

BOOSTING TECH INNOVATION ECOSYSTEMS IN CITIES

A framework for growth and sustainability of urban tech innovation ecosystems

Victor Mulas
ICT Innovation Specialist

Michael Minges
Senior ICT Consultant

Hallie Applebaum
Open Innovation Consultant

Data Scientists

Kathy Qian

Nga Phuong Nguyen

Mary Alexander Sherman



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ABBREVIATIONS

BPO	Business process outsourcing
EC	European Commission
GCI	Global Cities Index
GERN	Global Entrepreneurship Research Network
ICT	Information communication technology
MIEP	Mobile Internet Ecosystem Project
NYC	New York City
NYEDC	New York Economic Development Corporation
VC	Venture capital

EXECUTIVE SUMMARY

Cities are emerging as hubs of technological innovation. This is characterized by an ongoing shift from technology parks in suburban areas to entrepreneurial activity within cities. San Francisco is home to more venture capital investment than Silicon Valley. New York City, where the innovation startup scene was nascent a decade ago, was the second-largest recipient of venture capital in 2013. This trend is global with startups surging in cities from Berlin to Buenos Aires and Mumbai to Madrid, to name just a few.

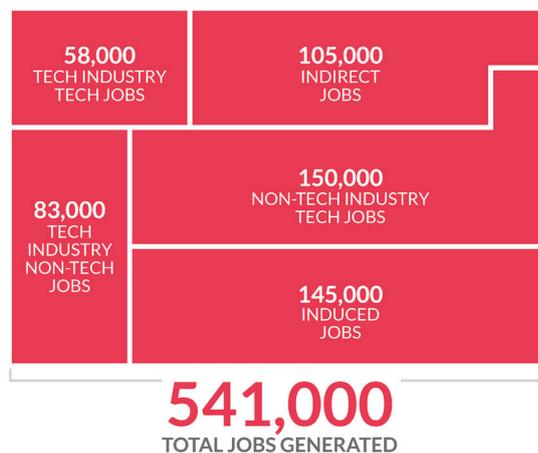
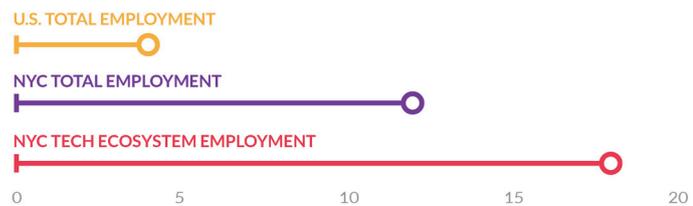
There are several implications arising from this trend. The rise of technology startups (particularly, information and communications technology, ICT) in cities is leading to new sources of employment and economic growth by creation of new businesses and employment categories. In New York City, the technology sector has increased jobs faster than in other sectors, becoming a new source of direct and indirect employment (**Figure 0.1**). The positive correlation between growth in the ICT industry of a city and job creation is being observed in other cities as well. Bangkok has been adding over 3,000 direct jobs a year to its ICT industry. In Barcelona, ICT is recognized as a key industry with almost a third of all companies and around half of the labor force involved in the knowledge economy. As the economy evolves into what many think is a “third industrial revolution,” traditional manufacturing

and routine cognitive skills jobs are being eroded and the creation of new sources of employment and growth is paramount to maintaining competitiveness, reducing poverty, and increasing shared prosperity.

The emergence of technology innovation hubs in cities presents an opportunity for developed and developing countries alike. Globally, over half of the world’s

population lives in cities and approaches 80 percent in Latin America. The fastest urbanization rates in the world are in Africa and Asia. Developing countries can tap into the growing resource of human capital and talent to create innovation centers that generate growth, entrepreneurship, and employability. Tech proficiency has become easier to develop for unskilled and unemployed populations,

FIGURE 0.1
Employment generated in New York City by the tech startup ecosystem (2003-2013)
PERCENT GROWTH IN EMPLOYMENT
2003-2013



SOURCE
Adapted from HR&A Advisors, 2014

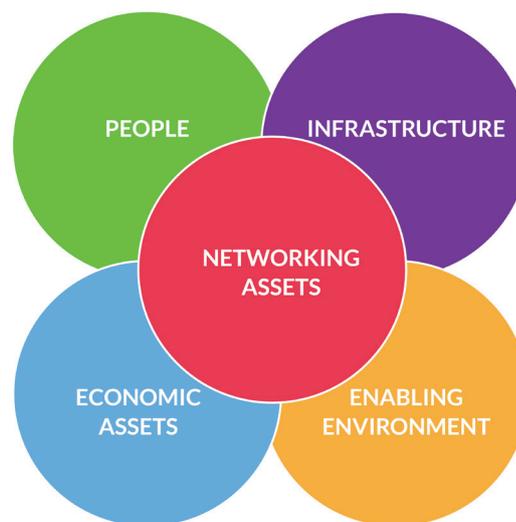
especially for young people. For instance, coding and hardware skills that previously took years to learn can now be taught in weeks.

However, tech innovation and entrepreneurship is not growing equally. Some cities are experiencing higher, faster, and more sustainable growth than others. There is anecdotal evidence that connections and communities play a key role in the surge and sustainability of urban tech innovation. Some cities, such as New York, are already creating policy actions to nurture tech innovation with this hypothesis in mind. Identifying key success factors to grow, develop, and sustain technology innovation in cities can help to inform policy actions. This working paper describes the findings of a research project to investigate these factors to understand what makes tech innovation and entrepreneurship grow faster and larger in some cities. These findings include the following: a) proposed framework for urban technology innovation ecosystems; b) testing of the framework hypothesis in New York, and; c) policy implications.

PROPOSED FRAMEWORK FOR URBAN TECH INNOVATION ECOSYSTEMS

A literature review is presented where existing studies applicable to city competitiveness and innovation are identified, including key elements and models. Based on this review, experiences working with client countries and partner research, a framework is developed identifying four key properties relevant to city innovation ecosystems: people, infrastructure, economic assets and the enabling environment. The framework revolves around the hypothesis that connections and communities are key success factor for ecosystem growth and sustainability. Networking assets, which are defined as community building events, skill training events, collaboration spaces, and networking of mentors, create and sustain these communities (see **Figure 0.2**).

FIGURE 0.2
Proposed framework with networking assets as central to ecosystems



TESTING OF FRAMEWORK HYPOTHESIS

New York City was selected to test this hypothesis. There were several reasons for this. The city has experienced rapid growth of a technology innovation ecosystem, providing a live case study. Second, there is abundant data and initial research of impact in terms of employment and growth. The city government and other key actors involved in its ecosystem were also willing to collaborate with the team. New York City is unique and not always comparable with many other cities in the world. However, given the growth of the ecosystem and the policies applied to support and foster this growth, the results from this initial analysis can provide a base for a proposed framework that can then be tested in other cities in developed and developing countries.

The initial findings support the hypothesis that the social dimension, or the connections and communities, of the ecosystem is critical for the growth and sustainability of the ecosystem and that networking assets, as defined above, are central to this social dimension. The analysis produced three conclusions: First, networking assets (using accelerators and incubators as a proxy) are central to the ecosystem's social dimension, being nodes of connection

for startups and other stakeholders. Second, social momentum of startups has a direct impact in their success (in terms of funding). However, there is not such impact with the geographic dimension of startups. Finally, the social dimension of startups expands and provides diversity to the ecosystem beyond geographical clustering or technology districts' boundaries.

These findings are consistent with and reinforced by recent research on the social dimension of the technology urban innovation ecosystem (Endeavor Insights 2014), which finds that social connections has been critical in the growth and sustainability of New York's ecosystem.

POLICY IMPLICATIONS

These results have several policy implications. First, technology innovation ecosystems need to be understood as a community or combination of communities, where the social dimension is critical. Second, the scope of policies to support these ecosystems is the community (defined by its social dimension) and not a geographic area (for example, a district or technology park). The geographic dimension seems to be a tool for the development of social connections, but it does not develop these connections by itself. This means that

the focus of policy to support ecosystems should pay attention to the development of networking assets that kickstart communities, build networks (for example, meetups, mentors) and provide platforms for community building (for example, collaboration spaces). Policies that focus on the geographic dimension only will have less impact and ignore the key factors that make the ecosystem sustainable.

The findings presented in this working paper are only the initial results from a larger research. For following research, the sources of data will need to be expanded and additional cities will

be researched in both developed and developing countries. The hypothesis tested will also need to be analyzed further, including the time dimension, and will need to be tested in more cities from developed and developing countries. Following research will need to be carried out with research and city partners (see Appendix B).

The team will work on expanding this research to investigate additional issues such as:

- how technology innovation ecosystems impact employment and economic growth, with a particular focus on generation of new sources of

jobs in both developed and developing country cities, and

- how city governments can build effective policies to support the growth and sustainability of urban technology ecosystems.

The first question will provide insights into the potential for employability and growth in the current environment of economic transformation where traditional sources of employment are changing. Existing policies and their impact on ecosystem's growth and sustainability will be analyzed as well as the results in producing employability.

SECTION 1

INTRODUCTION

CITIES ARE BECOMING THE NEW HUBS OF INNOVATION

Cities are increasingly emerging as the new centers of technological innovation. A shift is under way from technology parks in suburban areas, where universities, research labs, and the private sector are located together, to entrepreneurial activity within cities. Studies on venture capital (VC) investment in the United States reveal that innovation is moving from suburbs to downtown cities (MPI, 2014). Today, San Francisco hosts more VC investment than Silicon Valley and New York City, where the innovation startup

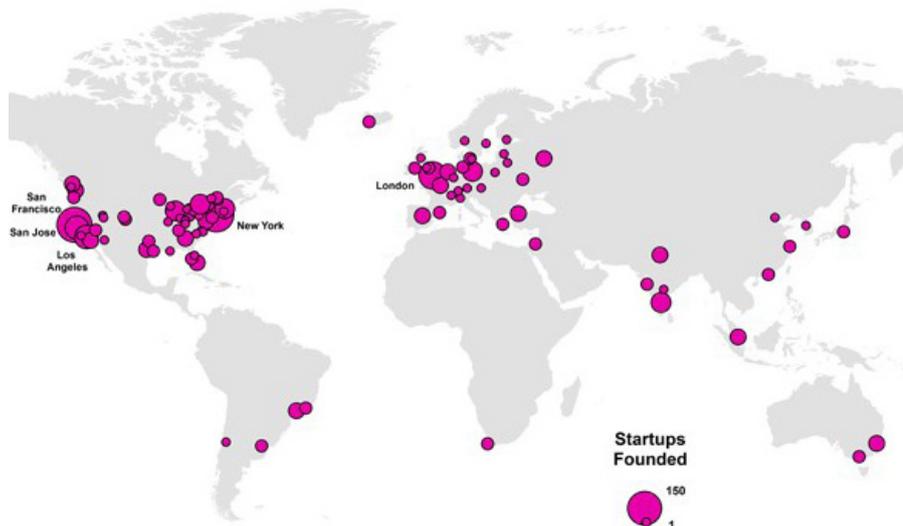
scene was nascent a decade ago, has become the second-largest tech startup ecosystem in the United States, with over \$3.1 billion in VC investment in 2013 (Endeavor Insight 2014). This trend is not unique to the United States. Startups are burgeoning in major cities around the world, including London, Berlin, Madrid, Moscow, Istanbul, Tel Aviv, Cape Town, Mumbai, Buenos Aires, and Rio de Janeiro, to name a few (see Figure 1.1).

Factors such as proximity, density, and variety of people and firms contribute to this phenomenon (Athey et al 2007). New technology trends have lowered the cost of innovation and allowed

entrepreneurs to enjoy the benefits from agglomeration economies. Cloud computing, open software and hardware, social networks, and global payment platforms, among other things, have made it easier to create a startup with fewer physical resources and personnel. If in the 1990s an entrepreneur needed \$2 million and months of work to develop a minimum viable prototype, today an entrepreneur would typically need less than \$50,000 and six weeks of work (Center for an Urban Future 2012) and, in some cases, these costs can be as low as \$3,000 (Mytton 2009). This trend is allowing entrepreneurs to take advantage of city agglomeration effects to a greater extent than before.

Entrepreneurs “want to live where the action is” – that is, in places where other young people, social activities, peers, and entrepreneurs are located (Florida 2013). Entrepreneurs look for conventional startup support, such as mentor networks or role models, as well as nightlife, meetups, social activities, and other potential “collision” points, a combination best provided by cities (Satell 2013). Innovation is becoming urban; what was previously the preserve of “innovation parks” is now growing organically within cities. In this paper, urban technology innovation ecosystems are defined as the collection of stakeholders, assets, and their interactions in city environments resulting in

FIGURE 1.1
Startups founded by city



SOURCE
Florida, 2013

technology (in particular ICT)-based innovation and entrepreneurship. The unit of study of this research is the city area of influence, understood as the core metropolitan area. The terms “urban” and “city” are used interchangeably to refer to the ecosystem.

URBAN TECHNOLOGY INNOVATION ECOSYSTEMS RESULT IN NEW SOURCES OF EMPLOYMENT AND GROWTH

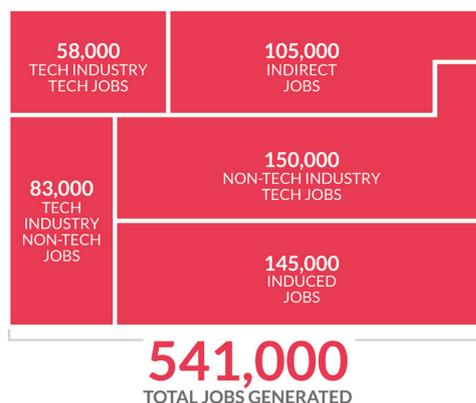
Urban technology innovation ecosystems not only increase the number of technology startups in cities but also result in new employment and economic growth by creation of new businesses and employment categories. In New York City, the technology sector has increased jobs faster than in other sectors and accounts for 12 percent of city tax revenue (HR & A Advisors 2014). From 2006 to 2013, the technology innovation ecosystem in New York City created over 500,000 new jobs (see **Figure 1.2**). The positive correlation between growth in the ICT industry of a city and job creation is being observed in other cities as well. Bangkok has been adding over 3,000 jobs a year to its ICT industry (National Statistical Office of Thailand). In Barcelona, ICT is recognized as a key industry with 29 percent of all companies and 48 percent of employees involved in the knowledge economy (Barcelona City Council 2012). Medellin generates over \$100 million a year from Business Process Outsourcing (BPO) and has attracted a number of multinationals to establish BPO centers in the city (Keshetri et al 2012).

As the economy evolves into what many

think is a “third industrial revolution” (The Economist 2012) that may erode traditional manufacturing jobs and those requiring routine cognitive skills, the creation of new sources of employment and growth is paramount to maintaining competitiveness, reducing poverty, and increasing shared prosperity.

centers within their own countries that generate growth, entrepreneurship, and employability while addressing local problems. Tech and entrepreneurship skills have become easier to develop for unskilled and unemployed populations, especially young people. For instance, coding and open hardware skills that

FIGURE 1.2
Technology Employment and Impacts in New York City



SOURCE

Adapted from HR&A Advisors, 2014

THE OPPORTUNITY FOR DEVELOPED AND DEVELOPING COUNTRIES

The emergence of technology innovation ecosystems in cities presents an opportunity for developed and developing countries alike. Globally, over half of the population lives in cities (United Nations 2014), and this percentage approaches 80 percent in regions such as Latin America. The fastest urbanization rates in the world are in Africa and Asia (Phillips 2014; United Nations 2013; and United Nations 2014). Developing countries can tap into the growing resource of human capital and talent to produce innovation

previously took years to learn can now be trained in months or even weeks. There is anecdotal evidence that these programs are increasing employability and entrepreneurship in these ecosystems (Meng 2013; and Amirtha 2014).

However, technology innovation ecosystems are not growing equally in all cities. Some cities are experiencing higher, faster, and more sustainable growth of these ecosystems than others, resulting in a higher number of startups, investment, employment, and economic growth. It is as yet unclear what factors cause different growth rates and how this growth can be supported with policy

TABLE 1.1
World Bank activities relating to technology innovation ecosystems

Project/Activity	City (Country)	Launched (Year) and Status
Mobile Internet Ecosystem Project	Beirut and others (Lebanon)	Prepared 2012, supporting activities started 2014
Colombia Open Innovation for Municipal Services	Barranquilla, Cali, and Manizales (Colombia)	Launched 2012, completed 2013
Smart City Gran Concepcion	Gran Concepcion (Chile)	Launched 2013, completed 2014

actions. Research suggests that density of people and firms and agglomeration effects play a critical role (Carlino and Kerr 2014; and Pan et al 2013). There seems to be a positive correlation between the size and density of the city and the organic growth of urban tech innovation ecosystems, as the ecosystems tend to emerge first in the largest cities,

such as New York, London, Mumbai, Sao Paolo, or Shanghai (Pan et al 2013). However, it is unclear why some of the largest and densest cities grow their ecosystems at different rates, or why some smaller cities, such as Manchester or Helsinki, have strong technology innovation ecosystems.

