The Rise of Innovation Districts: A New Geography of Innovation in America

Bruce Katz and Julie Wagner

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Introducing Innovation Districts

As the United States slowly emerges from the Great Recession, a remarkable shift is occurring in the spatial geography of innovation.

For the past 50 years, the landscape of innovation has been dominated by places like Silicon Valley—suburban corridors of spatially isolated corporate campuses, accessible only by car, with little emphasis on the quality of life or on integrating work, housing, and recreation.

A new complementary urban model is now emerging, giving rise to what we and others are calling "innovation districts." These districts, by our definition, are geographic areas where leading-edge anchor institutions and companies cluster and connect with start-ups, business incubators, and accelerators.[1] They are also physically compact, transit-accessible, and technically-wired and offer mixed-use housing, office, and retail.

Innovation districts are the manifestation of mega-trends altering the location preferences of people and firms and, in the process, re-conceiving the very link between economy shaping, place making and social networking.[2]

In recent years, a rising number of innovative firms and talented workers are choosing to congregate and co-locate in compact, amenity-rich enclaves in the cores of central cities. Rather than building on green-field sites, marquee companies in knowledge-intensive sectors are locating key facilities close to other firms, research labs, and universities so that they can share ideas and practice "open innovation."

Instead of inventing on their own in real or metaphorical garages, an array of entrepreneurs are starting their companies in collaborative spaces, where they can mingle with other entrepreneurs and have efficient access to everything from legal advice to sophisticated lab equipment. Rather than submitting to long commutes and daily congestion, a growing share of metropolitan residents are choosing to work and live in places that are walkable, bike-able, and connected by transit and technology.

Led by an eclectic group of institutions and leaders, innovation districts are emerging in dozens of cities and metropolitan areas in the United States and abroad and already reflect distinctive typologies and levels of formal planning. Globally, Barcelona, Berlin, London, Medellin, Montreal, Seoul, Stockholm and Toronto contain examples of evolving districts. In the United States, districts are emerging near anchor institutions in the downtowns and midtowns of cities like Atlanta, Baltimore, Buffalo, Cambridge, Cleveland, Detroit, Houston, Philadelphia, Pittsburgh, St. Louis, and San Diego. They are developing in Boston, Brooklyn, Chicago, Portland, Providence, San Francisco and Seattle where underutilized areas (particularly older industrial areas) are being re-imagined and remade. Still others are taking shape in the transformation of traditional exurban science parks like Research Triangle Park in Raleigh-Durham, which are scrambling to meet demand for more urbanized, vibrant work and living environments.

Innovation districts represent a radical departure from traditional economic development. Unlike customary urban revitalization efforts that have emphasized the commercial aspects of development (e.g., housing, retail, sports stadiums), innovation districts help their city and metropolis move up the value chain of global competitiveness by growing the firms, networks, and traded sectors that drive

broad-based prosperity. Instead of building isolated science parks, innovation districts focus extensively on creating a dynamic physical realm that strengthens proximity and knowledge spillovers. Rather than focus on discrete industries, innovation districts represent an intentional effort to create new products, technologies and market solutions through the convergence of disparate sectors and specializations (e.g., information technology and bioscience, energy, or education).

Innovation districts are still an early trend that, because of their multi-dimensional nature, has yet to receive a systematic analysis across the United States and other countries. Yet we believe that they have the unique potential during this pivotal post-recession period to spur productive, inclusive, and sustainable economic development.

Innovation districts help address three of the main challenges of our time: sluggish growth, national austerity and local fiscal challenges, rising social inequality, and extensive sprawl and continued environmental degradation.

They do so by providing a strong foundation for the commercialization of ideas and the creation and expansion of firms and jobs via proximity and collaboration. They are a vehicle for both revenue growth as well as the more efficient use of existing infrastructure. They offer the prospect of expanding employment and educational opportunities for disadvantaged populations given that many districts are close to low- and moderate-income neighborhoods. And, at a time of inefficient land use, they present the potential for denser residential and employment patterns, the leveraging of mass transit, and the repopulation of urban cores.

The purpose of this paper is to capture this emerging trend, explore the large forces and local practices and practitioners that are driving it and provide initial guidance to U.S. city and metropolitan leaders on how best to recognize and extend the growth of their own innovation districts, building on the distinctive assets and potential of their economies.

The next section of this paper defines innovation districts and offers a typology of places where they are developing. Section III then explains why they matter (namely their role in addressing a range of economic, social and environmental challenges our country now faces) while Section IV describes the profound market, demographic, technological, and cultural forces that are propelling this new spatial geography of innovation. Sections V and VI analyze the multiple assets of innovation districts, and provide real-world guidance and insights for cities trying to start or extend this model in their own communities. The paper concludes by exploring the implications of the innovation district trend for large private companies and institutional investors, federal and state government, and the broader field of urban practitioners.

