, examining the networks and connectivity of entrepreneurs founding tech-startups requires a more expansive measure of professional social networks, which can reach the more specialized resources, technological expertise, and tacit knowledge required for startup success (Sorenson and Audia, 2000).

In addition, prior work did not have direct measures of entrepreneurs' professional networks and thus relied on indirect proxy measurements such as the linear distance between an entrepreneur's residential address and the addresses of their hometown/parents/siblings (Dahl and Sorenson, 2009). To measure network connectivity, our analysis leveraged rich relational data from a popular social networking platform to directly measure an individual's professional networks in particular locations and in turn evaluate the influence of social tie-density on the entrepreneur's decision where to launch their startup.

Based on results, our findings have several implications for public policy officials and business leaders developing policy and strategy in the technology space. Organizing concepts like the "Technopolis" have influenced public officials and business leaders pursing strategic and tactical aims for technology-based economic development in major American cities like Austin (Gibson and Butler, 2013) and Boston, as well as many international cities around the globe (Gibson and Butler, 2013, Fetters et al., 2010, p. 120). However, to our knowledge there has not been any empirical study attempting to operationalize and measure key segments of the Technopolis wheel to understand the primary factors influencing entrepreneur (re)location decisions. Thus our empirical analysis is a novel investigation of an unmeasured and untested theoretical construct and the results point to the factors that make entrepreneurial talent "stick" within a region.

More specifically, this study shows the importance of social and institutional connectedness, investment capital, and innovation (patents)—as well as local stickiness and work experience—in understanding why entrepreneurs stay/move in particular ecosystems to launch technology startups. One finding is that social networks in Austin and Silicon Valley are an important factor in retaining potential entrepreneurs. Additional support for this finding was reported in the interviews with entrepreneurs in Austin and Silicon Valley. Entrepreneur responses support the explanation that these locations have strong institutional structures that promote the creation of social ties and thus help increase one's embeddedness in these locations.

Entrepreneurs consistently spoke about how particular structures within entrepreneurial ecosystems were central to them building their social network. Some of these structures included social groups/clubs, Meetups, startup/entrepreneur-centric events, and incubators. It was clear from several interviews that social groups and meetups played an important role in entrepreneur tie formation. Institutional structures are important in fostering network ties, which impact entrepreneurs' ability to access and mobilize the resources necessary to launch new ventures.

Furthermore, the ease or pace at which newcomers can get plugged into crucial networks could be an important factor in creating or sustaining a healthy startup ecosystem. For persons moving from another region to Austin, We find the higher the person's tie-proportion in Austin the more likely the person will start a company in Austin after a short duration working as an employee. Based on the interviews, it is plausible that this finding stems from many of the characteristics of Austin's distinct ecosystem. For one, Austin's startup ecosystem is much smaller than Silicon Valley and New York. Several interview responses characterize the entrepreneurial ecosystem in Austin as more decentralized with more accessible channels to key players and influencers in the Austin ecosystem. Based on the interviews, this environment could be derived from Austin's distinct culture, which was often described as more friendly and collaborative relative to the ecosystems in Silicon Valley, Boston, and New York. This is supported across multiple interviews with Austin entrepreneurs who have spent time in Silicon Valley, Boston, and other key cities.

For Silicon Valley, Austin, and Boston, we found that the number of funding rounds per year, or frequency of opportunities for funding in a location, seems to influence whether or not an entrepreneurs move elsewhere to start a venture. We should note that it is the number of rounds rather than the average funding amount per year that appears to influence entrepreneur location choices. More research is needed to help validate this finding in the analysis. Once corroborated with additional research studies, this finding could be very important to state and city policy makers. City officials might consider policies that encourage the organization of angel networks, which fund more seed investment rounds relative to the large capital infusions by venture capital firms (e.g. series A, series B, series C). These policies might include financial and other regulatory incentives. This seems particularly relevant to declining industrial metropolitan areas with stagnating local economies, which are striving to encourage local entrepreneurship and retain local talent that is flowing to cities like the San Francisco Bay Area, Austin, Boston, and New York City. Based on interview responses from entrepreneurs, access to sufficient investment is widely perceived to be the dominant impediment to startup success. Thus, future studies should further test this association, perhaps exploring potential moderating factors that could establish indirect relationships.

5. Limitations

Although this study makes several contributions to the literature, there are some limitations to our analysis. While our use of ego-centric endorsement ties has its advantages over measures used in prior work, an even better measure would capture the full interconnectedness of the entire social network within an ecosystem. This would enable us to make deeper insights about differences in the institutional and social structure within technology ecosystems across the U.S. (or even international hubs). Unfortunately this kind of data is not yet available. Another limitation is that some entrepreneurs might be more or less active on LinkedIn, and thus their endorsement networks might not be as complete as others. Since our analysis only uses the endorsement ties as proxy of an individual's general connectedness in a location, they would need to be systematically incomplete with respect to geography in order to bias our results. While there is no reason to think this is the case, it is possible and future survey work could help validate our results.

6. Conclusion

The attraction and retention of entrepreneurs is important to local and regional economies (Florida, 2005). Recognizing that the creation of a new startup is principally an individual decision made by a founding entrepreneur, the analysis uses an original dataset of entrepreneur career paths with direct observation of personal connections, in addition to key economic and investment factors, to model the location and entrepreneurial choice of individuals. This paper leveraged institutional theory and the Technopolis Wheel to empirically investigate the location choice of technology entrepreneurs to better understand why they “stick” to and refuel four major U.S. technology ecosystems. Having shown the utility of this framework for understanding entrepreneur movement in different regions, we hope future work will continue to expand on the Technopolis wheel, perhaps adding additional measure of institutional structures and the alliances between them—to investigate more on the emergence and re-invention of technology clusters.

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