BOX 1.1

New York City policies to create a sustainable and vibrant tech innovation ecosystem

The growth of New York City's tech innovation ecosystem is not entirely random. It has received active support from Government of New York City, with targeted and strategic policy actions. New York consciously followed this strategy to create new sources of income and competitiveness during the financial crisis. Despite the size and importance of New York, the challenges faced by the city to develop a technology-based innovation ecosystem were similar to those facing many other cities. This included: (i) lack of technology-specialized talent, (ii) insufficient sources of seed capital for startups, (iii) lack of physical space for entrepreneurs, and (iv) a limited and uncoordinated community of tech-led innovators and entrepreneurs.

New York addressed these challenges through a strategic program with targeted policies. Specific actions included (i) promoting collaborator spaces linked to mentor networks and incubators, (ii) fostering entrepreneurial funds to attract VCs into New York startups, (iii) attracting engineering schools to develop programs in the city and providing basic skills training and access to open hardware tools in public spaces (for example, libraries), and (iv) energizing the community through competitions and challenges (based on city problems). This last strategy is accomplished by the city opening data, developing mentorship networks for tech entrepreneurs, and promoting the tech community, including promotion campaigns, support of high-ranking city officials, and public awards. These actions were conducted in partnership with the community and private sector, thereby providing incentives to the latter. The focus on community development, collaboration spaces, and mentorship networks proved to be a success, attracting a community that is self-sustainable and continues to grow.

New York City's success in developing a sustainable technology-led innovation ecosystem presents lessons for cities around the world, in both developed and developing countries. As its ecosystem grew, New York also actively engaged poor neighborhoods through training and integration into new employment opportunities generated by the ecosystem. Almost half of the jobs generated in the New York tech ecosystem do not require a bachelor's degree (HR & A Advisors 2014). Pilot initiatives targeting poor and unskilled population from neighborhoods, such as the Coalition for Queens, confirm that rapid skills training with mentorship results in direct employability. From the first batch of this program, 20 graduates, 70 percent obtained full-time employment, 15 percent became entrepreneurs, and the rest entered formal education programs (Hsu 2014). Further, almost a quarter of New York tech startup founders do not have any technical background, and most of these startups focus on non-tech sectors, introducing technology-driven innovation to existing industries and businesses (HR & A Advisors 2014).

New York has been able to develop one of the largest tech-innovation ecosystems with limited tech talent, which is a constraint many cities face. New York is not the only city applying these policies and support. Other cities—including Amsterdam, Barcelona, Helsinki, and London, to name a few—are also actively supporting the growth and sustainability of their innovation ecosystems with similar policies and areas of focus targeted to their local needs.

INPUTS FROM FIELD EXPERIENCE: CONNECTIONS AND COMMUNITIES PLAY A KEY ROLE

The World Bank has been involved in a number of activities with client countries to build ecosystems of technology-led innovation. Through these activities, we have observed factors that support the growth and sustainability of urban technology innovation ecosystems. We find that creating and supporting a community of tech entrepreneurs, coupled with incentives for kickstarting the ecosystem, for example through competitions and challenges, and provision of rapid skills programs, often provides a formula to grow and sustain technology innovation ecosystems. **Table 1.1** lists some of the World Bank activities related to technology innovation ecosystems that follow this formula. Appendix C provides more details on these activities.

Through these activities, we have observed how urban tech innovation ecosystems develop and grow in cities with different population sizes and wealth characteristics, ranging from three hundred thousand inhabitants in Manizales to two million in Beirut. Anecdotally, we have found that connections and communities play a key role in the surge and sustainability of these innovation ecosystems. Partners in these activities, including city governments and entities supporting urban innovation from Amsterdam, Barcelona, Helsinki, New York, and the Republic of Korea, have arrived at the same conclusions (see Appendix B for details of these partners).

This finding implies that the emergence and sustainability of urban technology ecosystems can be supported with policy actions, and that those policy actions can obtain results in the short term (that is, one to three years). Some cities, such as New York, are already creating technology innovation ecosystems with this hypothesis in mind (see **Box 1.1**).

SECTION 2

A FRAMEWORK TO ANALYZE URBAN TECH INNOVATION ECOSYSTEMS

RESEARCH OBJECTIVE AND APPROACH

Given that connections and communities play a key role in the growth and sustainability of innovation ecosystems, which can be supported with policy actions, a research project was developed to **identify the key success factors to grow, develop, and sustain technology innovation ecosystems in cities in order to inform policy actions.**

Research began by identifying and reviewing existing studies applicable to urban technology innovation ecosystems. Following this review, and taking into account experiences with working with client countries and partners, a framework was developed to test the following hypothesis: **Connections and communities are key success factors for the growth and sustainability of urban technology innovation ecosystems.** This hypothesis was tested for New York City and initial results are presented in this working paper.

The framework identifies and categorizes key success factors for the growth of an urban technology innovation ecosystem and compares the impact of such factors to different ecosystems across cities. Ultimately, it is expected that the framework can be used to assess the impact of policies to grow and sustain urban technology innovation ecosystems.

LITERATURE REVIEW

A review of the literature on innovation ecosystems in cities was conducted, first examining innovation and ecosystems and then considering the applicability of these concepts in the urban context. There are a limited number of studies and frameworks that specifically address urban technology innovation ecosystems, so the review also included studies on innovation and cities, primarily indexes of city innovation and competitiveness to identify key factors for innovation in cities that could apply to the technology innovation ecosystems. The key findings from this review are that:

- There is only a limited consensus on the how urban innovation ecosystems develop and grow, and
- A measurable framework is lacking that enables urban innovation ecosystems to be compared across cities.

However, there is consensus on the critical factors that impact innovation in cities. Building upon these factors, operations experience, and the experiences of partners, a framework was developed.

INNOVATION AND ECOSYSTEMS

The OECD (2005) defines two forms of innovation:

1. Technological *product*

innovation: “the implementation/commercialization of a *product* with improved performance characteristics such as to deliver objectively new or improved services to the consumer.”

2. Technological *process* innovation:

“the implementation/adoption of new or significantly improved *production or delivery methods*. It may involve changes in equipment, human resources, working methods or a combination of these.”

This report is concerned with both of these aspects and in their translation through entrepreneurship into startups. The literature is ripe with studies relating innovation to ecosystems (Durst and Poutanen 2013). An innovation ecosystem parallels the environmental concept where interrelated elements strive for equilibrium. The ecosystem is modeled as an economic equilibrium resulting from the interaction between various innovation actors (for example, business, universities, government) (Jackson 2011). There are several definitions of innovation ecosystems in the literature. Mercan and Göktas (2011) define an innovation ecosystem as consisting of “economic agents and economic relations as well as the non-economic parts such as technology, institutions, sociological interactions

and the culture.” The Brookings Institution, applying this concept to urban environments, but limiting it to districts, defines an innovation ecosystem as “a synergistic relationship between people, firms, and place (the physical geography of the district) that facilitates idea generation and accelerates commercialization” (Katz and Wagner 2014).

FACTORS FOR INNOVATION AND COMPETITIVENESS IN CITIES

This section begins with a review of indexes and studies that include factors of innovation in cities. This is followed by a review of studies of models for innovation ecosystems in cities. These elements are analyzed to develop an urban tech innovation ecosystem framework.

Several institutions compile city rankings based on various measures of competitiveness, a number of which are related to innovation aspects. These indexes can help identify factors to develop innovation within cities and were used as a starting point in developing our framework:

Hot Spots 2025: Benchmarking the future competitiveness of cities (EIU 2013)

notes, “Global business is beginning to plan strategy from a city, rather than a country perspective.” It defines a city’s competitiveness as the ability to attract capital, businesses, talent, and visitors, also important criteria for city innovation ecosystems. The index ranks 120 cities across the world using 32 mainly qualitative indicators grouped into eight categories: economic strength, physical capital, financial maturity, institutional character, human capital, global appeal, social and cultural character, and environment and natural hazards.

The *Global Cities Index* (GCI) (A.T. Kearney 2014) states, “By creating an environment that spawns, attracts, and retains top talent, businesses, ideas, and capital, a global city can generate benefits that extend far beyond municipal boundaries.” The GCI measures the level of city global engagement covering 84 cities using 26 metrics in five categories: business activity, human capital, information exchange, cultural experience, and political engagement.

A study ranking cities by GDP per capita (OECD 2006) finds that labor productivity is the main factor in explaining differences. Innovation is intimately tied to productivity; cities

with high value-added activities such as high-tech and advanced services are closely linked to R&D activities and the generation of innovation. The study notes that applicants located in cities file over 80% of patents in the countries studied.

The *Most Innovative Cities in Asia Pacific* (Solidance 2013) uses six categories to measure the level of innovativeness in 16 cities in the region: human talent, knowledge creation, technology, society, government, and global integration. The findings are aimed at informing companies about the “most attractive places” in terms of an effective innovation ecosystem. Key factors include availability of educated and skilled people attracted by diversity and amenities; ability of universities, enterprises and government to produce knowledge; the livability of a city and its ability to sustain culture; the level of technology in the city; a favorable regulatory environment; and global integration and future orientation.

The New York Economic Development Corporation has created a New York innovation index. The index tracks progress in six dimensions related to resources directed towards innovation and the results of such innovation in

TABLE 2.1
Comparison of indexes related to competitiveness and innovation in cities

Hot Spots 2025	Global Cities Index	Most Innovative Cities in Asia Pacific	New York Innovation Index
Economic strength	Business activity		Entrepreneurship and employment dynamics / high-tech gross city product
Physical capital		Technology	
Financial maturity			Finance
Institutional character	Political character	Government	
Human capital	Human capital	Human talent	Human capital
Global appeal		Global integration	
Social and cultural character	Cultural experience	Society	
Environment & natural hazards			
	Information exchange	Knowledge creation	Intellectual property / R&D

the city’s economy. Inputs to innovation include R&D, Finance, Human Capital; outputs include Intellectual Property, High-tech Gross City Product, and Entrepreneurship and Employment Dynamics (NYEDC 2011).

Table 2.1 summarizes the categories used by these indexes.

A review of the indexes in Table 2.1 shows that similar factors are used in the reviewed indexes to determine innovation within cities. The factors that are most common in these indexes are:

- Human capital
- Business activity
- Government
- Information/knowledge
- Infrastructure
- Finance
- Social/cultural Aspects

EXISTING FRAMEWORKS TO UNDERSTAND URBAN INNOVATION ECOSYSTEMS

Few studies have proposed frameworks to explain innovation ecosystems in urban environments. From the review, six approaches were identified. These frameworks and their key factors were compared with those identified from the city indexes review. This analysis formed the basis for the proposed framework. This section describes the six framework approaches that were reviewed:

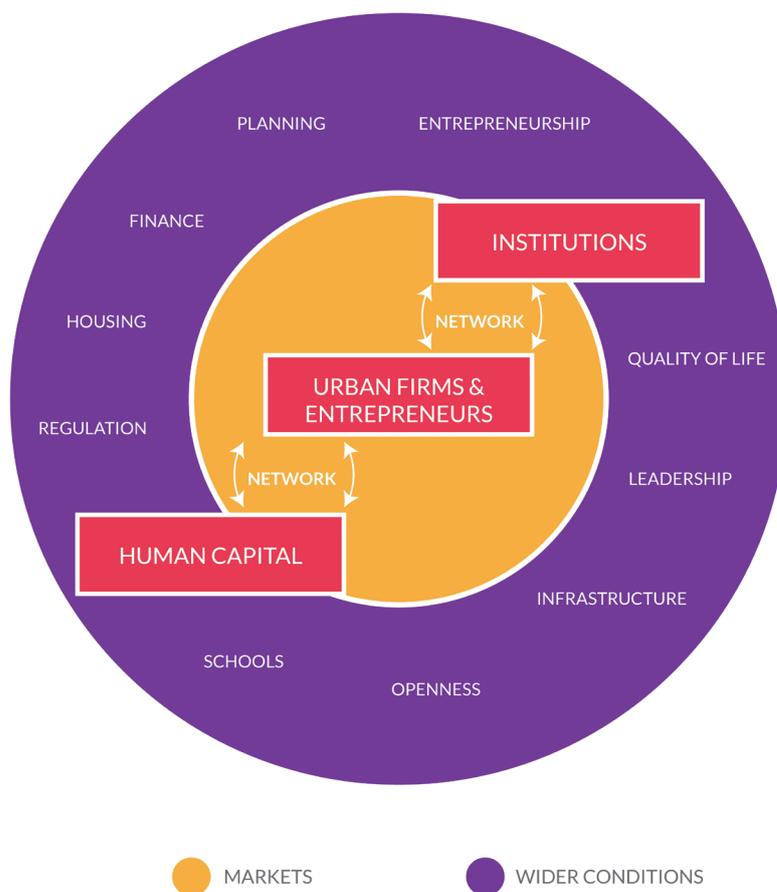
Winden et al (2007) in a first approach looking at the knowledge economy in cities finds that the quality of city foundations and successful organizing capacity are important for generating human capital and knowledge-based industries that then generate innovation. This framework focuses on factors to develop the knowledge economy in cities, including the knowledge base (human capital), the industrial structure, quality of life and amenities, accessibility (infrastructure), diversity, scale, and social equity.

Schaffers et al (2011), taking the perspective of smart cities, propose a framework where all city economic activities and utilities form the innovation ecosystem, with citizens and organizations participating in its development via supply and consumption of goods and services.

Crowley (2011) proposes a framework with three main elements: urban firms and entrepreneurs, institutions, and human capital (see **Figure 2.1**). Firms and entrepreneurs are at the core, driving the supply and demand for innovation. Institutions, including governments, universities, research centers, business organizations and others, create and spread knowledge, a key driver of innovation. The third component in this framework is human capital. Crowley (2011) argues, “The concentration of highly skilled people in one place

promotes the exchange of ideas and learning, facilitating the process of innovation.” Cities need to attract talent by providing the adequate environment. Three key drivers of innovation are proposed: networks, markets, and wider conditions. Firms and entrepreneurs connect with institutions and people through networks. These networks promote collaboration, and help generate ideas and disseminate knowledge. Markets, including consumer markets and public procurement, drive the demand for new products and services. People’s mobility within the labor market contributes to knowledge dissemination. Finally, Crowley finds that the wider conditions, such as good schools, availability of financial resources, well-maintained infrastructure, and adequate housing available, also contribute to the success of an innovation ecosystem.

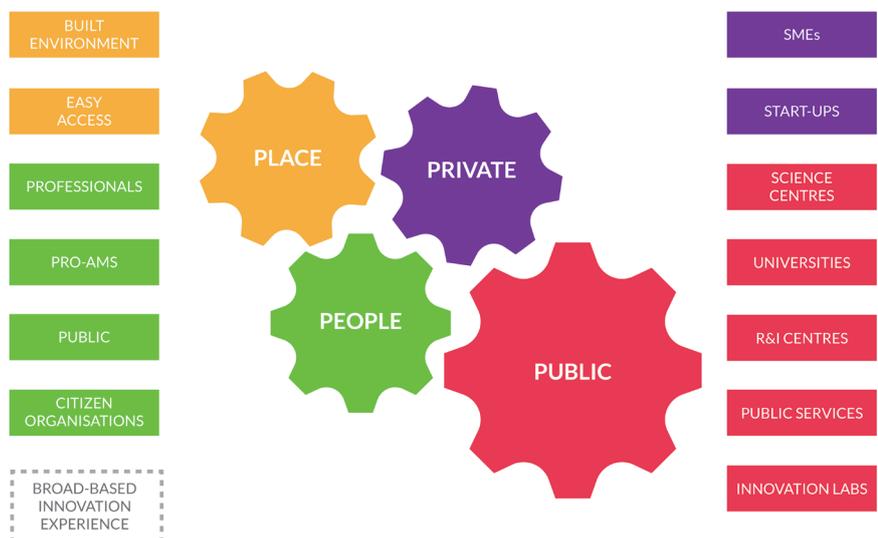
FIGURE 2.1
Crowley’s Innovation Ecosystem Framework



SOURCE
Crowley, 2011

FIGURE 2.2
European Commission Innovation Ecosystem Framework

iCapital Innovation Ecosystem



SOURCE
European Commission, 2013

The European Commission (EC) (2013) considers a city innovation ecosystem to consist of the processes linking citizens (People) with a built environment (Place) and public organizations and policymakers (Public) through business (Private) (see **Figure 2.2**). With over two thirds of Europeans living in urban areas, the EC recognizes the importance of promoting innovation to enhance economic growth and increase citizen

welfare.

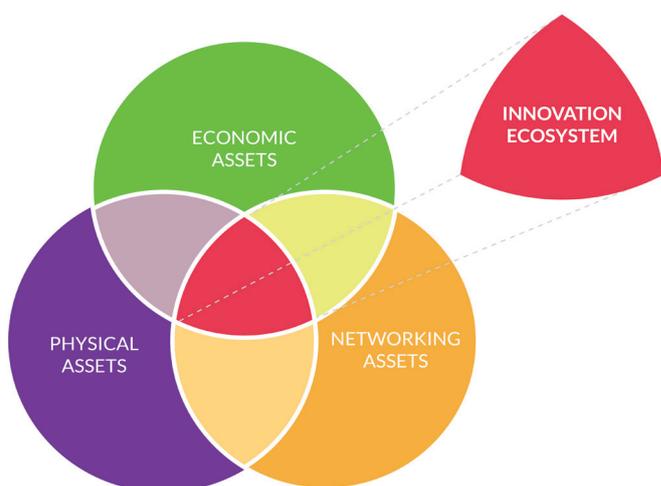
Bell (2014) proposes nine elements that make innovation ecosystems succeed in cities:

- **Talent:** people with the right skills and passion;
- **Customers:** although clients can be found around the globe thanks to the use of internet, some product sales depend on the local market;

- **Capital:** financing available for new product developments;
- **Academic institutions:** supply skilled labor and promote the development of new ideas;
- **Heroes:** examples of successful startups;
- **Guides:** provide advice and help;
- **Support services:** include lawyers, government officials, public relations firms, advertising firms, etc.;
- **Gathering places:** promote “collisions” and the generation of ideas; and
- **Comparative advantages:** unique characteristics of the city.