Defining Districts

Innovation is when new or improved ideas, products, services, technologies, or processes create new market demand or cutting-edge solutions to economic, social and environmental challenges.

Innovation districts constitute the ultimate mash up of entrepreneurs and educational institutions, start-ups and schools, mixed-use development and medical innovations, bike-sharing and bankable investments—all connected by transit, powered by clean energy, wired for digital technology, and fueled by caffeine.

They embrace those very attributes of urbanism—what Saskia Sassen calls "cityness"—that were denigrated and often destroyed in the 20th century: complexity, density, diversity of people and cultures, and a layering of the old and the new. As Business Week observed in June 2009, "The trend is to nurture living, breathing communities rather than sterile remote, compounds of research silos."[3]

Given the vast distinctions in regional economies, the form and function of innovation districts differ markedly across the United States. Yet all innovation districts contain *economic, physical, and networking assets*. When these three assets combine with a supportive, risk-taking culture they create an *innovation ecosystem*—a synergistic relationship between people, firms, and place (the physical geography of the district) that facilitates idea generation and accelerates commercialization.[4]

Most innovation districts adhere to one of three general models.[5]

The "anchor plus" model, primarily found in the downtowns and mid-towns of central cities, is where large scale mixed-use development is centered around major anchor institutions and a rich base of related firms, entrepreneurs and spin-off companies involved in the commercialization of innovation. "Anchor plus" is best exemplified by Kendall Square in Cambridge (and the explosion of growth around

MIT and other nearby institutions like Mass General Hospital), Philadelphia's University City (anchored by The University of Pennsylvania, Drexel University and the University City Science Center), and St. Louis (flanked by Washington University, Saint Louis University, and Barnes Jewish Hospital). Other emerging districts can be found in the Greater Oakland neighborhood of Pittsburgh (around Carnegie Mellon University and the University of Pittsburgh Medical Center), Midtown Atlanta (around Georgia Tech University), downtown and midtown Detroit (around Quicken Loans, the Henry Ford Health System and Wayne State University) and the Texas Medical Center in Houston, Texas.

The "re-imagined urban areas" model, often found near or along historic waterfronts, is where industrial or warehouse districts are undergoing a physical and economic transformation to chart a new path of innovative growth. This change is powered, in part, by transit access, a historic building stock, and their proximity to downtowns in high rent cities, which is then supplemented with advanced research institutions and anchor companies. The model is exemplified by the remarkable regeneration underway in Boston's South Waterfront, San Francisco's Mission Bay, Seattle's South Lake Union area, and the Brooklyn Navy Yard. The ambitious plans for the Cornell-Technion Campus on Roosevelt Island in New York City and Hunters Point in San Francisco also hold great promise. Many of these areas draw from the experiences of 22@Barcelona, a self-proclaimed innovation district that involved the complete re-make of an older industrial area in the city core.[6]

The third model, "urbanized science park," commonly found in suburban and exurban areas, is where traditionally isolated, sprawling areas of innovation are urbanizing through increased density and an infusion of new activities (including retail and restaurants) that are mixed as opposed to separated. North Carolina's Research Triangle Park, perhaps the 20th century's most iconic research and development campus, is the strongest validation of this model. In November, 2012, after several years of review and outreach, RTP announced a new 50-year master plan to urbanize the quintessential exurban science park, recognizing that its isolated car-dependent environment is no longer optimal for spurring innovation and attracting younger talent. The master plan calls for a greater concentration of buildings and amenities, including the creation of a vibrant central district, the addition of up to 1,400 multi-family housing units, retail, and the possible construction of a light rail transit line to connect the park with the larger Raleigh-Durham region, including the universities.[7] Other science parks actively engaged in urbanization efforts include the University Research Park at the University of Wisconsin-Madison, the University of Virginia Research Park in Charlottesville and the University of Arizona Tech Park in Tucson.[8]

Unlike convention centers or suburban malls, innovation districts are not cookie cutter developments; rather, they leverage distinct economic strengths in each metropolitan area. Districts vary not only by type but also in size, from 200 acres in St. Louis to 1000 acres in Boston. They have different avenues for growth, with some leading with new fields like "tech/information" (including the burgeoning "app economy"), others leading with life sciences (with clear niches in such fields as nano-technology,

WHO DELIVERS INNOVATION DISTRICTS

The list of institutions and individuals that are driving the growth of innovation districts is as varied as the economic composition of districts themselves. The following list provides a sample of the leaders at the vanguard of this trend in the United States and abroad:

- ***Mayors and local governments***, such as former Mayor Tom Menino of Boston, former Mayor Joan Clos of Barcelona, and the Stockholm city government.
- ***Major real estate developers and major land owners***, such as Vulcan Real Estate in Seattle's South Lake Union and the Brooklyn Navy Yard.
- ***Managers of research campuses***, such as the Research Triangle Park Foundation in Research Triangle Park and the Texas Medical Center in Houston.
- ***Anchor companies***, such as Quicken Loans in Detroit, Comcast in Philadelphia, and Amazon in Seattle's South Lake Union.
- ***Advanced research institutions***, such as Washington University in St. Louis, Carnegie Mellon in Pittsburgh, Drexel University in Philadelphia, and MIT in Cambridge.
- ***Advanced medical campuses***, such as the Henry Ford Health System in Detroit and the University of Pittsburgh Medical Center in Pittsburgh.
- ***Philanthropic investors***, such as the New Economy Initiative and the Kresge Foundation in Detroit and the former Danforth Foundation in St. Louis.
- ***Incubators, accelerators, and other economic cultivators***, such as Barcelona Activa in Barcelona, the Cambridge Innovation Center in Cambridge, and the BioGenerator in St. Louis.
- ***Social networking programmers***, such as Venture Café Foundation in Boston and Cambridge and High Tech Campus Eindhoven.

imaging, and robotics), and others still leading with highly creative industries, such as industrial design, media, and architecture. Further, they vary in their urban form and density, the historic presence of transit (one hundred years in the case of Kendall Square, one year in the case of the Texas Medical Center), the presence of housing and retail, and the extent of collaboration with local schools and community organizations. Finally, they are distinctive in their level of geographic and institutional formality, where some, like Boston, are officially designated and branded, while others, like Kendall Square, are growing more organically in response to market forces. This intense variation in innovation districts requires practitioners to assess assets and liabilities with clear-eyed objectivity, so that growth strategies can be realistic and customized.

Why Innovation Districts Matter

Metropolitan areas in the United States and other mature economies face outsized challenges in the aftermath of the Great Recession. At the most basic level, U.S. cities and metropolitan areas need more and better jobs. According to the March 2014 Brookings Metro Monitor, the number of jobs in 61 of the 100 largest U.S. metro areas are still lower than their pre-recession peak; incredibly, job levels in 23 metros are more than 5 percent below their pre-recession peak figures.[9] At the same time, the number of people living in poverty and near poverty has grown precipitously in the largest 100 U.S. metros—from 48 million in 2000 to 66 million in 2012—due not only to the recession but broader trends around wage stagnation and economic restructuring.[10] Beyond these economic and social demands, cities are on the front lines of addressing enormous fiscal and environmental challenges given federal gridlock and the absence of leadership in many states.

In the face of these challenges, cities and metropolitan areas are experimenting with new approaches to economic development and sustainable development that focus on growing jobs in productive, innovative, and traded sectors of the economy while concurrently equipping residents with the skills—particularly STEM (science, technology, engineering and math) skills —they need to compete for and succeed in these jobs.[11] These new approaches try to build on the distinctive assets and advantages of disparate places rather than merely pursuing heavily subsidized consumption-oriented strategies (e.g., building the next sports stadium, convention center, or performing arts facility) that yield low quality jobs or aspiring to unrealistic economic goals ("becoming the next Silicon Valley").

Innovation districts are a key part of the new wave of local economic development and advance several critical objectives.

First, innovation districts further the ability of cities and metropolitan areas to grow jobs in ways that both align with disruptive forces in the economy and leverage their distinct economic position. Innovation districts enable companies, entrepreneurs, workers, researchers and investors to work across disparate sectors and institutions to commercialize ideas and co-invent and co-produce new discoveries for the market. They foster innovation across industries by concentrating people with different knowledge and expertise in dense urbanized areas; experts in technology, for example, work closely with experts in bioscience, finance, education, and energy. Innovation districts are, in essence, the vanguard of a new "convergence economy" which is galvanizing the growth of more competitive firms and higher quality jobs and spurring expansion in supportive professional and commercial service sectors.

Second, innovation districts can specifically empower entrepreneurs as a key vehicle for economic growth and job creation. Studies show the important role that entrepreneurs and start-up companies play in urban and metropolitan job growth and innovation districts can support this trend in several ways. The rise of collaborative facilities and spaces can, for instance, reduce overhead costs by offering below rate, low risk work spaces and providing technical spaces where exorbitantly expensive technologies are shared. At the same time, imaginative programming and networking can support idea generation and efficiently link young firms to mentors, advisors with specialized expertise, and potential investors.