The Brookings Institution focuses on innovation districts (Katz and Wagner 2014). This focus is limiting as it reduces the scope of innovation across a city and ignores the social connections generated beyond geography. However, some of the concepts and factors identified can be applicable to the city as a whole and inform a wider approach of the city as the innovation ecosystem. The Brookings Institution’s framework finds that economic, physical, and networking assets are present in all innovation districts (see **Figure 2.3**). These three assets classes are described as follows:

FIGURE 2.3
Brookings Innovation Ecosystem Framework



SOURCE
European Commission, 2013

- 1. Economic assets** refer to institutions, organizations and enterprises that drive, cultivate or support innovation. Thus, economic assets are categorized in three types: (i) Innovation drivers, focused on developing cutting-edge products and services (for example research institutions); (ii) Innovation cultivators, support the growth of entrepreneurs (for example incubators, accelerators, coworking spaces, community colleges); and, (iii) Neighborhood-building amenities, provide support to workers and residents (for example, coffee shops, retail stores).

2. **Physical assets** refer to private and public buildings and infrastructure that allow collaboration and connectivity. Public assets include parks and streets. Public spaces not only bring people together, but they also can serve as labs to test new products. Private assets include private spaces and buildings, such as office affordable office spaces for

startups. There are also physical assets that help “knit the district together”, such as sidewalks, bike lanes and public spaces, and others that connect the district to the city and the world, such as transportation and broadband.

3. **Networking assets** refer to the relationship between the ecosystem’s actors. These networks and cultivate

and accelerate innovation through the exchange of information and ideas, and the increased collaboration. Networking assets can build strong ties (for example, workshops and conferences) or weak ties (for example, networking events and hackathons).

Table 2.2 summarizes the categories of these framework approaches.

TABLE 2.2
Comparison of categories related to innovation ecosystems in cities

Winden et. al. (2007)	Schaffers (2011)	Crowley (2011)	European Commission (2013)	Bell (2014)	Brookings Institution (2014)
Human capital / scale / diversity	Citizens	Human capital	People	Talent	
Quality of life / amenities (infrastructure)	Utilities	Wider conditions (infrastructure)	Place (infrastructure)	Gathering places / competitive advantage	Physical assets (infrastructure)
		Institutions / government	Policymakers		
Industrial science	Organizations / economic activities	Research centers / businesses / universities / urban entrepreneurs	Private (businesses)	Academic institutions / capital / support services	Economic assets
		Networks		Guides / heroes	Networking assets
	Supply of goods and services (markets)	Markets		Customers	

SECTION 3

A NEW APPROACH TO URBAN TECHNOLOGY INNOVATION ECOSYSTEMS

Through the literature review on indexes and frameworks related to innovation in cities and innovation ecosystems in urban environments, four main categories to grow and sustain innovation ecosystems emerge:

1. Human capital or people
2. Physical assets or infrastructure
3. Economic assets, and
4. Government and policy or enabling environment

These four categories are connected through networks and markets. This last element finds traction in the most recent two frameworks proposed (Bell and The Brookings Institution). The Brookings Institution framework expands the concept to networking assets, which include events that create community, such as meetups or challenges and collaboration spaces, such as coworking spaces, accelerators, or incubators.

Work with country clients on activities related to developing and strengthening urban innovation ecosystems corroborates these categories. Several urban innovation ecosystems have been mapped by the World Bank and the Research Partners (see Appendix B for World Bank activities and Appendix C for Research Partners). Through these mapping efforts, these four categories have been identified as the

main components of city innovation ecosystems. As urban innovation ecosystem growth and development relies increasingly on community building and sustainability, networking assets have become more relevant and central. This importance is also experienced by city partners, which are focusing on developing and sustaining these communities (see Appendix C).

The first four elements result from agglomeration effects and provide a picture of the ingredients that the city must possess in order to develop and grow its innovation ecosystem. The networking element acts as a multiplier of these factors that can boost the size and rate of growth of the ecosystem. As creators and sustainers of communities, the networking element can increase

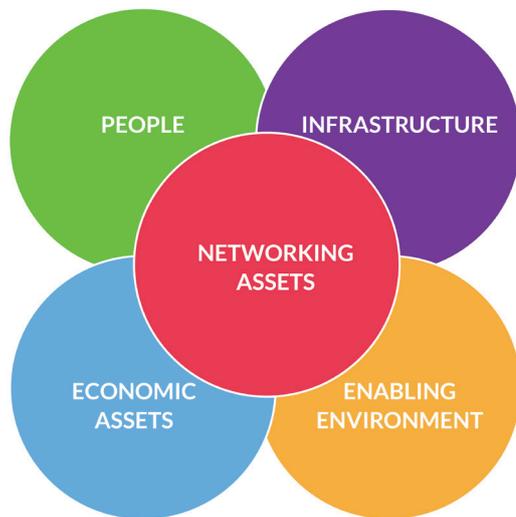
FIGURE 3.1
Networking assets as multipliers of random collisions



SOURCE

Minges, 2014, adapted from Roberts, 2014

FIGURE 3.2
City Innovation Ecosystem Framework



the number of “collisions” that result in innovation within cities. Collisions are random encounters with people one would normally not meet. The theory of collisions argues that these encounters bring new ideas, perspectives, and value for creating opportunities and innovation (Kaplan 2012). The more collisions individuals have with people with different ideas, the more creative and innovative these individuals may become (Satell 2013). Hence, the potential for collisions stimulates innovation and entrepreneurial opportunities (Roberts 2014). Networking assets (as defined in the following section) increase the potential for collisions, acting as a multiplier of the existing elements produced by the agglomeration effects in the city innovation ecosystem (see **Figure 3.1**).

Based on this premise and borrowing concepts from the literature review, a holistic framework to map and diagnose city innovation ecosystems in developed and developing countries was proposed. The following section describes this framework and its elements.

A HOLISTIC FRAMEWORK TO MAP AND DIAGNOSE CITY INNOVATION ECOSYSTEMS

The framework to map and diagnose

urban innovation ecosystems comprises two layers. The first introduces the four categories that result from agglomeration effects and that are common in the literature. The second layer, which is a multiplier of the agglomeration effects, is networking assets. All these elements interact with each other, but only networking assets function as multiplier for the ecosystem growth. This framework is presented visually in **Figure 3.2**.

People are the basic element for innovation to happen. Innovation results from the interactions and the work of people. A survey of tech entrepreneurs in the United States highlighted the talent pool of employees as being the most important business-related resource that cities offered (Endeavour Insight 2013). The “creative class” has been cited as an important factor for generating economic output in cities (Florida 2002). A number of characteristics of a city’s population have a bearing on innovation and growth. One of the most important is that growing populations generate an increase in productivity (Hardesty 2013). Other people-related factors affecting innovation include the share of immigrants, number of residents with a college degree, the labor force and its

characteristics, the number of patent holders, and so on. People also form part of the innovation support network by serving as mentors and guides and are a testing ground for innovative products and services. Within the proposed framework, this category maps the characteristics of people that increase the potential for innovation, including their diversity, in terms of background and education, their level of education, and the education and training capacity of the city, including provision of technology-related training.

Economic Assets include the elements that: (i) interact with people to increase the number of ideas resulting in innovation and, (ii) allow for implementing these ideas into practical innovation. This category maps elements such as the variety of industries, business and sectors; the size, amount, and diversity of companies and businesses; the universities and research and development facilities; the maturity and size of the technology and creative industries; and the availability and size of innovation-oriented investment firms, particularly for providing seed financing.

Infrastructure facilitates interactions among people and economic assets. This category maps the infrastructure in the city that: (i) provides basic living conditions, (ii) facilitates access to people and knowledge, or (iii) facilitates random collisions. This includes transportation infrastructure, broadband access, parks and venues for events, festivals, cafes, restaurants, theaters, and so on. Green spaces attract talent to live in the city and provide a venue for collisions, in the same way as the amenity sector. Offices are needed to house tech firms; startups need inexpensive and adaptable venues (that is, flexible office space). Physical and digital connectivity—transport and communications networks—bind city neighborhoods “together and/or tie it to the broader metro area” (Katz and Wagner 2014).

Enabling Environment refers to public policies and the government commitment to promote innovation. This category identifies: (i) the enabling environment provided by the government for innovation to occur, and (ii) the degree of commitment, promotion and facilitation by the government for development of the innovation ecosystem. This category maps policies such as doing business, property and IP protection, business associations, as well as specific policies to promote the innovation ecosystem, such as open data, challenges, innovation promotion, and so on.

Networking assets increase the number of collisions in the ecosystem, multiplying the effect provided by agglomeration. Innovation ecosystems will produce higher results in terms of, for instance, (i) increased number of startups, (ii) increased value of startup exits, (iii) increased employment in tech innovation related activities, if the number of random collisions increases. This category maps the main networking assets, including meetups, tech community events, bootcamps and skill training programs, collaboration spaces, accelerators, incubators, angel investors, venture capital, and networks of mentors.

A list of categories of collaboration spaces is presented in Appendix E. Accelerators, incubators, angel investors, and venture capital are hybrid assets with economic assets but the impact of their network of mentors and entrepreneurs makes them more valuable for the growth and sustainability of the ecosystem; therefore, they are categorized as networking assets. The financing functions of these assets are included in economic assets under seed capital and financing. **Table 3.1** presents an indicative list of networking assets.

FINDINGS FROM NETWORKING ASSETS ANALYSIS

If networking assets are multipliers of the agglomeration effects in urban innovation ecosystems this means that networking assets are central to the ecosystem and that connections among stakeholders are central to the growth and sustainability of such ecosystems. This rationale supports the understanding of urban technology innovation ecosystems as a community (or a combination of communities) (see Appendix C).

This hypothesis was tested through a combination of qualitative (interviews) and quantitative (data analytics) approaches in New York City’s ecosystem. To familiarize itself with the

city ecosystem and its main actors—government agencies, entrepreneurs, coworking spaces, and accelerator spaces—the team conducted 21 interviews with actors to learn about the development of New York City’s tech innovation ecosystem. From these discussions, the team began to identify sources of data in New York City that describe the tech innovation ecosystem. The interviews also provided insights on New York City’s ecosystem, its growth, and the role of networking assets, such as meetups, competitions and collaboration spaces. The interviews also allowed the team to learn about the policies of New York City, its impact, its successes and failures, and how it evolved to support the growth and sustainability of the ecosystem.

For the data analysis, the team used available data sources to quantify the value of networking assets via their centrality in the ecosystem as well as the impact of geography on the ecosystem and how geographical and social connectivity centrality affected the performance of startups (in terms of capital raising). Because it used mainly CrunchBase and Angel List data, the team focused the analysis on accelerators and incubators. These are collaboration spaces providing investment along with

TABLE 3.1
Networking assets

Community building events	Skills training events	Collaboration spaces	Collaboration spaces / networks of mentors	Network of mentors
Meetups	Bootcamps and technology training linked to community building	Collaboration and community building spaces e.g. coworking spaces, maker spaces, fablabs	Accelerators (network value)	Angel investors (network value)
Tech community events / conferences	Rapid technical and entrepreneurial skills training programs		Incubators (network value)	Venture capital (network value) Networks of mentors and startup “alumni” networks (if different from accelerators, incubators, angel investors, and venture capital)

(and sometimes as primary function to) their networking functions. This phase of the research did not analyze community building events or skills training programs and events because insufficient sources of data were available. In addition, because this phase of research focused on testing the effectiveness of the proposed social network analysis methodologies against publicly available data sources, research focused on exploring the dataset at a static point in time and did not explore impacts over time. These additional perspectives can be addressed in future research (see Section 4).

The findings from the analysis of four research questions in relation to New York City's urban innovation ecosystem are summarized below. As mentioned above, the results presented here, and in more detail in Appendix F, are interim findings resulting from the data sources and limitations of this research. Final outputs will be produced as a result of forthcoming research and analysis. Data sources and methodologies are also described in detail in Appendix F.

In order to measure the value of networking assets in urban innovation ecosystems, research explored the impact of connections on ecosystem success outcomes. Following this, the value of incremental connections was quantified, enabling us to rank and value individual networking assets by multiplying their success in creating new connections by the value of incremental connections.

Connections are defined as either social or geographic. While there are multiple metrics that can be used to define success, this analysis considers the raising of a round of funding as a successful outcome for startups and by extension the ecosystem as a whole. As such, the analysis focuses on examining the interplay between the geographic, social, and funding dynamics within New York City's urban innovation ecosystem.

The findings of this analysis (see Appendix F) support the hypothesis that the social dimension, or the connections and communities, of the ecosystem is critical for the growth and sustainability of the ecosystem and that networking assets, defined as community building events, skills training events, collaboration spaces, and networking of mentors, are central to this social dimension. First, networking assets (using accelerators and incubators as a proxy) are central to the ecosystem's social dimension, being nodes of connection for startups and other stakeholders. Second, social momentum of startups has a direct impact in their success (in terms of funding). However, there is not such impact with the geographic dimension of startups. Finally, the social dimension of startups expands and provides diversity to the ecosystem beyond geographical clustering or technology districts' boundaries.

NETWORKING ASSETS ARE CENTRAL TO THE ECOSYSTEM

These initial findings support the hypothesis that **networking assets are central to urban technology innovation ecosystems**. This implies that networking assets are the connectors which: (i) sustain the social network of the ecosystem, and (ii) have the potential to boost the ecosystem's growth by increasing the collisions that result from social connections. By being central to the ecosystem and these connections, **networking assets would play a critical role in the growth and success of urban technology innovation ecosystems**. Either the social dimension of startups determines their success (in terms of capital raising) or success determines the of startups centrality for the ecosystem (in its social dimension).

Compared to this social dimension, the geographic dimension or clustering of startups does not seem to play a critical role in their success (in terms of capital raising) or centrality within

technology urban innovation ecosystems. This seems to imply that the geographic dimension of startups is just one of many mechanisms to contribute to the social dimension of startups. In urban environments, the geographic dimension becomes less relevant. In particular, in New York City, with an extensive, affordable and fluid transportation network, the geographic contribution seems to be rather small compared to that of networking assets.

These initial findings have important implications because they position networking assets as significant factors of technology innovation ecosystems in cities. The significance of these assets combined with the importance of a startup's social dimension compared with its geographic dimension are important considerations that should inform the policy of cities that support the growth and sustainability of these types of ecosystems (see next section).

These findings are preliminary and based on limited sources of data. However, in combination, they provide support to the hypothesis that: (i) fostering the increase of connections, and building a community are critical actions to grow and sustain technology innovation ecosystems, and (ii) that networking assets play a key role in creating both of them. These findings are reinforced by the insights from the interviews the team conducted and the recent research produced in New York City's technology innovation ecosystem by Endeavor Insight. This research (Endeavor Insight 2014) found that connections have been critical in the growth and sustainability of the ecosystem and that they provide a virtuous cycle for growth. Endeavor Insight mapped the connections of over 650 entrepreneurs and key actors in the ecosystem, showing the growth in size (about 25 per cent CAGR from 2003 to 2013) and complexity (see **Figure 3.3**) as the ecosystem grew exponentially to become the largest in the United States

during that period of time.

These findings are limited by the characteristics of the city object of this research (New York City), the limitations of data sources (see Appendix F) and scope of analysis (limited types of networking assets). Transportation and connectivity (for example, broadband) infrastructure in New York City provides easy physical and digital transit within the city, and may reinforce the importance of social connectivity compared with geographic connectivity. In other cities, different transportation and connectivity infrastructure (for

example, long daily commute, poor public transport, limited broadband access), may impact this result. Data from voluntary reporting by members of the ecosystem may not provide a complete or unbiased picture of reality. Finally, networking assets, such as community building events and skill training programs, are critical in the hypothesis of ecosystems as a community (or combination of communities). This research did not analyze the impact of these events and programs. For these reasons, the findings presented in this paper should be considered as interim and further research and analysis is planned in a

subsequent phase of the study (see Section 4).

POLICY IMPLICATIONS

The significance of networking assets for the growth and sustainability of technology innovation ecosystems in cities and the importance of startups’ social dimension compared with their geographic dimension have policy implications for cities and other policy actors that want to support the growth and sustainability of technology urban innovation ecosystems.

The most relevant implications for policy design and implementation are that: (i) technology innovation ecosystems in cities need to be understood as a community or combination of communities, and (ii) the focus of policies to support these ecosystems is the community (defined by its social dimension) and not a geographic area (for example, a district or technology park) within the city.