Third, innovation districts can grow better and more accessible jobs at a time of rising poverty and social inequality. A substantial number of emerging innovation districts across the United States are close to low- and moderate-income neighborhoods, offering the prospect of expanding

employment and educational opportunities for disadvantaged populations. Leaders in cutting edge innovation districts are already dedicating resources to revitalize neighborhoods directly through investments in affordable housing, education, infrastructure and improved internet connectivity, and indirectly via enhanced tax revenues. Leaders in these districts are particularly focused on increasing labor market participation of local residents through training for jobs in both the STEM sector as well as retail and service firms.

Fourth, innovation districts can reduce carbon emissions and drive denser residential and employment patterns at a time of growing concern with environmentally unsustainable development. Innovation districts are potential engines for sustainable development since they embrace residential and employment density via the strategic use of transit, historic buildings, traditional street grids, and existing infrastructure. Some districts are going further by using renewable energy as their primary power source and by transforming their buildings, streets, and parks into living labs to test cutting edge sustainable projects in concert with technology firms and entrepreneurs.

Finally, innovation districts can help cities and metropolitan areas raise revenues and repair their balance sheets at a time when federal resources are diminishing and many state governments are adrift. Municipal governments generally rely on property, business, and sales taxes for revenue. Innovation districts can generate revenues through increased economic activity, rising housing values and increased demand for goods and services. Increased revenues can then be used to make necessary investments in infrastructure, public safety, affordable housing, local schools, and other necessary services. At time when federal resources are shifting to entitlement programs (e.g., Social Security) and many states are otherwise focused, these types of investments disproportionately fall on local governments.

Why Now—The Evolution of Innovation

The early rise of innovation districts could constitute the next phase of what one observer has called the "architecture of technology."[12] This architecture was once represented by industrial districts, and later by suburban science parks, both of which were products of the distinctive mix of demographic preferences, cultural norms, and economic imperatives of their times. Similarly, the growth of innovation districts is reflective of forces that are radically altering the requirements and preferences of people and firms that are today engaged in technology driven activities. These shifts are forging new links between economy-shaping, place-making, and network building that were not evident in early models.

A. Industrial Districts to Science Parks

In the 19th century and early 20th century, industrial districts—areas with high concentrations of manufacturing enterprises commonly engaging in similar or complimentary work—emerged in cities like Manchester, Milan, and Stuttgart in Europe and Baltimore, Cleveland, Detroit, New York, and Philadelphia in the United States. In the United States, these districts straddled the temporal boundary between the early mercantile city and turn-of-the-century industrial metropolis, a period marked by new types and organizational forms of manufacturing activity, innovations in energy and transportation, and rapid urbanization.[13] Many cities in fact had multiple districts, which varied by product type, methods of production, power source, and labor force composition.[14] Such a clustering of like activities facilitated the supply of materials and parts from one firm to another, and also attracted a large and fluid supply of workers, many of whom lived in the surrounding communities and walked to work. Enmeshed in the urban fabric, these "sub-city" areas thus provided not only a high density of employment opportunities, but essential neighborhood services and social amenities.[15]

As the 20th century moved forward, the nature of manufacturing activity changed and eventually dispersed—first within regions, and eventually across the globe—and by the mid-1900s production in U.S. and European cities had sharply declined. The foundations of modern technology laid during the preceding decades had, however, enabled the advent of a new era of invention and innovation in science, communications, and information—as well as the rapid suburbanization of housing and commercial activity.

In the United States, technological advancement and geographic dispersion together helped drive the creation of innovative enclaves variably referred to as science parks or research parks. Beginning in the 1950s, collaborations of universities, private developers, and government designed and built these clusters of labs and firms with the aim of increasing the commercialization of research and attracting entrepreneurially-oriented scientists from industry and academia.[16] The model originated with the Stanford Research Park—in what is now Silicon Valley—and was then expanded to include the development of Research Triangle Park in Raleigh Durham, and later the innovation corridors outside Boston, Philadelphia, and Washington D.C. Unlike urban industrial districts, these suburban parks were built as spatially isolated corporate campuses accessible only by car, mirroring the patterns of residential and commercial growth that dominated the post war landscape. They also reflected a research culture and patenting policies that encouraged secrecy. As such, they were generally closed innovation systems in which firms and scientists carefully guarded their ideas, and where interactions between them were limited.