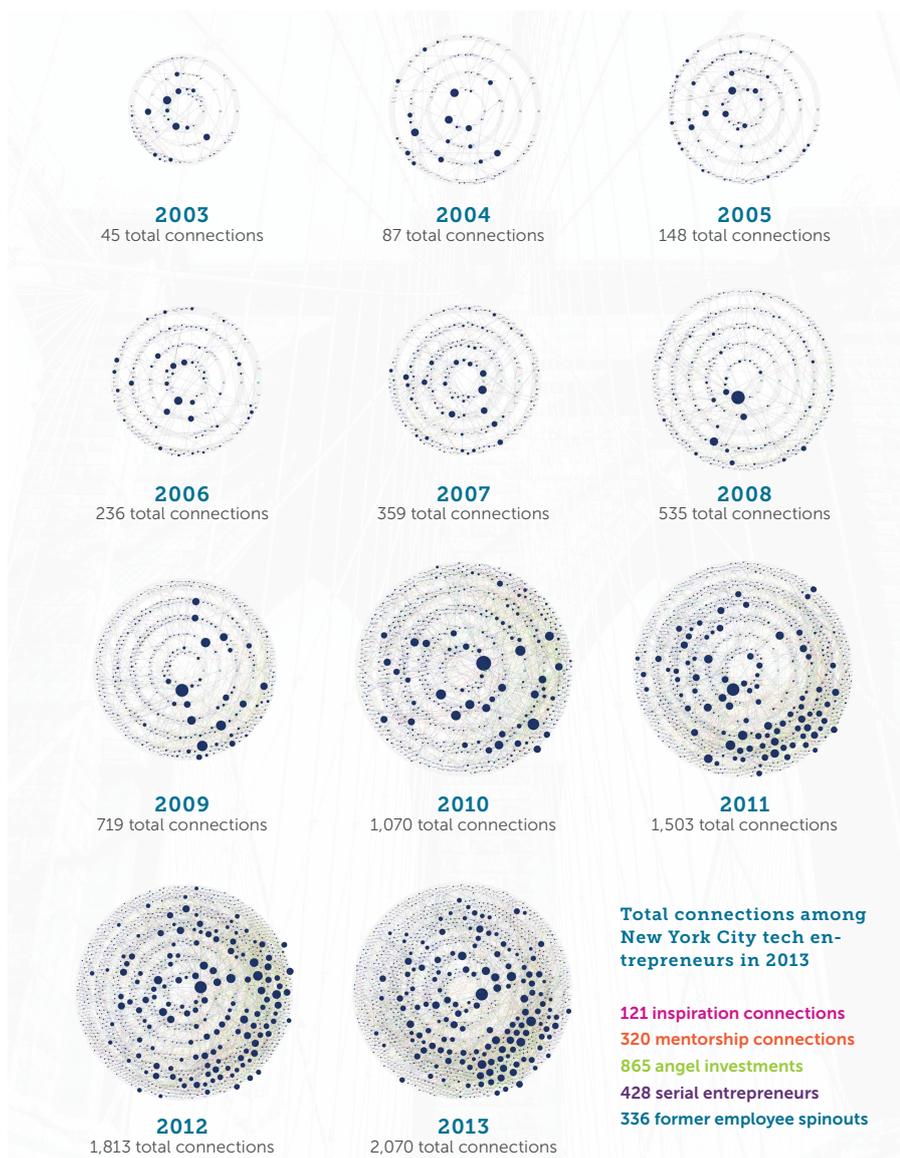
Addressing ecosystems as a community

By understanding the innovation ecosystem as a community, where social connections play a critical role, policies can better target the bottlenecks and market failures precluding or slowing the growth of the ecosystem.

Policy to support the ecosystem should focus on fostering the development of networking assets that kickstart communities (for example, challenges, hackathons or competitions), build networks (for example, meetups, networks of mentors), or provide platforms for community building (for example, collaboration spaces). Bringing legitimacy to the community can play a critical role in its initial growth and further expansion. Promotion campaigns and support that produce role models and highlights the community of entrepreneurs help to support this goal. Additionally, providing rapid skills

FIGURE 3.3

The Growth of New York City’s tech sector from 2003-2013



SOURCE

Endeavor Insight, 2014

training programs enlarges the potential members of the community and expands the sense of belonging by providing cohorts of new members.

This is one of the approaches pursued by New York City, and many other cities with growing ecosystems are now following their lead (see **Box 1.1**). Furthermore, this approach is also shaping the World Bank's innovation ecosystem-related activities (see Appendix C). The research team will review policies adopted by cities and other relevant actors as well as

case studies and lessons learnt in the following phase of this research in collaboration with city partners to expand the diagnosis tool (see Section 4).

The focus of policies should be the community and not a limited geographic area

If the focus of policies to support the growth and sustainability of the ecosystem is the community, these cannot be limited to a geographic area (that is, a district or technology park). Policies that focus on the geographic will have

less impact and may completely ignore the key factors that make an ecosystem sustainable.

This, of course, does not mean that policies that target specific geographic areas (for example, neighborhoods or districts) cannot be effective. However, if the objective of such policies is to support the technology innovation ecosystem, their target should be the features of the ecosystem's social dimension. Geographically targeted policies should only complement this broader objective.

SECTION 4

NEXT STEPS AND FUTURE WORK

The findings presented in this working paper are the outcome of the beginning of a larger research. Some of the findings are based on initial analysis and need further work, largely because of limited data and because research was mainly restricted to New York City.

For future research, the sources of data will need to be expanded, additional cities will need to be researched (including those in both developed and developing countries), and the analysis of networking assets will need to include the remaining assets that could not be covered in the initial phase. This research will need to be carried out with research and city partners (see Appendix B).

The scope of future research can be expanded to investigate issues such as:

- how technology innovation ecosystems impact employment and economic growth, with a particular focus on generation of new sources of jobs in both developed and developing country cities, and
- how city governments can build effective policies to support the growth and sustainability of urban technology ecosystems.

The first topic will provide insights into the potential for employability and growth in the current environment of economic transformation where traditional sources of employment are

changing. Existing policies and their impact on ecosystem's growth and sustainability will be analyzed as well as the results in producing employability.

Additional resources and partnerships will be required in order to undertake some of this additional research. The next steps and future work that the research team envisions undertaking is described below.

Further research on the role of networking assets

The team will plan to continue its research on networking assets and their role and impact on the growth and sustainability of urban technology innovation ecosystems. The team will need to access more data sources (including enriched data from survey and interviews and social network data) and will need to work in more cities as it conducts data gathering with its city partners (see below). The team will then explore the role of community building networking assets (for example, events to kickstart and sustain communities, collaboration spaces and mentors of networks) and analyze impacts over time.

Expanding scope to more cities and refining the diagnosis tool

The scope of research will need to be expanded to include more cities. This includes working with partner cities

to collect data through a common methodology agreed with the research partners. For the data collection process, cities will be prioritized based on those in the Working Group that have shown interest in participating in this process. The list of city members of the Working Group is shown in Appendix B.

Impact of technology innovation ecosystems on employment and economic growth

Research on the impact of urban technology innovation ecosystems on employment and economic growth will be expanded. This will include exploring the relationship between ecosystems and the creation of new jobs, the role of the ecosystem as an ad hoc skills training program, and the impact of networking assets and rapid technical training programs on employability, with a particular focus on the poor and uneducated population. It will also explore the impact of the ecosystem on economic growth and economic transformation within cities, and in poverty reduction. Research will be focused on developing country cities to explore the potential of these ecosystems for providing additional sources of inclusive growth.

Compilation of policies and analysis of impact

The team will also work with its

city partners to compile and analyze policies applied to support urban technology innovation ecosystems. This compilation will provide additional

resources for policymakers to understand approaches to: (i) support the growth and sustainability of urban technology innovation ecosystems, and (ii)

increase the impact of the ecosystem for employment and growth. Case studies to highlight best practice will be provided.

APPENDIX A

LIST OF INTERVIEWEES

Name	Organization	Role
<i>Government</i>		
Dmytro Pokhylko	NYC Economic Development Corporation	Director in The Center for Economic Transformation and the head of the Media & Tech team
Will Colegrove	Manhattan Borough President's Office	Director of Budget & Transparency
Rachel Haot	Chief Digital Officer and Deputy Secretary for Technology	State of New York
Stacy Gardener	Council Member James Vacca	Legislative Director
Gianluca Galletto	NYC Economic Development Corporation	Director of International Affairs
Kara Chesal	iZone/NYC Department of Education	Program Manager
Monica Abend	Office of Council Member Laurie Cumbo	Deputy Chief of Staff
<i>Collaboration Spaces</i>		
Mykim Dang	Krash	Director of Marketing
Matthew Champines	WeWork	VP of Business Development and Marketing
Tarek Pertew	Uncubed	Cofounder and CCO
Niamh Hughes	Shutterstock	Tech Communications Manager
Jukay Jsu	Coalition for Queens	Founder
KJ Singh	Techstars NYC	Director
<i>Entrepreneurs</i>		
Courtney Boyd Myers	audience.io	Founder
David Rose	Gust	Founder and Chief Executive Officer
Noel Hidalgo	BetaNYC	Cofounder
Kane Sarhan	Enstitute	Founder
<i>Meetups</i>		
Jessica Lawrence	NYC Tech Meetup	Executive Director
Kristin Hodgson	Meetup.com	Communications Director
<i>Other</i>		
Andrea Coleman	Bloomberg Philanthropies	Government Innovation
Malina Tran	Coalition for Queens	Director of Community and Partnerships

APPENDIX B

PARTNER PROFILES

RESEARCH PARTNERS

Computation Institute, Harris School of Public Policy, University of Chicago

The Computation Institute (CI) was established in 2000 as a joint initiative between The University of Chicago and Argonne National Laboratory to advance science through innovative computational approaches. Scholarship in the sciences, arts, and medicine depends increasingly on collection and analysis of large quantities of data and detailed numerical simulations of complex phenomena. Progress is gated by researchers' ability to construct complex software systems, to harness large-scale computing, and to federate distributed resources. The CI is both an intellectual nexus and resource center for those building and applying such computational platforms for science. As an intellectual nexus, it brings together researchers from different disciplines with common interests in advancing the state-of-the-art in computing and its applications. As a resource center, it provides expert assistance to scholars whose work requires the most advanced computational methods.¹

Endeavor Insight

Endeavor Insight is the research arm of Endeavor, which seeks to deepen understanding of how high-impact entrepreneurs contribute to job creation and long-term economic growth in order to educate key constituencies, such as policy makers. Endeavor Insight seeks to serve as a knowledge center for high-impact entrepreneurs, VCs and others in order to provide useful information and tools that assist high-impact entrepreneurs as they grow their business.²

Global Entrepreneurship Research Network (GERN)

"A collaboration of research organizations around the world whose goals are to generate useful and actionable knowledge for entrepreneurs, policymakers, and others; fill gaps in what we know about entrepreneurship; standardize data, especially longitudinal survey work; conduct experiments and evaluation of entrepreneurship education and training programs; and, gain a better understanding of policy barriers and what the right policies are for fostering entrepreneurship. The organizations participating in this network commit to collecting and sharing research results so they are accessible, usable, and open. Key founding partners, along with Kauffman, are Endeavor Insight and the World Bank."³

MaRS Innovation and NESTA are also participating in similar research on urban innovation ecosystems as part of GERN.⁴

CITY PARTNERS

City partners include agencies and departments from local city governments as well as innovation hubs and collaboration spaces. The list of city partners includes the members of the Working Group on urban innovation ecosystems from the Community of Practice of Open Innovation in Cities. In addition, a ministry and a national agency also participate. The list of city partners is as follows:

City entities

Entity	City	Country
Economic Affairs Department, CTO Office	Amsterdam	Netherlands
Economic Promotion Department	Barcelona	Spain
Fukuoka Directive Council	Fukuoka	Japan
Forum Virium	Helsinki	Finland
iHub	Nairobi	Kenya
Ruta N	Medellín	Colombia
Laboratorio para la Ciudad	Mexico City	Mexico
New York City Economic Development Corporation (NYCEDC)	New York	United States

National entities

Entity	Country
Enterprise team, Ministry of Economy	Lebanon
National IT Promotion Agency (NIPA)	Republic of Korea

APPENDIX C

WORLD BANK OPERATIONS AND ACTIVITIES

Innovation ecosystem-related projects the team has been working with include, but are not limited to:

LEBANON MOBILE INTERNET ECOSYSTEM PROJECT (MIEP)

MIEP's objective is to strengthen technology-led innovation ecosystem and foster entrepreneurship and employability in Lebanon. The project focus is to grow and sustain the ecosystem community, expand technical and entrepreneurial skills and to expand the technology ecosystem throughout the economic sectors in Lebanon.

The project is a 4-year program with a budget of USD 12.8 MM with four main activities:

- 1. Skills training for youth and entrepreneurs.** The activity will develop a series of crowdsourcing competitions, which will include intense hand-on training (for example, bootcamp style) with a light acceleration phase. The result of this competition will be a series of startup projects (that is, minimum viable prototype beta tested, a business plan and a pitch). The competitions will also include an international mentorship program and exchange to connect the Lebanese ecosystem to others. In addition, this activity will create a university-industry platform for industry project training and a series of technology skills activities for schools. The university-industry platform will provide final-year students to team up with industry to solve real challenges from companies through a start-up or product projects in a 6-month timeframe.
- 2. Growth and sustainability of the tech-innovation community.** The activity will develop network of mentors, links among entrepreneurs and networking events (for example, meetups) to support existing community. The activity will also complement existing collaboration spaces and provide technology tools (for example, maker space), labs (for example, living labs), and a space for community networking. This space will be managed by an innovation hub (the Mobile Innovation Hub, MiHub), which will serve to coordinate the community and the community-building activities. The MiHub will also take the role of promoting the community and its exemplary members.
- 3. Innovation for legacy industry and other sector of the economy.** The activity will develop a series of hands-on workshops and activities between technology startups and entrepreneurs, and legacy industries that have not integrated widely technology in their production processes. This activity will also develop exchange activities with experts from other innovation ecosystems globally. This project is supported by a Trust Fund of the Korean-World Bank partnership.⁵

SMART CITY GRAN CONCEPCION

Smart City Gran Concepción activity objectives are: (i) to introduce open innovation in municipal government, (ii) to use the government as a platform to kickstart the local technology innovation ecosystem, and (iii) create the mechanisms to develop a sustainable technology innovation ecosystem to solve city challenges and create entrepreneurship and employability.

The activity focused on the transport sector and follows four consecutive components that result in the above-mentioned goals:

- 1. Hands-on skills training on open innovation methodologies to city officials.**

2. Cocreation of a vision for technology support for urban transport with the city ecosystem (for example, government, academia, private sector, civil society, technology hubs, citizens).
3. Challenge competition of city challenges to kickstart the technology innovation ecosystem and develop solutions to city problems.
4. Cocreation of local innovation hub with the stakeholders of the city ecosystem (for example, government, academia, private sector, civil society, technology hubs, citizens).

This activity was funded by the Spanish Trust Fund for Latin America and the Caribbean.⁶

COLOMBIA OPEN INNOVATION FOR MUNICIPAL SERVICES

The objectives of this activity are to promote local government transparency, efficiency and e-services delivery to improve public service delivery and ultimately the quality of life of the population. To achieve this goal, the activity introduced open innovation in three cities in Colombia: Barranquilla, Cali and Manizales.

The activity worked in the sectors that each city selected and followed a sequential approach comprised of the following components:

1. Cocreation of e-services (for example, mobile apps) with city officials and rapid prototyping.
2. Cocreation of a roadmap for technology support to city services and eliminating departmental silos.
3. Challenge competition of city challenges as mechanism of open innovation for municipal governments and development of local entrepreneurship.
4. Development of strategic plan with local ecosystem stakeholders (for example, government, academia, private sector, civil society, technology hubs, citizens) to support government's open innovation and development of local entrepreneurship.

This activity was funded by the Information Communications Technologies (ICT) Korean Trust Fund.

GLOBAL: BARCELONA URBAN TECHNOLOGY AND INNOVATION HUB

The objectives of this activity is the co-creation of new knowledge and the dissemination of good practices on urban technology and innovation that the city of Barcelona and its partners have developed over the years. The main areas of focus relates to bottom-up innovation and how city government can engage with the city ecosystem to develop innovation and entrepreneurship that addresses urban challenges. The activity organizes Citisense (an annual event on bottom-up approaches to urban innovation) together with Smart City Expo World Congress, and the City as a Laboratory training course (a practical program for policy-makers to introduce open innovation in city government) and develops common research on urban innovation and entrepreneurship.

THE CITIES WHERE WE HAVE CONDUCTED THESE ACTIVITIES ARE THE FOLLOWING:

City	Population (million)
Barranquilla, Colombia	1.11
Beirut, Lebanon	2.02
Cali, Colombia	2.04
Gran Concepcion, Chile	1.01
Manizales, Colombia	0.36

SOURCES

UN Data (2005 for Colombia and 2007 for Beirut), National Institute of Statistics of Chile (2002), Manizales City Hall (2012)

APPENDIX D

OPEN INNOVATION IN CITIES COMMUNITY OF PRACTICE



BACKGROUND

Cities everywhere face a growing influx of people and subsequent demand for public services. Investing in digitalization and civic innovation can reduce service development costs, account for user needs in solutions and eventually lead to a more affordable delivery and accountable management of resources. Administrators want to learn from each other but participatory approaches applied in digital service design often still reside as a tacit know-how in the heads of few committed practitioners. This initiative will bring practitioners together to identify, analyze and codify good practices applied in participatory design of ICT enabled services/policies in global cities and to share it with peers where mostly needed.

OBJECTIVE

The Community of Practice (CoP) provides a vehicle to network lead practitioners in different cities and a platform to engage them to work together on promoting open innovation for cities. The CoP will develop an open repository of good practices and host a calendar of thematically related events targeted to share knowledge and lessons learned among cities.

ACTIVITIES

The CoP is an informal group for practitioners and based on projects of common interest focused on learning and new business development. Activities can be discussions, blogging and presentation of members' knowledge, but also more formal projects that link members to joint work. Projects can be proposed by the members and executed within the CoP or outside of its domain depending on members' interest. Members can propose new projects executed within the CoP. These should have a leader and initial work plan. If there is enough support amongst the members, projects are to be defined and started with the working group led by a thematic leader.

WORKING GROUPS

The proposed Working Groups (WG) are the following:

- WG 1: Mapping and diagnosis of urban tech innovation ecosystems
- WG2: Compilation and impact of policies for open innovation
- WG3: Compilation and common solving mechanisms of challenges that cities face
- WG4: Curation and knowledge sharing of cases studies and best practices for open innovation tools in cities

MEMBERSHIP

The CoP starts initially with a closed membership to prepare the initial work and deliverables. The secretariat of the CoP is hosted by the World Bank who will prepare a draft work plan including a proposal for gradual expansion and intake of new members to the CoP. The work plan is to be approved by initial members.

Initial members include the following:

City entities

Entity	City	Country
Economic Affairs Department, CTO Office	Amsterdam	Netherlands
Waag Society	Amsterdam	Netherlands
Economic Promotion Department	Barcelona	Spain
Fukuoka Directive Council	Fukuoka	Japan
Forum Virium	Helsinki	Finland
iHub	Nairobi	Kenya
Ruta N	Medellín	Colombia
Laboratorio para la Ciudad	Mexico City	Mexico
New York City Economic Development Corporation (NYCEDC)	New York	United States
Numa	Paris	France
CTO Office	Santander	Spain
Metropolitan Region Government	Santiago	Chile

National entities

Entity	Country
Enterprise team, Ministry of Economy	Lebanon
Ministry of Education and Sports	Uganda
National IT Promotion Agency (NIPA)	Republic of Korea

APPENDIX E

COLLABORATION SPACES

Collaboration space	Description	Examples
Coworking spaces	<p>Coworking spaces are open spaces that usually provide broadband connectivity, a few other amenities e.g., a cafeteria and a space for work. Typically coworking spaces tend to be an open floor with shared desks for members, though some offer close-door offices. The main three characteristics of coworking spaces are to offer interaction with other people, flexible working hours, and an environment for serendipity discoveries. Coworking spaces have multiple models, where some are owned by companies and no external members are allowed (usually aligned with corporate's open innovation strategy), others are independently operated and open to the public (some of which create communities of interest), and some are publicly owned e.g., city governments. Many coworking spaces have evolved into tech-innovation community management centers also providing links with, or including in the same space, networks of mentors, skills training courses, accelerators, and incubators.</p>	<p>WeWork, New York https://www.wework.com</p> <p>Impact Hub, London and other locations http://www.impacthub.net/</p> <p>Alt City, Beirut http://www.altcity.me/</p>
Accelerators	<p>Accelerator programs, or accelerators, can be virtual, but most of them are attached to a physical space, where a cohort of start-ups work together to develop their projects for a limited period of time. Accelerators can be part of a broader a coworking space or incubator or a space on its own. Accelerators support entrepreneurs and start-ups in early stages of development and they are often comprised of the following features: (i) a highly competitive and open application process for entrepreneurs, (ii) provision of small amounts of seed investment, (iii) focus on small teams rather than individual founders, (iv) intensive support for a limited period of time (usually 3-6 months), with active mentorship and networking, and (v) collaborative work among start-ups through cohort or classes of start-ups.</p>	<p>Tech Stars, Boulder, New York, and other locations http://www.techstars.com/</p> <p>Seedcamp, London and other locations http://seedcamp.com/</p>
Maker spaces	<p>Maker spaces are community centers or coworking spaces, typically independently owned, that provide access to a series of tools and light equipment for fabrication, most significantly 3D printers and open source hardware board toolkits and technology e.g., Arduino boards.⁷ Maker spaces can be more sophisticated, offering more advanced tools and materials for textiles, or metal- and wood-working. Some of these spaces also provide mentors and a community of interest around the "makers movement" or DIY (Do-It-Yourself) fabrication and prototyping.</p>	<p>Santiago Maker Space, Santiago de Chile http://www.stgomakerspace.com/</p> <p>Maker Space, Madrid http://makespacemadrid.org/</p> <p>GearBox, Nairobi http://gearbox.co.ke/</p>

Collaboration space	Description	Examples
Fablabs	Fablabs are similar to maker spaces, though they have standard requirements including a minimum set of tools for fabrication and an accreditation program for fablabs managers. ⁸ Fablabs are small-scale workshops that were originally designed as prototyping platforms for local entrepreneurship, but have expanded to universities and higher education facilities to provide complimentary hands-on training. Fablabs are part of the Fablab program from the Massachusetts Institute of Technology (MIT). Fablabs have to subscribe to the Fablab charter and have to offer public access to its facilities. The FabLab program has a Fablab Academy to train and accredit Fablab managers and a network of collaboration (global FabLab Network). ⁹	Fab Lab Barcelona http://www.fablabbcn.org/ Fab Lab Lisboa http://fablablisboa.pt/ Fab Lab South Africa http://www.fablab.co.za/
Techshop	Techshop is an example of a sustainable business model of the concept of fablab and maker space, where access to the fabrication equipment and mentorship is offered for a fee. ¹⁰ Techshop has developed partnerships with universities, such as Arizona State University, or companies, such as Ford Motor Company, to develop ad hoc facilities for internal R&D. ¹¹	Techshop, multiple locations http://www.techshop.ws/
Living Labs	Living labs are environments where the user-centric design methodology is applied to test with user prototypes developed by entrepreneurs, companies, universities, or the public in general. The basic principle of the living lab is to form collaboration environments among different actors and help developing products through interactive user-centric design. Living labs have flexible approaches and have been applied for academic purposes in universities and/or city governments to form local communities of innovation, companies to develop products, etc. Although there are no specific requirements, the common minimum elements of a living lab are: (i) a methodology for product development through user-centric design, (ii) space, (iii) a community of users, and (iv) a vacillator/management structure. There is an international network of living labs, which originated in the European Union and it is managed by the ENoLL council. ¹² Some of these living labs have evolved, similar to coworking spaces, into tech-innovation community management centers, becoming innovation hubs (see below) and coordinating the local ecosystem and providing links among actors e.g., Citilab, and also providing links with or including in the same space, networks of mentors, skills training courses, accelerators, and incubators.	Waag Society, Amsterdam https://waag.org/en Citilab, Barcelona http://citilab.eu/en Living Lab Maputo http://www.micti.co.mz/micti/index.php
Urban Labs	Urban labs is a concept that has been implemented by some cities e.g., Barcelona, to provide companies a platform to test products and services in the real environment within the city. ¹³ The city can provide a specific area for testing e.g., a testing district, or allow companies to request real-life testing environments. The selection of companies to test their products and services usually follows an open call procedure and the testing of products last for a limited period of time.	Urban Lab, Barcelona http://www.22barcelona.com/content/view/698/897/ New Urban Mechanics, Boston http://www.newurbanmechanics.org/boston/
Industry Innovation Labs	Industry Innovation Labs provide a platform connecting industries with other stakeholders of the ecosystem, particularly entrepreneurs and universities, to create open innovation and commons environments for existing industries and business to absorb innovation in their processes and business models. ¹⁴ Innovation labs include living lab concepts of rapid prototyping and iteration, and are similar to innovation hubs in providing a platform coordinating a community of diverse stakeholders.	U+I Labs, Chicago http://www.uilabs.org/

Collaboration space	Description	Examples
Innovation Hub	<p>Although there is no common definition of an innovation hub, this concept can be applied to define the evolution of collaboration spaces into community managers that coordinate or integrate many of the other functions of collaboration spaces defined above, including coworking, maker spaces, fab-labs, accelerators, living labs, and urban labs. Innovation hubs' main function is to coordinate all actors or the ecosystem and help manage the community of tech-innovators and entrepreneurs to be sustainable and continue to grow. Many of these innovation hubs have participation of the most relevant actors of the technology innovation ecosystem, including entrepreneurs, universities, private sector, collaboration spaces, accelerators, incubators, and other providers of seed capital, community managers, and government, particularly city government. Some of these innovation hubs have collaboration spaces in their facilities, such as coworking and maker spaces, while others coordinate their functions with those spaces. Typically, these hubs will phase out their other functions when there are enough offerings for the community provided by third parties.</p> <p>For a detailed description of how this concept of innovation hub can be applied to develop and strengthen a technology-led innovation ecosystem, see description of the Lebanon Mobile Innovation Ecosystem Project at www.mie-p.org.</p>	<p>Factory, Berlin http://www.factoryberlin.com/</p> <p>NUMA, Paris http://en.numa.paris/</p> <p>Forum Virium, Helsinki http://www.forumvirium.fi/en</p> <p>Ruta N, Medellin http://rutanmedellin.org/</p> <p>iHub, Nairobi http://www.impacthub.net/</p>

Source: Mulas, 2014

APPENDIX F

ANALYSIS OF GEOGRAPHIC AND SOCIAL DIMENSIONS OF ECOSYSTEM

Kathy Qian and Nga Phuong Nguyen are the main authors of this Appendix.

In order to measure the value of networking assets in urban innovation ecosystems, the impact of connections on ecosystem success outcomes must first be understood. Once the value of incremental connections can be quantified, individual networking assets can be ranked and valued by multiplying their success in creating new connections by the value of incremental connections.

Connections are defined as either social or geographic. While there are multiple metrics that can be used to define success, in this analysis the raising of a round of funding is considered as a successful outcome for startups and by extension the ecosystem as a whole.

As such, this analysis focuses on examining the interplay between the geographic, social, and funding dynamics within New York City's (NYC) urban innovation ecosystem. The research questions explored and findings were as follows:

- 1. Where is the geographic center of NYC's urban innovation ecosystem?** The geographic center of NYC's urban innovation ecosystem is located in Midtown Manhattan.
- 2. Which people or organizations are located at the social center of NYC's urban innovation ecosystem?** While startups have the highest closeness centrality and are at the center of the social network, incubators have the highest degree, eigenvector, and "betweenness" centralities and are key connectors within the ecosystem.
- 3. How do the geographic and social connectivity of startups influence their funding outcomes?** Social momentum matters. The faster a startup gains second-order connections to investors, the more likely they are to successfully fundraise. A significant impact of geographic centrality on funding outcomes was not found.
- 4. What is the relationship between geographic and social centrality?** While startups in the geographic center of the startup scene may be highly connected, their connections are not as socially diverse.

In summary, a relationship was found between social connections and funding outcomes within the NYC innovation ecosystem. Evidence was also found to support the hypothesis that networking assets are central to the urban innovation ecosystem.

DATA

The dataset is comprised of two dimensions: social and geographic. The social dataset includes connections between startups, investors, and incubators¹⁵ and was obtained from the raw data Endeavor Insight developed for its study *The Power of Entrepreneur Networks* (Endeavor Insight, 2014).¹⁶ The geographic data was obtained by gathering address data through Mechanical Turk and geocoding through an online geocoder.¹⁷

The urban innovation ecosystem is represented as a network of nodes and edges. Nodes are entities such as people and organizations, while edges connect nodes through their relationships. For example, a startup is a node. An investor is also a node. An investment is an edge that connects the startup and the investor.

It can be difficult to determine which nodes fall within the scope of each city's urban innovation ecosystem if one is focused solely on geography. What happens if a startup moves from one city to another? Or if a startup takes investment from a firm outside the

city? Fortunately, the primary interest of this research is in mapping the social dimensions of the urban innovation ecosystem, so the dataset is more flexible in incorporating nodes outside of NYC.

In order to define the scope of the data, the startups interviewed by Endeavor from 2013-2014 were first added as nodes. Next, the founders of these startups were added as additional nodes, and then their associated investors and incubators were added to the list of nodes. Finally, funded companies from which they sourced mentors, previously funded non-NYC startups, and former employers that have received funding were included as other nodes. The aim was to map the first and second-order network each startup can draw upon in order to reach investors.

BOX F.1

The differences between accelerators and incubators

Although the dataset and analysis does not differentiate between incubators and accelerators, there is a difference in their definitions:

Accelerators support entrepreneurs and start-ups in early stages of development and they are often comprised of the following features: (i) a highly competitive and open application process for entrepreneurs, (ii) provision of small amounts of seed investment, (iii) focus on small teams rather than individual founders, (iv) intensive support for a limited period of time (usually 3-6 months), with active mentorship and networking, and (v) collaborative work among startups through cohort or classes of start-ups.

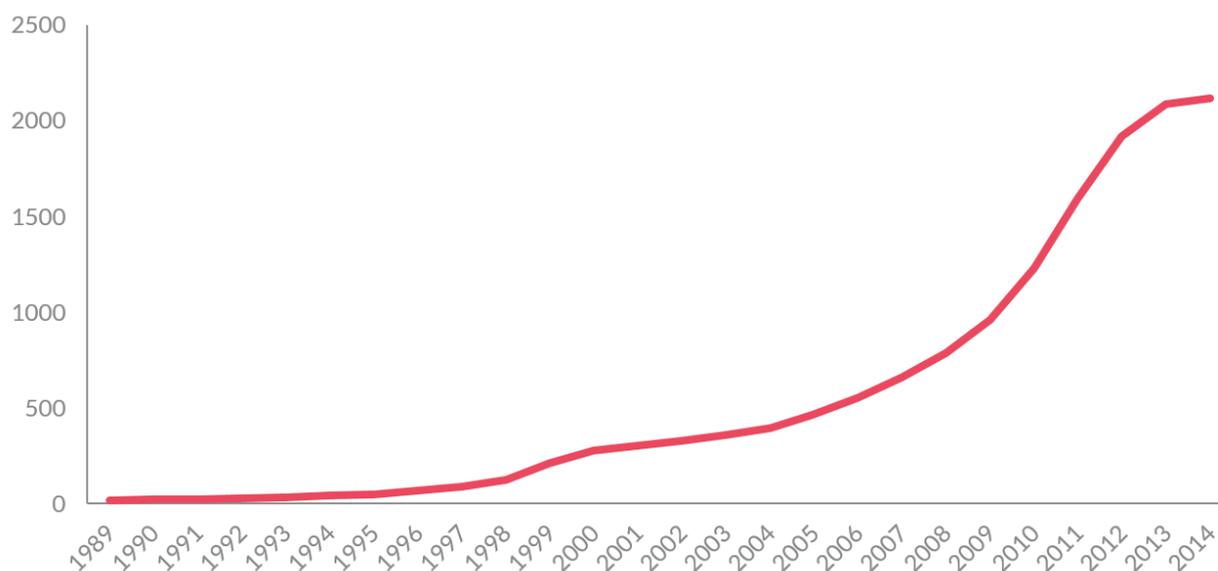
Incubators are spaces that support start-ups by providing an office space and administrative support services. The most typical services are legal, recruiting, IT, accounting, public relations and pooled buying programs. In addition, incubators may also provide coaching, mentorship and help with access to funding at an ad hoc basis. Startups pay rent (which is usually below market rent) for the office space and there is normally not a time limit set for startups staying in the incubator (average staying ranges widely from 18 months to 5 years). Some incubator providers may ask for a profit share in the future or require minority stake in the startup as prerequisite to access the incubator.

Nodes are never removed from the dataset, even if the represented entity no longer exists. In other words, once a startup appeared in the dataset, they were kept in the dataset for all subsequent years. There were two reasons for this decision. First, accurate end dates for startups were difficult to gather. Second, the primary interest was in mapping the social dimensions of the startup network, not creating a year-by-year catalogue of startups. Although startups may close, socially they still function as nodes within the urban innovation ecosystem that can introduce other nodes to second-order connections.

As seen in **Figure F.1**, in 2014, the latest year of data within our dataset, there were 2,119 startups in the ecosystem. Although our dataset is smaller than the Digital.NYC and CrunchBase datasets (the largest publicly available databases of startups in NYC), which include about 6700 and 7500 startups respectively, the survey-based sourcing of our dataset is more helpful in obtaining historical connection data. However it is important to note that, when it comes to historical data, our dataset also shows survivorship bias. As such, our dataset is most accurately described as a year-by-year mapping of how founders of startups that existed in 2013-2014 evolved within the ecosystem.