B. A New Geography of Innovation

Innovation districts maintain elements of these earlier models but embody a new interplay of form and function that the modern innovation economy demands, and in turn supports. Like their predecessors, these districts grow out of a powerful set of economic, cultural, and demographic forces that are reshaping both how and where people live and work.

The emergence of innovation districts has been observed by a number of scholars and practitioners, many of whom have offered initial theories for their development. Research led by Thomas Hutton in over seven global cities found a rise of new industrial clusters within the inner city to "constitute important aspects of the spatiality of the New Economy," making four classifications of specialized production.[17] A research team at MIT's Department of Urban Studies and Planning likewise identified discrete geographic clusters of creative industries, life sciences, and applied sciences within large-scale real estate development projects. Defined as "New Century City Developments," these innovative clusters are "driven by inter-organization and cross-industry collaboration, open systems for R&D, and workers who have the aptitudes and skills required by the networked, knowledge economy."[18]

George Bugliarello of Polytechnic University in New York observed the emergence of "urban knowledge parks," concluding that these urban parks develop around a knowledge institution in a city, provide public space or spaces for community activities, and possess high levels of density."[19] In September, 2013, the American Institute of Architects released a report on Innovation Districts, describing them as "creative, energy-laden ecosystems" that are emerging world-wide.[20]

Richard Florida has provided important validation for the new geography of innovation. His recent mapping of venture capital activity by ZIP codes and area codes, rather than more expansive metro areas, shows that "high tech development, startup activity, and venture investment have recently begun to shift to urban centers and also to close-in, mixed-use, transit-oriented, walkable suburbs."[21]

These observations—and ours—recognize a trend that is both multi-dimensional and hyper-local, one reason why market dynamics on the ground have outpaced uniform labeling or analysis. Quantitative assessments, therefore, are still a work in progress. Innovation districts in Boston and St. Louis, for example, are assiduously documenting district-level growth, although not against broader city and metropolitan trends or other cities with similar economic starting points.[22] Similarly, studies in New York, Pittsburgh, and San Francisco have documented the growth of leading tech sectors at the city rather than innovation district scale.[23] While the analytics supporting this trend mature, Brookings and a growing number of practitioners are turning to broader economic and demographic research to understand the forces driving this new spatial geography of innovation.

1. The evolution of a knowledge and technology driven economy is altering the value and function of density and proximity.

In the past several decades, the U.S. economy has become increasingly reliant on knowledge and innovation. Today, approximately 20 percent of all U.S. jobs are in science, technology, engineering, or math (STEM) related occupations—a share that has doubled since the Industrial Revolution.[24] These occupations can be found in a wide range of fields including the production of advanced goods like pharmaceuticals, medical devices, motor vehicles and aerospace as well as the provision of advanced

services like software, data processing, among many others.[25]

As the role of these innovative industries and occupations has grown in size and importance, so too, then, has the value of density and agglomeration. The benefits of clustering that produced industrial districts, and then science parks, are intensifying in ways that we are just beginning to understand. A growing body of research shows that employment density not only eases resource, goods, and labor sharing, but also enhances innovation. This happens by enabling a more seamless transfer of knowledge within and across firms, workers, and supporting institutions—in turn facilitating the creation and exchange of new ideas that fuel even greater economic activity and growth. A recent study by the British government captures this latter point well:

> "While the marginal cost of transmitting information across geographical space has fallen significantly, the marginal cost of transmitting knowledge still rises with distance …. Therefore, the knowledge spillover benefits of clustering in cities can be large for high-value, knowledge intensive sectors."[26]

The proximity effect is significant. Recent research conducted by Gerald Carlino and Robert Hunt found the clustering of R&D labs to be by far the "most significant" at very small spatial scales, such as distances of about one-quarter of a mile. They also discovered the clustering effect to quickly dissipate with distance, concluding knowledge spillovers to be "highly localized."[27] Isaac Kohane and several colleagues at Harvard Medical School found that even working in the same building on an academic medical campus makes a difference for scientific breakthroughs; "Otherwise, it's really out of sight, out of mind."[28]

Density also matters when it comes to workers. The large number of employers within an urban area allows workers to change jobs more easily, giving them both greater flexibility and stability than employees in non-urban locales. This concentration of employment, which economists refer to as "labor market pooling," also contributes to labor productivity.[29] One seminal study found that doubling employment density increases average productivity by around 6 percent.[30]

This general research on proximity and density takes on new meaning in what one observer has called the "age of convergence." In biosciences, digital and biological technologies are co-mingling, opening entirely new possibilities for innovation breakthroughs to be commercialized.[31] A recent San Francisco analysis coined the term "tech/information" industries to reflect "the convergence between technology and content."[32] The spatial implications of this hybridization of industry are profound.