FIGURE F.1

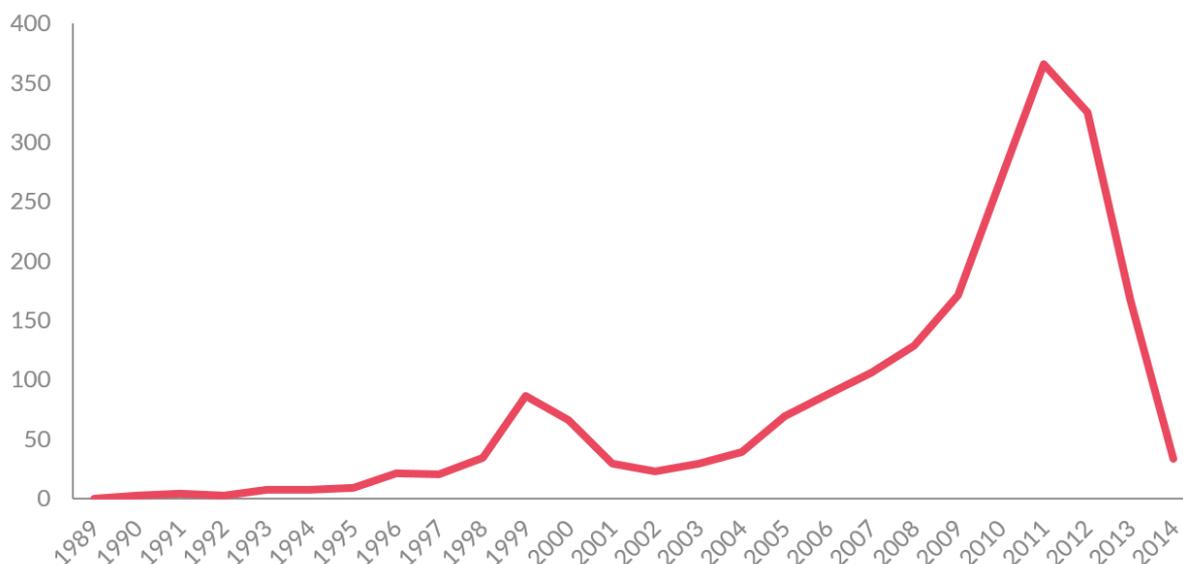
Cumulative number of startups per year



However, the fact that the dataset was sourced through surveys also introduces biases that we should be aware of. When interpreting the results within this paper, it is important to remember that our dataset comprises startups that have already “burst” onto the NYC startup scene. As such, these startups are more likely to have already existed for some time and are more likely to have already received funding.

This effect may be seen in **Figure F.2**, where the number of new startups in our dataset drops after 2012. Given the consistent growth in the number of new startups in every year leading up to 2012, it is unlikely that there was a sharp decline in the number of new startups. Rather, it is more likely that there was a systematic bias in how interview targets were gathered that caused newer startups to be underrepresented.

FIGURE F.2
Number of new startups per year



In addition to startups, our dataset also includes venture capital firms and incubators. The number of active NYC institutional investors is defined as institutional investors with locations in NYC who have made an investment within our dataset in that year or prior. Institutional investors include venture capital firms, banks, and investment arms of large corporations. The number of active NYC institutional investors jumped in 2000, grew steadily from 2000-2006, then grew more quickly from 2006 onward (**Figure F.3**). In addition to the NYC institutional investors, our dataset also includes institutional investors who have invested in at least one NYC startup but are located outside of NYC (**Figure F.4**).

FIGURE F.3
Number of active NYC institutional investors per year

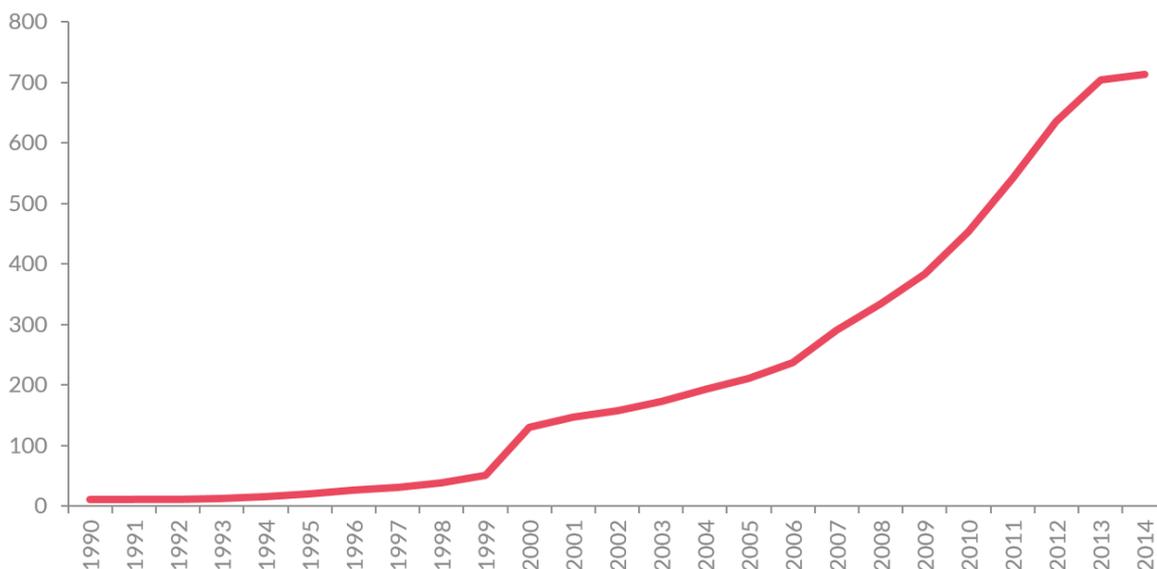
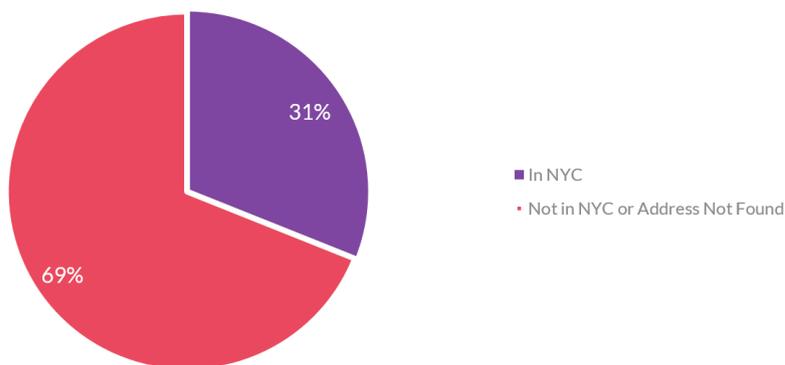


FIGURE F.4
Geographic location of institutional investors



The number of active NYC incubators is similarly defined as incubators with locations in NYC who have made an investment within our dataset in that year or prior. The number of active NYC incubators grew steadily from 1995-2009, then grew more quickly from 2009 onward (**Figure F.5**). In addition to the NYC incubators, our dataset also includes incubators who have invested in at least one NYC startup but are located outside of NYC (**Figure F.6**).

FIGURE F.5
Number of active NYC incubators per year

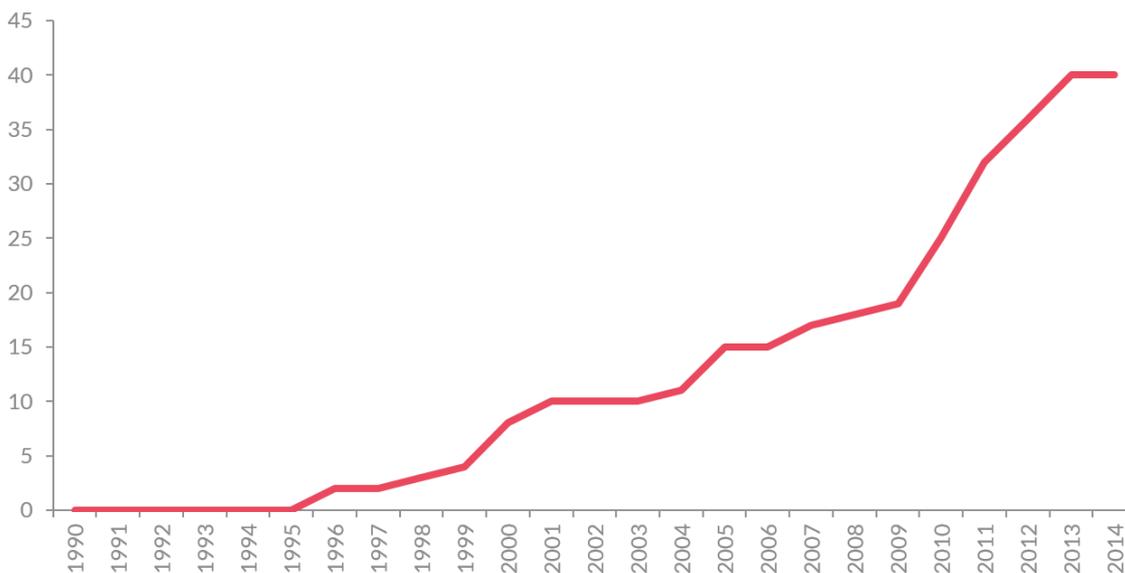
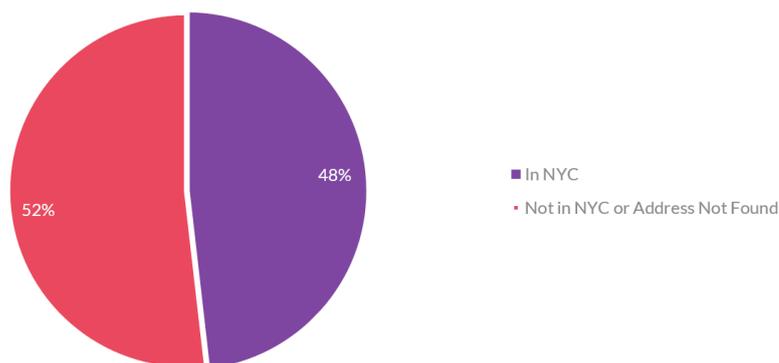
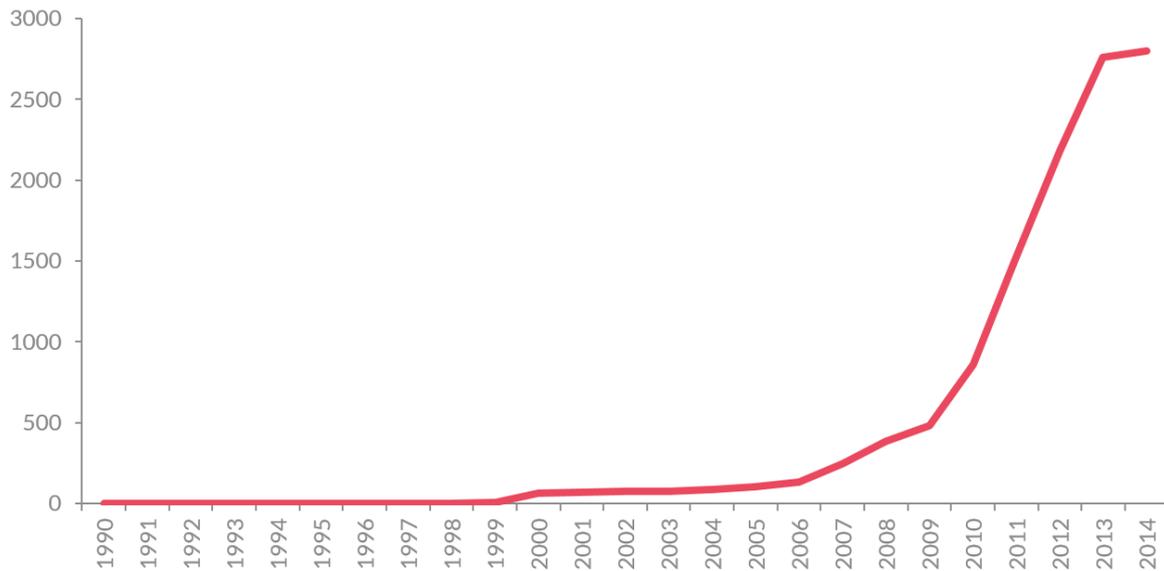


FIGURE F.6
Geographic location of incubators



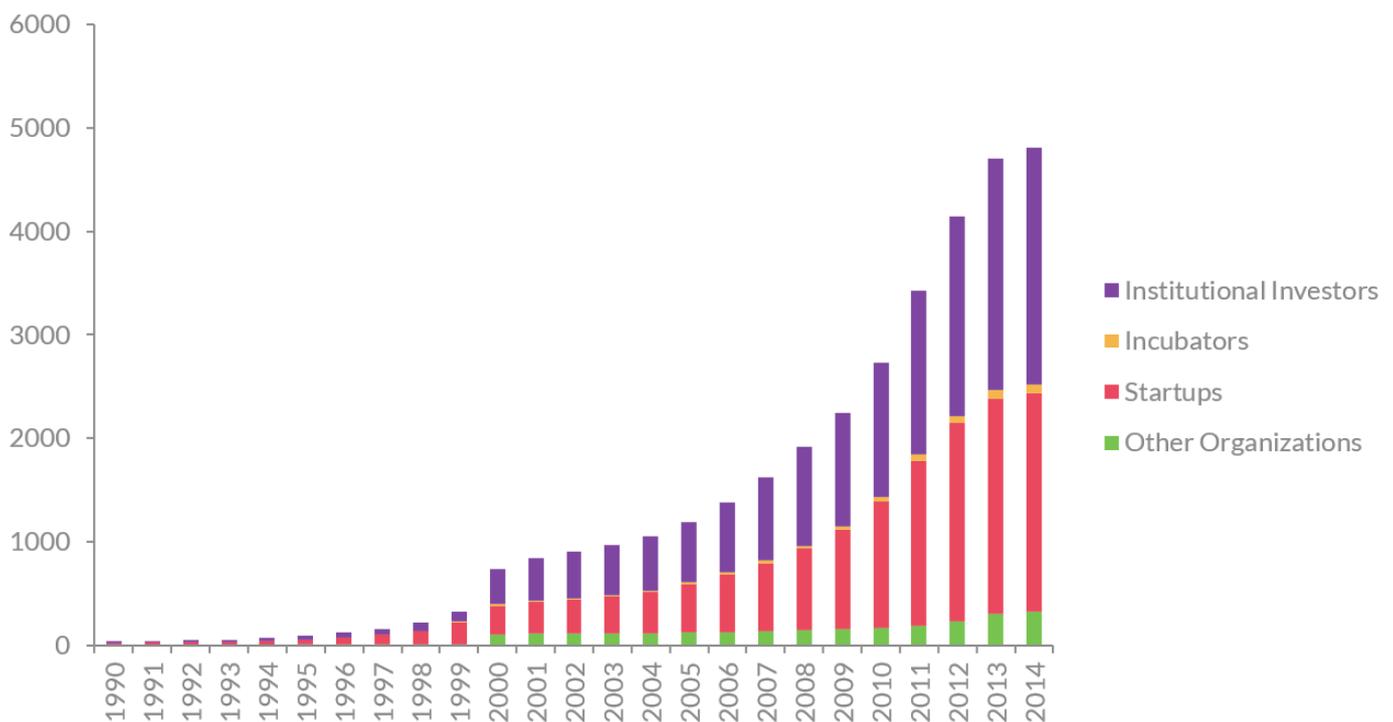
Our dataset also includes the number of active individual investors each year. Individual investors are commonly known as “angel investors.” Unlike institutional investors and incubators, location data for individual investors was not available, so we do not differentiate between individual investors located in NYC and those who do not. The number of individual investors in our dataset also rises rapidly beginning in 2009 (Figure F.7).

FIGURE F.7
Number of active individual investors per year



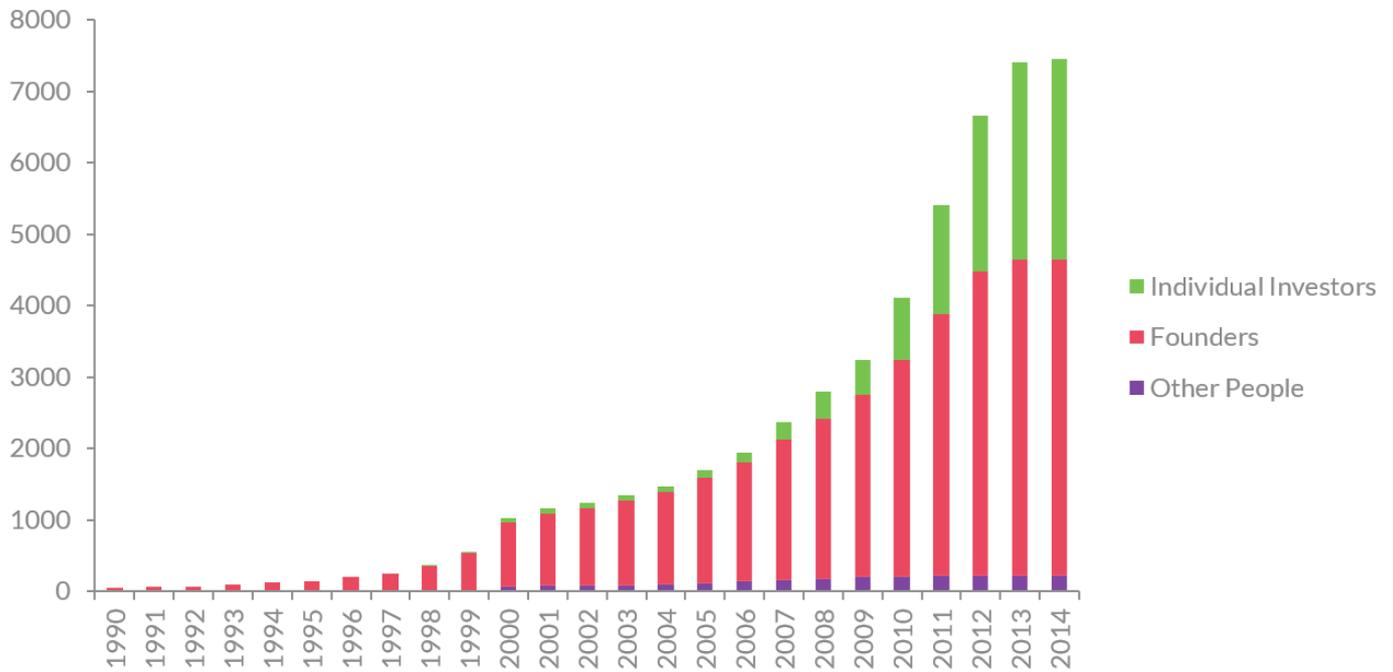
In addition to startups and investors, our dataset also includes a few other organizations (Figure F.8). These are the funded companies from which startups have sourced mentors,¹⁸ previously funded non-NYC startups of founders, and former employers of founders that have received funding. These nodes exist to allow second-order connections to investors within the dataset to be measured.