> "[Tech/information] companies thrive in urban environments, where they can connect with other industries, drawing on the culture and diversity of the city. By contrast, the previous generation of tech companies thrived with their headquarters located in suburban areas, located mainly near other tech companies. *There was no possibility of cross-industry diversity.*" [Emphasis added][33]

Recent analysis in New York similarly found tech industries to be less focused on building new technologies but rather "applying technology to traditional industries like advertising, media, fashion, finance, and health care."[34] These shifts reinforce and reinterpret notions of proximity and density.

> The early days of technology growth was driven by semiconductors and computer hardware, products that depended on a deep roster of engineering talent and required large amounts of physical space to develop. … In contrast, today's growth is being fueled by the Internet and smart phones, and the creation of new ways of taking advantage of these now widely used platforms to deliver content, sell products, deliver services, play games and simplify life for individuals and businesses. … [In other words], today's technology revolution is much less about creating the infrastructure and plumbing for the Internet, but about applying technology to traditional industries.[35]

To be sure, physical proximity alone doesn't guarantee greater collaboration and idea exchange, nor is it necessarily even required. Silicon Valley, while a huge regional agglomeration of innovative activity, is the quintessential low-density, suburban model of physical development—yet its strength and success is defined by a pervading culture of openness and network building. But urbanization—and

the physical proximity that comes with it—does appear to both grow from, and in turn help smooth, the development of "horizontal" relationships both within and between large firms, smaller subcontractors, vendors, and, importantly, talent. The move to create denser enclaves of innovation thus appears to be a critical shift for communities that are not as "wired" for collaboration as Silicon Valley.

2. An economy increasingly oriented toward open innovation is changing both where firms locate and how buildings and larger districts—from research labs to collaborative spaces to mixed-use developments—are designed.

As the knowledge and technology driven economy grows, it is also becoming increasingly characterized by what Henry Chesbrough and others call "open innovation." Chesbrough describes this as a process whereby companies and firms more openly generate new ideas and bring them to market by nimbly drawing on both internal and external sources. Under this new modus operandi, external sources can generate the ideas that are then commercialized internally by a firm, while internal ideas can be commercialized by external start-up companies and entrepreneurs. In other words, as Chesbrough observes, "The boundary between a firm and its surrounding environment is more porous, enabling innovation to move easily between the two."[36]

What was once a phenomenon for highly specialized fields, the imperative to collaborate has expanded to a broader group of knowledge-intensive sectors, including such science- and technology-heavy fields as chemicals, biotechnology, telecommunications, and semiconductors. McKinsey & Company, for example, has noticed a move from internal R&D labs to new "multichannel R&D models," which involve partnerships with "academic centers, partners, competitors, customers, venture capital funds, and startups."[37]

The rise of smaller companies engaged in research and development has also contributed to the growing movement toward open innovation. A field once dominated exclusively by large corporations, research labs and universities has become increasingly stratified, prompting greater collaborations between firms of disparate sizes to develop and advance innovations. A number of factors contributed to the proliferation of smaller R&D companies, namely the downsizing of larger companies, the passage of the Bayh-Dole Act (which enables university and individual researchers to own their federally-funded research, sparking a new entrepreneurial mind set), and the growth of venture capital funding, from very little funding in 1970 to nearly $100 billion in 2000.[38]

The result is that in today's economic landscape, no one company can master all the knowledge it needs, so companies rely on a network of industry collaborators.[39] This, in turn, has led to a shift in where companies and support organizations locate. A recent article, for example, on the growth of Pfizer, Novartis, and other major pharmaceutical companies in Cambridge noted the following:

> "Pharmaceutical companies traditionally preferred suburban enclaves where they could protect their intellectual property in more secluded settings and meet their employees' needs. But in recent years, as the costs of drug development have soared and R&D pipelines slowed, pharmaceutical companies have looked elsewhere for innovation. Much of that novelty is now coming from biotechnology firms and major research universities like MIT and Harvard, just two subway stops away."[40]

The more open, collaborative nature of the knowledge economy has also altered the design inside and outside the walls of the singular company. A recent *New York Times* piece on the "monuments of tech" refers to this trend as the "aesthetic of disruption"—design which embodies change, flexibility, and openness while at the same time displays the unique character and ethos of the individual company.[41]

The early, highly-recognizable model for open and highly networked workplaces is the newspaper newsroom, but these principles have been implemented in places ranging from former New York City Mayor Michael Bloomberg's "bullpen" in New York City Hall to the campuses of Silicon Valley technology firms. Facebook and Google, for example, have embraced "hackable buildings," with open floor plans that can be easily reconfigured to create dense, collaborative spaces for new teams and projects.[42]

Beyond office spaces and individual buildings, the planning and design shifts described above have extended to the public and private realm. When Henderson, NV-based Zappos, the online retail shoe giant, was looking for a new headquarters in 2010, CEO Tony Hsieh decided to create a more dynamic

workplace, with the goal of increasing interaction and collaboration among its workers. That inspired for Hsieh a move toward open floor plans and the provision of greater amenities within the office. More than that, it also led him to embed the new headquarters building (and 2,000 Zappos workers) in Las Vegas' old City Hall, and launch the $350 million Downtown Project to catalyze growth of a dense, multi-use, and walkable environment. "The idea," Hsieh said, "went from 'let's build a campus' to 'let's build a city.'"[43]

In short, the phenomenon of open innovation is changing over time: expanding into new industries, altering the design of office spaces, reshaping the relationship between buildings, and now occurring at the district scale. Similar to open innovation between firms, innovation districts are experiencing the breakdown of traditional boundaries, making the process of innovation more porous between the public and private realms. Ideas, for instance, can be brainstormed in wired, public spaces, advanced in shared work spaces, prototyped in private technology labs, and tested on public streets.

3. Shifting demographic and household dynamics are fueling demand for more walkable neighborhoods where housing, work, and amenities intermix.

Recent data show that cities and metropolitan areas are increasing in population faster than the rest of the country, with the largest growth seen in large urban areas. From 2012 to 2013, large metropolitan areas with over 1 million people grew twice as fast as smaller metropolitan areas with populations under 250,000, while nonmetropolitan/micropolitan regions saw a collective decline.[44] Brookings' demographer William Frey believes that this trend is likely to continue, while the future of non-urban America is far less certain.[45]

Within many large metropolitan areas, the trend becomes more acute as one examines areas in greater proximity to commercial downtowns. The country's 10 largest "live-work" downtowns, as examined by the Philadelphia Center City District for the International Downtown Association, grew 77 percent faster than the country as a whole, and nine of the 10 downtowns increased in population faster from 2000 to 2010 than zones within a half-mile or mile of downtown.[46]

What's driving this revival in cities and their cores?

America's family structure has been altered by the simultaneous aging of the population and the tendency of young adults to delay marriage and have fewer children. As a result, the prototypical family of the suburban era—a married couple with school age children—now represents just under 20 percent of American households, down from 24.1 percent in 2000 and 40.3 percent in 1970.[47] This trend is only expected to accelerate in coming decades. As Arthur C. Nelson documents in his provocative book, *Reshaping Metropolitan America*, "Between 2010 and 2030, households with children will account for about 13 percent of the total change in households; households without children will represent the rest."[48]

This demographic tumult is sparking a palpable shift in consumer—and worker—preferences toward more urban-oriented environments. Research has documented, for example, that 70 percent of Americans place a high priority on walkability, and similar majorities prioritize proximity to health care, entertainment, recreation, work and school, and social contacts.[49] Older Americans are increasingly seeking smaller homes and apartments, as well as places with easy access to medical services, shopping, and other daily necessities. Meanwhile, middle-aged couples, whose children have "left the nest," show greater receptivity to urban neighborhoods, cultural amenities, and shorter commutes.[50]

These preferences are particularly prevalent among the millennial generation (Generation Y)—whose young and educated members form the core of our innovation workforce. For many of these young people, especially those that have delayed childrearing, "quality of life" is increasingly understood to mean proximity to urban amenities such as restaurants, retail, cultural, and social venues.[51] This is evidenced in residential choices of this cohort. According to Joseph Cortright, between 2000 and 2009, the number of 25- to 34-year olds with college degrees living in neighborhoods near the central business districts in the nation's 51 largest metropolitan areas increased by 26 percent, double the growth rate of college educated young adults in the rest of the metropolitan area.[52]

Data from the Urban Land Institute reveals that 63 percent of millennials plan to move in the next five years, and 40 percent of them indicate a preference for living in medium or large cities (compared to only 28 percent of Americans as a whole). Within urban areas, living in close proximity to shopping, dining, and work is preferred by 62 percent of this demographic, along with 60 percent of both singles

and renters.[53] A recent *New York Times* article underscored how these shifts in demographics are challenging the New York City housing supply, noting that "there are more single households, thanks to the young urban migration and the silver tsunami, that gathering wave of urban-minded retirees."[54]

Collectively, these three shifts—a converging knowledge economy, more open innovation ecosystems, and changing demographics—are stirring new demands for density, proximity, collaboration, and walkability, and in so doing are re-working the spatial geography of innovation. With concerted effort, the rise of innovation districts holds the potential to bring numerous benefits to the cities and regions in which they are located, and to the people who live and work there.