FIGURE F.8
Roles of active organizations by year



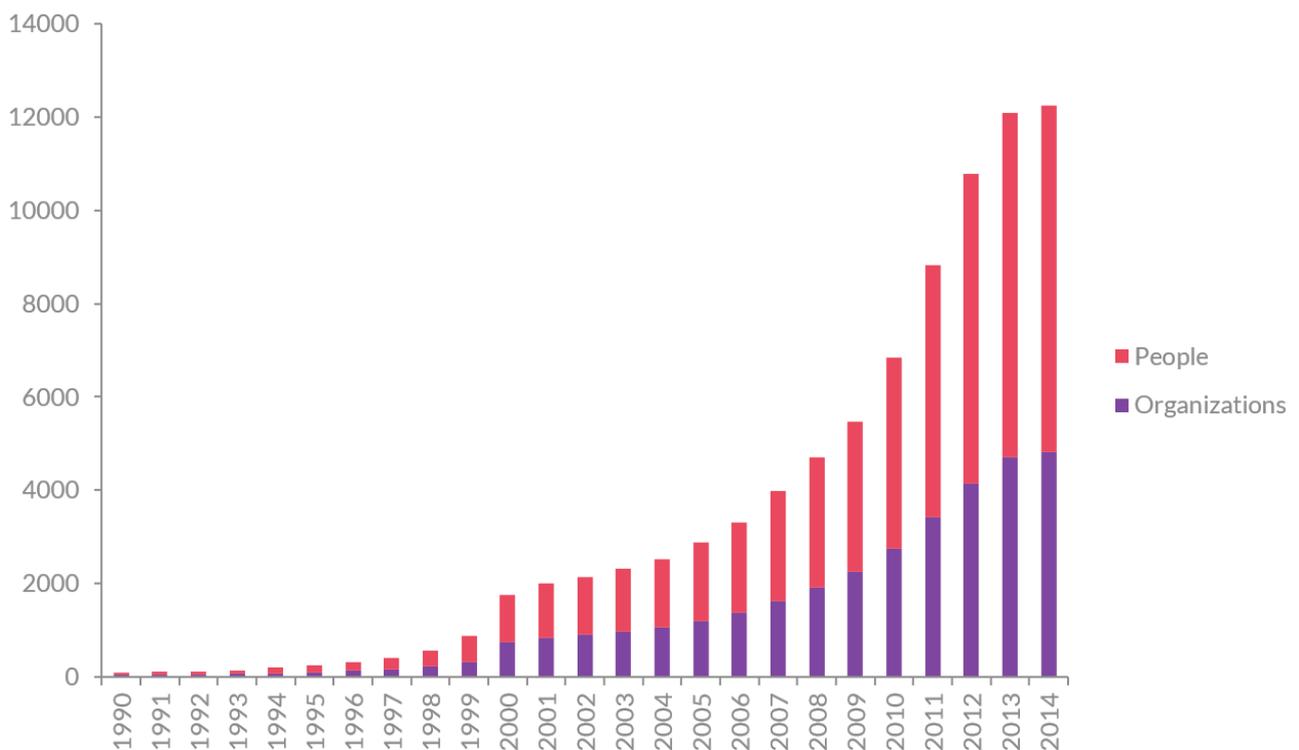
In addition to individual investors and founders, our dataset includes a few other individuals who were key employees at funded startups but not founders (**Figure F.9**).

FIGURE F.9
Roles of active people by year



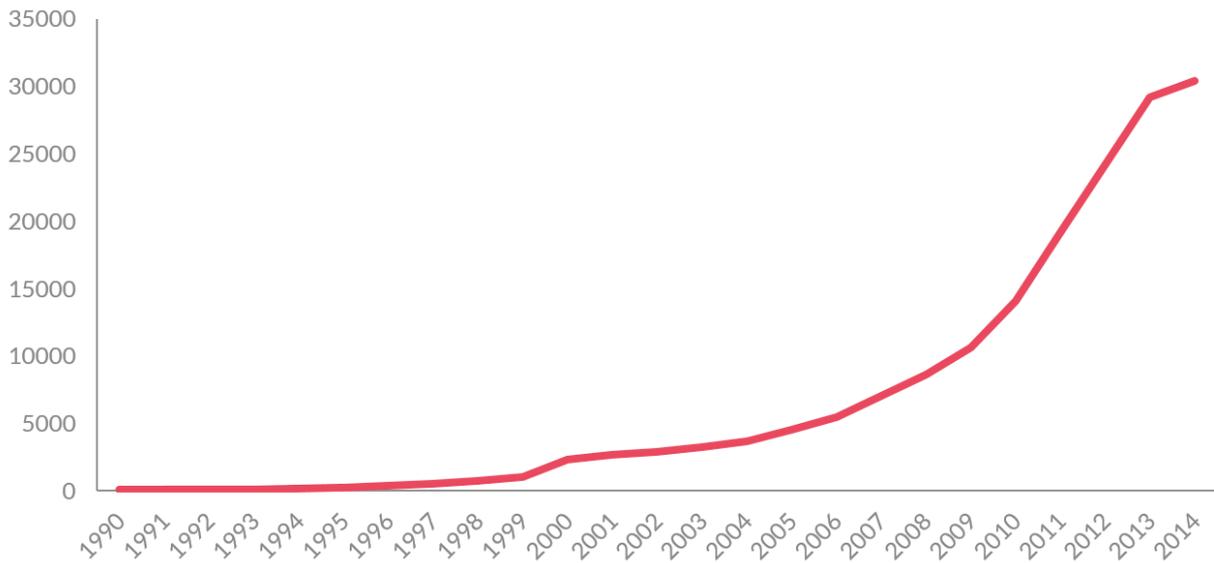
Our dataset comprises both individuals and organizations (**Figure F.10**). Technically, the network is bipartite. However, given that individual investors can function similarly to institutional investors and founders of small startups are practically synonymous with their companies, the network is treated as if it only contains one type of entity.

FIGURE F.10
Types of active nodes by year



There are a total of 30,440 total edges, or connections between the nodes (**Figure F.11**).

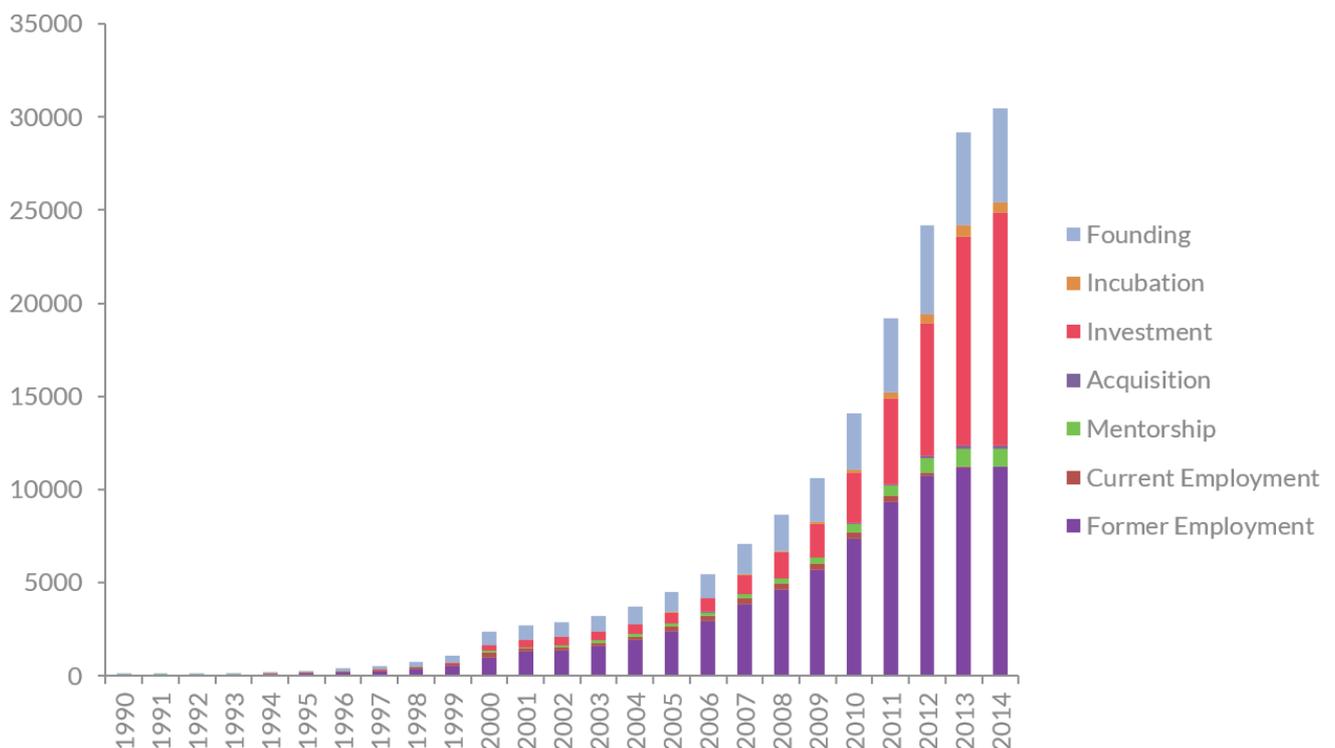
FIGURE F.11
Number of edges by year



These edges include all founding events,¹⁹ funding events, exits, mentorship, and employment relationships (**Figure F.12**). It is important to remember that edges represent distinct events—if an investor invests in a startup twice, there would be two edges between the startup and the investor.

The vast majority of employment relationships observed in our dataset are the prior employment relationships of current startup founders. As such, the number of “current employment” edges is nonexistent in the most recent years.

FIGURE F.12
Types of edges by year



By looking at 2014 data, a quick summary of the types of connections seen in the dataset were generated (**Table F.1**).²⁰ On average, each founder founded 1.12 companies, each startup received 5.90 investments, each incubator incubated 7.25 startups, each institutional investor made 2.76 investments, and each individual investor made 1.65 investments.

TABLE F.1
Average edges by role (2014)

Average Number of Companies Founded (per Founder)	1.12
Average Number of Investments Received (per Startup)	5.90
Average Number of Companies Incubated (per Incubator)	7.25
Average Number of Investments Made (per Institutional Investor)	2.76
Average Number of Investments Made (per Individual Investor)	1.65

TOOLS

A variety of tools were used for the analysis.

Data was munged and cleaned using SQL and stored in a MySQL database. The graph data was then transformed into a Neo4j database. Neo4j allows us to store and search a directed graph database that captures the labels and properties of nodes and edges. It also allows for easy querying and visualization of subsets of the graph.

Data was exported from the Neo4j database and imported into Gephi in order to quickly calculate network statistics such as centrality and degree. These values were then imported into Stata to be summarized and regressed.

Maps were created using Tableau. Charts were created in conjunction with pivot tables in Excel.

RESULTS

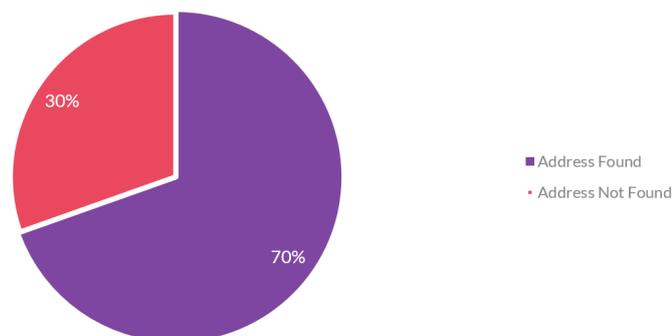
Our results are fourfold. First, the geographic dimension of the NYC urban innovation ecosystem was mapped and then the social dimension was mapped. Then, the interplay between the geographic dynamic, the social dynamic, and the funding dynamic within the ecosystem was examined. Finally, the interplay between the geography and social dynamic was explored.

Geographic Network

Research question #1: Where is the geographic center of NYC’s urban innovation ecosystem?

It was possible to map the current locations of 70 percent of the NYC startups within our dataset (**Figure F.13**).

FIGURE F.13
Geocode coverage of NYC startups



Most startups and investors were located in Manhattan (**Figure F.14**). However, startups were more likely than investors to be located in the lower Eastern part of the island, as well as in Brooklyn. The majority of startups are clustered in the top 10 neighborhoods (**Table F.2**).²¹

FIGURE F.14
Map of nodes

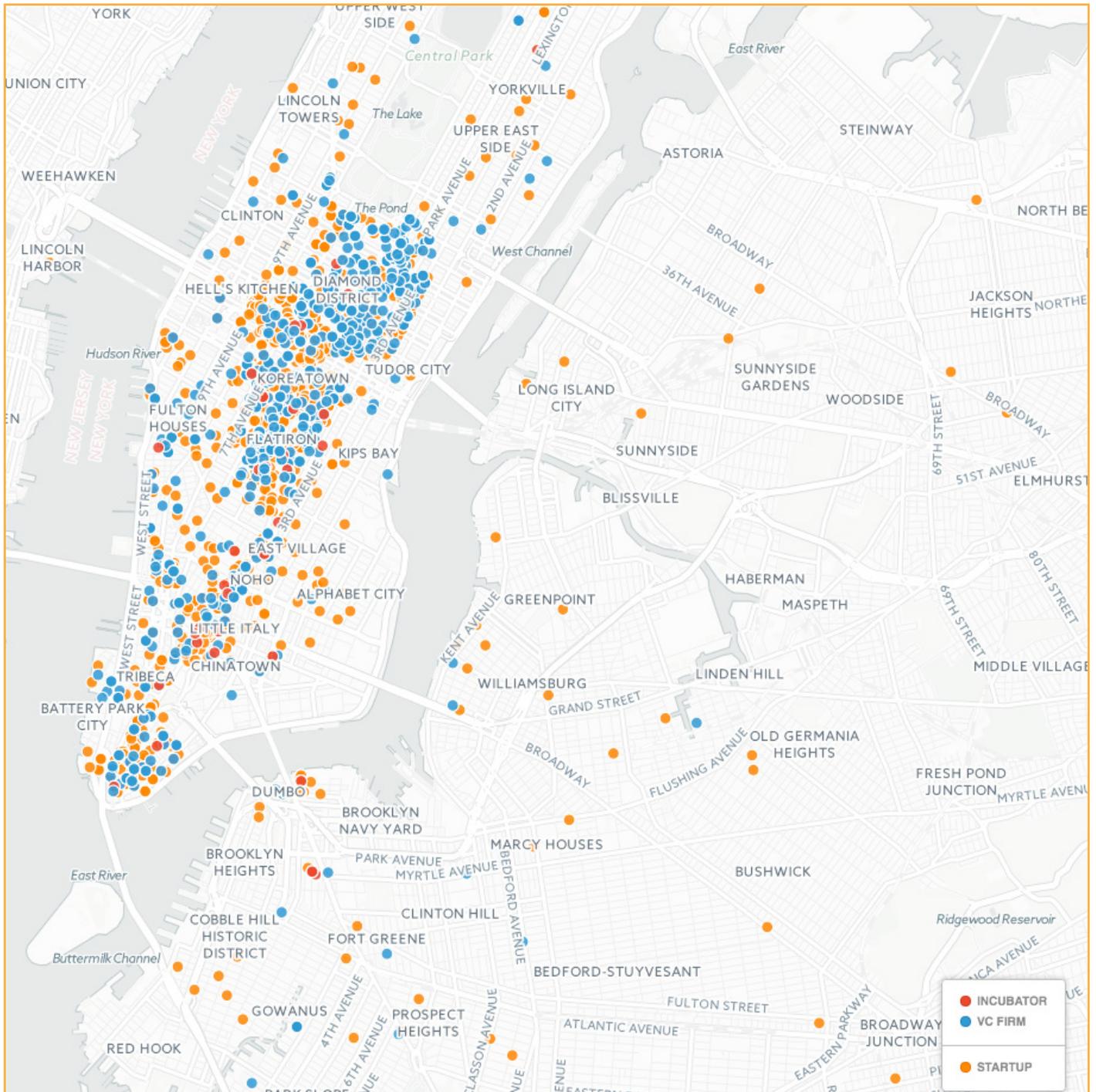


TABLE F.2
Top 10 most popular neighborhoods (2014)

<i>Neighborhood</i>	<i># of Startups</i>	<i># of Investors</i>	<i># of Incubators</i>
Midtown-Midtown South	380	212	8
Hudson Yards-Chelsea-Flatiron-Union Square	316	134	6
SoHo-TriBeCa-Civic Center-Little Italy	212	76	8
Battery Park City-Lower Manhattan	109	47	2
West Village	106	44	5
Murray Hill-Kips Bay	67	38	1
Turtle Bay-East Midtown	42	54	0
Gramercy	35	15	1
DUMBO-Vinegar Hill-Downtown Brooklyn-Boerum Hill	32	5	4
Hell's Kitchen	28	5	0

Research finding #1: The geographic center of NYC’s urban innovation ecosystem is located in Midtown Manhattan.

Social Network

Research question #2: Which people or organizations are located at the social center of NYC’s urban innovation ecosystem?

An analysis of network statistics indicates that the network is becoming more interconnected over time. Nodes have more direct edges over time (**Figure F.15**), and the average diameter and average path length decrease steadily post dot-com bust (**Figure F.16**, **Figure F.17**).²² This may mean that players within the urban innovation ecosystem are more likely to know each other over

FIGURE F.15
Average degree by year (for nodes with connections)

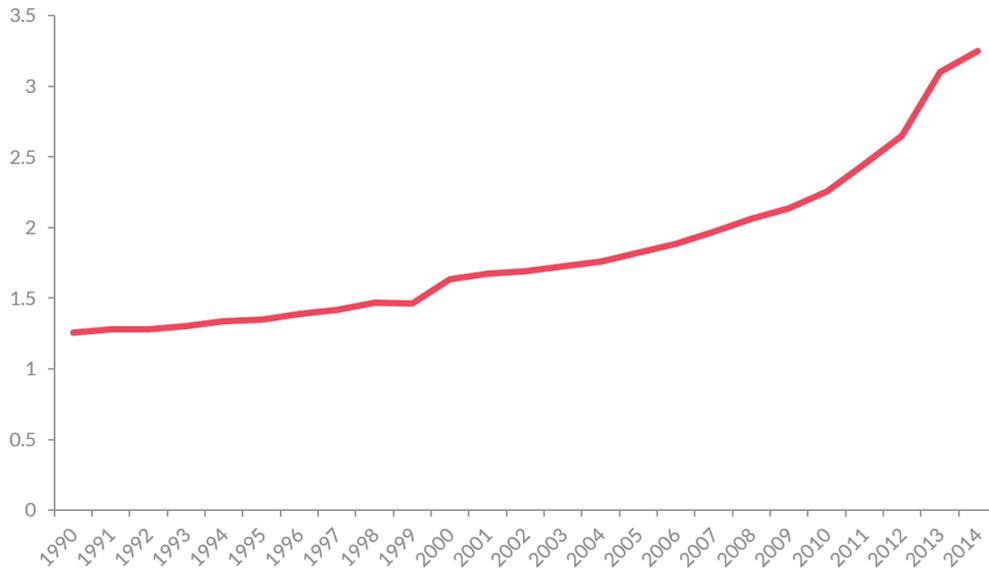


FIGURE F.16
Average diameter by year



FIGURE F.17
Average path length by year

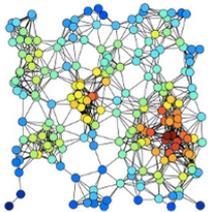


time, but most likely it is because of better data population over time.

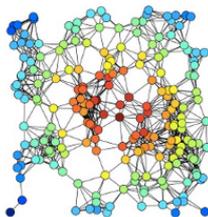
In addition to network statistics, for each node the following statistics were also generated.

The diagrams in **Figure F.18** below, while not specific to our dataset, help illustrate the definition and interpretation of each type

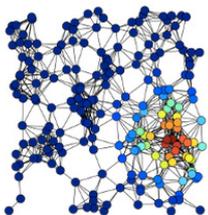
FIGURE F.18
Centrality types



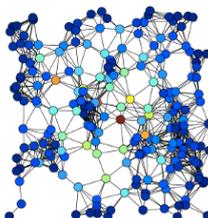
Degree centrality measures the number of other nodes within the ecosystem each node is directly connected to. It does not take into account any second-order connections.



Closeness centrality measures a node’s social distance to other nodes. It is expressed as the inverse of the average distance from each node to every other node in the network. A low closeness centrality indicates that the firm is on the edge of the network.



Eigenvector centrality augments degree centrality by taking into account the connectivity of the nodes a node is connected to. Highly connected nodes within highly interconnected clusters have high eigenvector centrality.



Betweenness centrality measures how many times a node acts as a gateway in the network. The higher the betweenness centrality of a firm, the more paths run through that firm to connect two other firms. High betweenness centrality means that a node is a key bridge or facilitator between different clusters.

of centrality.²³ Red indicates higher centrality values. Blue indicates lower centrality values.

Startups have the highest closeness centrality, while incubators have the highest degree, eigenvector, and betweenness centralities (Table F.3). These results support the hypothesis that incubators are key connection spaces within the urban innovation ecosystem.

TABLE F.3
Centralities by role (2014)

	Average of Degree Centrality	Average of Closeness Centrality	Average of Eigenvector Centrality	Average of Betweenness Centrality
Individual Investor	1.653	0.216	0.000	0.012
Founder	1.788	0.270	0.000	0.008
Incubator	11.145	0.196	0.003	0.056
Startup	6.694	0.363	0.001	0.029
Institutional Investors	4.771	0.253	0.001	0.023

Research finding #2: While startups have the highest closeness centrality and are at the center of the social network, incubators have the highest degree, eigenvector, and betweenness centralities and are key connectors within the ecosystem.

Impact of Connectivity on Funding Outcomes

Research Question #3: How do the geographic and social connectivity of startups influence their funding outcomes?

In order to measure the impact of social and geographic connections on startup outcomes, measures of both types of connectivity in year n were regressed against the likelihood of obtaining funding in year n+1.

A binary outcome was used, of either obtaining funding in year n+1 or not, rather than a continuous outcome, such as the size of the round obtained. This was because the latter is more likely to be influenced by the particular business opportunity rather than the ability to connect to investors.

We hypothesize that there are unobserved omitted variables that vary by startup and as such a fixed effect model should be used, as opposed to a mixed effects model that assumes that unexplained fluctuations within the dataset are random and not inherently related to characteristics of each startup. In essence, this acknowledges that there are variables outside of our dataset, for example, the presentation skills of the founders, which influence funding outcomes. The hypothesis was tested using a standard econometric

TABLE F.4
Results of Hausman Test

	(b) Fixed	(B) Mixed	(b-B) Difference	sqrt(diag(V_b-V_B)) Standard Error
Had New Investors This Year (Dummy)	0.54	0.73	-0.19	0.14
Age of Startup (Years)	0.83	-0.01	0.84	0.06
# of Founders, Current Employees, and Past Employees	1.05	0.11	0.95	0.30
# of Years with Funding Rounds to Date	-2.43	-0.46	-1.97	0.19
# of Current Investors	-0.17	0.07	-0.24	0.06
# of Years Since Previous Funding Round	-0.07	0.01	-0.08	0.04

b = consistent under H_0 and H_a

B = inconsistent under H_0 , efficient under H_a

Test: H_0 : difference in coefficients not systematic

$$\chi^2(5) = (b-B)'[(V_b - V_B)^{-1}](b-B) = 312.39$$

Prob > $\chi^2 = 0.0000$

test called the Hausman Test (**Table F.4**). The results of the Hausman Test indicate that the coefficients under the fixed effects model are more likely to be consistent, so a conditional fixed-effects logistic regression was used on the panel dataset.

This led to the finding that social connectivity is more influential on funding outcomes than geographic connectivity (**Table F.5**).

TABLE F.5
Impact of Connectivity on Probability of Funding Next Year²⁴

	Odds Ratio^{xxv}	Standard Error	z	P > z 	95% Confidence Interval	
Average Distance to All NYC Startups, Institutional Investors, and Incubators (Degrees)	1097.05	112920.80	0.07	0.94	2.66E-85	4.52E+90
Number of 2 nd -Order Connections to Investors through Founders, Current Employees, and Past Employees	1.00	0.00	-0.29	0.77	0.99	1.00
Change from Previous Year in Number of 2 nd -Order Connections to Investors through Founders, Current Employees, and Past Employees	1.02	0.00	4.54	0.00	1.01	1.02
Had New Investors This Year (Dummy)	1.52	0.29	2.21	0.03	1.05	2.22
Age of Startup (Years)	2.38	0.21	9.67	0.00	1.99	2.83
Number of Founders, Current Employees, and Past Employees	3.12	0.98	3.61	0.00	1.68	5.79
Number of Years with Funding Rounds to Date	0.09	0.02	-11.27	0.00	0.06	0.13
Number of Current Investors	0.85	0.05	-2.58	0.01	0.75	0.96
Number of Years Since Previous Funding Round	0.88	0.06	-1.89	0.06	0.77	1.01

Geographic centrality, measured as the average distance to all NYC startups, institutional investors, and incubators, was not significant in our model. In alternative models, average distances to startups, institutional investors, and incubators was separated out, but the effects were mixed and unreliable.²⁶

However, it cannot be concluded that geographic centrality does not influence funding outcomes. Historical geographic data for nodes was not available, so in order to test the influence of geographic connections on funding outcomes, it was assumed that companies had been located in or near their current location since founding. In other words, only the latest address was available, so in order to populate address data for previous years the assumption was made that the latest address was also the address at the time of founding. It is likely that this assumption does not hold, and that is why the results are not significant.

Interestingly, the current number of second-order connections to investors also had an insignificant impact on funding outcomes in the following year. These are investor connections available through the startup's founders, current employees, and past employees. In other words, these second-order investors are connections that are "a phone call away" when a startup decides to raise a round of funding.

It was hypothesized that the number of second-order connections to investors would influence funding outcomes, so this result was surprising. However, given that our dataset is a more mature sample wherein most connections come from already receiving funding, it is likely that it was not possible to tease out the incremental effect of more second-order connections to investors after controlling for other investment-related variables because of an insufficient sample size of connections that occurred outside of funding events.

What is significant is social momentum. The faster a startup gains second-order connections to investors, the more likely they are to successfully fundraise. In fact, each additional second-order connection to an investor increases the odds of raising funding in the next year by approximately 2%. This finding is interesting because it suggests that startups can ride the coattails of fundraising

successes in their broader networks. Or, perhaps, combined with the finding that the absolute number of second-order connections to investors is insignificant, this result might suggest that the “freshness” of a connection is important, or that the value of connections possibly atrophies over time.

However, we should exercise caution in interpreting the social momentum findings given that our dataset is primarily comprised of founders. What this means is that most second-order connections we observe are through founders and their previous employers or through employees that have gone on to found companies of their own. As such, not only is the observed sample of each startup’s associated personnel probably limited in comparison to the actual number of founders, employees, mentors, and advisors, the effect is probably overstated given that the average employee is unlikely to have the number and strength of investor connections as our observed set of founders.

Finally, there are multiple nonconnectivity variables that are significant. A startup that has raised money this year is more likely to raise money next year. The more years a startup has existed and the more employee connections it gains, the more likely it is to raise funding. However, the more investments and investors a startup already has, the less likely it is to raise funding. This is probably because startups reach a threshold where they are self-sustaining enough to slow their fundraising efforts.

Research finding #3: Social momentum matters. The faster a startup gains second-order connections to investors, the more likely they are to successfully fundraise. We could not find a significant impact of geographic centrality on funding outcomes.

Relationship Between Geographic and Social Dynamic

Research question #4: What is the relationship between geographic and social centrality?

Although the lack of historical location data prevents us from understanding how changes in geography impact the social dynamic, an OLS linear regression enabled us to examine the relationship between geographic centrality and social centrality (Table F.6).²⁷

TABLE F.6
Correlation of Geographic Centrality with Social Centrality (2014)²⁹

		Degree Centrality ^{xxx}	Closeness Centrality ^{xxxi}	Eigenvector Centrality ^{xxxii}	Betweenness Centrality ^{xxxiii}
Average Distance to NYC Institutional Investors	+	***	- **	+	*** + **
Average Distance to NYC Incubators	+	***	- *	+	*** + **
Average Distance to NYC Startups	-	***	+ **	-	*** - **

*** = p < 0.01, ** = p < 0.05, * = p < 0.

While location alone does a poor job of explaining centrality,²⁸ the closer a startup is to other startups, the higher the startup’s degree, eigenvector, and betweenness centrality. Meanwhile, the closer a startup is to investors, the higher the startup’s closeness centrality. This result suggests that startups closer to other startups may be highly connected but within an insular startup community, while startups farther from other startups may be less connected but connected with a more diverse set of nodes.

Research finding #4: While startups in the geographic center of the startup scene may be highly connected, their connections are not as socially diverse.

Discussion

Our findings suggest that incubators are key networking assets within the urban innovation ecosystem, and the social dynamic is important for startups because increased social momentum can mean better chances of obtaining funding. However, our findings also suggest that while startups in the geographic center of the startup scene may be highly connected, their connections are not as socially diverse.

However, without historical location data, we are unable to determine whether it is the social dynamic that influences the geographic dynamic or the geographic dynamic that influences the social dynamic. Do incubators form where there is already a critical mass of startup activity? Or are they the key players that build the social activity? Do startups form more connections when they are located in the geographic center of activity? Or do they move into the center of the city after already having already made the social connections?

To answer these questions, we must obtain more granular timestamps for social and geographic changes. It would be informative, for example, to understand how many connections startups had before applying for incubation, and if it is the acceptance to the incubator that spurred their relocation or if they moved into the center of the scene beforehand in the hope of attracting funding and incubation.

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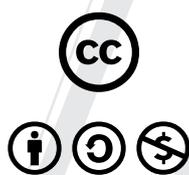
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4. <http://marsinnovation.com>; <http://www.nesta.org.uk>.
5. For more information about this project, see: <http://www.mie-p.org>.
6. For more information about this project, see <http://www.innovatingcities.org/Chile/en>.
7. Open source hardware refers to hardware whose design is made publicly available and can be modified, made, distributed and sold freely. Arduino boards are the most prominent open source hardware. See: <http://www.oshwa.org/definition/> and <http://www.arduino.cc/>.
8. Fablabs minimum equipment include “a laser cutter that makes 2D and 3D structures, a sign cutter that plots in copper to make antennas and flex circuits, a high-resolution Numerical Control (NC) milling machine that makes circuit boards and precision parts, a large wood router for building furniture and housing, and a suite of electronic components and programming tools for low-cost, high-speed microcontrollers for on-site rapid circuit prototyping.” See <http://fab.cba.mit.edu/about/faq/> and <http://www.fabfoundation.org/fab-labs/>.
9. See <http://www.fabfoundation.org/fab-labs/fab-lab-criteria/>.
10. See <http://www.techshop.ws/>.
11. For Arizona State University, see http://techshop.ws/ts_chandler.html; For Ford Motor Company, see <http://www.autotrends.org/2012/05/11/ford-advances-inventive-creativity-through-its-techshop-partnership/>.
12. See: <http://www.openlivinglabs.eu/>.
13. For Barcelona example, see <http://www.22barcelona.com/content/view/698/897/>.
14. See, for instance, U+I Labs description at <http://www.uilabs.org/>.
15. Our dataset does not differentiate between incubators and accelerators, and we use the term “incubator” to refer to both incubators and accelerators. For more details on the definitions, please see Box D.1.
16. <http://www.nyctechmap.com/nycTechReport.pdf>.
17. <http://www.findlatitudeandlongitude.com/batch-geocode/>.
18. Although mentors are technically individuals, in this analysis mentors were projected onto the organization level in order to simplify the calculation of second-order connections to investors.
19. Founding events were included as edges within the network because founders can found more than one startup, and as such founders and startups are treated as separate nodes.
20. Numbers are obtained by dividing the total number of edges by the number of appropriate nodes. These numbers include relationships with nodes outside of New York City.

21. The small number of startups located in Brooklyn is surprising. However, this may be explained by the fact that Brooklyn has not been developed for as long as Manhattan, and our data is incomplete for recent years.
22. The average diameter and path length likely first increases as unrelated nodes were added into the network, then decreases when the social graph “fills out” owing to better data population.
23. Diagrams are from <https://en.wikipedia.org/wiki/Centrality>.
24. In addition to this specification, multiple alternative models were explored. A year fixed effect was considered, where we expected to see effects in 2000 (dot-com boom) or 2008 (financial crisis), but no irregularity was detected. Likewise, there was no irregularity by neighborhood. Other variables such as centrality measures for startups and employees and non-linear transformations of variables were also considered. Regression outputs from these alternative models are available upon request.
25. Odds ratios tell us how many times more likely the outcome is to occur given a one-unit increase in the input variable. An odds ratio greater than 1 indicates that the outcome is more likely to occur.
26. Results from these models are available upon request.
27. The social centralities are the dependent variables. The geographic centralities are the independent variables.
28. The R2 of the regressions is low. See footnotes 30-33 for more details.
29. Correlations become weaker and weaker as we move backwards in time. Effects do not hold <2009, likely due to data population and the likelihood that our locations are not historically accurate.
30. Adjusted R2 = 0.0273.
31. Adjusted R2 = 0.0031.
32. Adjusted R2 = 0.0237.
33. Adjusted R2 = 0.0104.



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