Deconstructing Districts

The potential for innovation districts to drive innovative, inclusive, and sustainable growth requires us to understand what drives them and makes them productive and prosperous. Unlike segregated business or residential districts that have for decades populated most cities and suburbs, or even the activity centers that more recently have sprung up around public transit stations, innovation districts uniquely contain three categories of assets: *economic assets, physical assets, and networking assets.*[55]

- **Economic assets** are the firms, institutions and organizations that drive, cultivate or support an innovation-rich environment.
- **Physical assets** are the public and privately-owned spaces—buildings, open spaces, streets and other infrastructure—designed and organized to stimulate new and higher levels of connectivity, collaboration, and innovation.
- **Networking assets** are the relationships between actors—such as between individuals, firms, and institutions—that have the potential to generate, sharpen, and/or accelerate the advancement of ideas.

The relative strength of these assets in different communities varies considerably. In some places, districts are emerging from a cluster of strong economic assets but lack important physical assets and are initiating a planning process to comprehensively redesign the physical realm. In other cases, districts possess a strong set of physical assets with only a handful of economic assets and networks to build upon.[56]

Innovation districts reach their potential when all three types of assets, combined with a supportive, risk-taking culture, are fully developed, creating an *innovation ecosystem*. As described earlier, an innovation ecosystem is a synergistic relationship between people, firms, and place (the physical geography of the district) that facilitates idea generation and accelerates commercialization.

Both research and interviews suggest that a supportive risk taking culture consistently undergirds highly productive innovation areas. This means, most unconventionally, embracing failure by making risky investments in people, firms, and development projects. It means breaking down the traditional, vertical hierarchies and valuing a diversity of talent, from 20- and 30-year olds to the more experienced leadership class. It means changing conventional rules still found in many inward-focused research institutions and organizations to encourage spin-offs, allow greater idea sharing across firms, and share spaces and technologies. It also means taking the long view and not expecting short-term returns or rewards as innovation processes commonly require consecutive failures before any breakthroughs can be achieved.

In describing these assets it is important to recognize that a number of them may appear to be conventional, if not strikingly rudimentary. While many assets described here have been integral to existing urban economic development efforts, they are being re-engineered to support the innovative, traded sectors that drive metropolitan economies. Research universities, for example, are by definition teaching institutions with research departments. A small, but growing, subset of these universities are now valuing commercialization as a primary objective and are successfully advancing innovations into the market. Moving well beyond their tech transfer offices, these universities are investing resources in accelerators, encouraging and supporting spin-offs, and developing adjacent land to concentrate future economic growth. Many more research universities have not yet expanded their mission to embrace commercialization fully, demonstrating a growth opportunity for these universities and the areas surrounding them.

A. Economic Assets

Economic assets can be separated into three categories: innovation drivers, innovation cultivators, and neighborhood-building amenities.

Innovation drivers are the research and medical institutions, the large firms, SMEs, start-ups, and entrepreneurs focused on developing cutting-edge technologies, products, and services for the market. Due to regional variations in industry strengths, each district is comprised of a unique mix of innovation drivers, contributing significantly to their distinctiveness. The research described below reveals important insights for districts building and assembling these assets.

First, a subset of industries—sensitive to the economic, demographic, and cultural trends described above—distinguishes innovation districts from other models and largely explains their preference for compact, urban-oriented enclaves. These industries are:

- High-value, research-oriented sectors such as applied sciences (from life and material sciences to energy technology to nanotechnology) and the burgeoning "app economy."[57]
- Highly creative fields such as industrial design, graphic arts, media, architecture, and a growing hybrid of industries that merge tech with creative and applied design fields.[58]
- Highly specialized, small batch manufacturing such as advanced textile production and small artisan-oriented manufacturing.[59]

Large advanced manufacturing facilities are not located within urban innovation districts. These facilities require substantial building or land footprints and require easy access to major highways. This includes fabrication plants, OEMs (original equipment manufacturers) and large suppliers.

Second, the role of universities deserves special consideration given their effects on the local and metropolitan economy, including their role in driving innovation activity at the district scale. Anselin, Varga, and Acs, for example, sought to reconcile conflicting research findings on the role of universities and the local economy, drawing on larger and more geographically precise data sets. Their research found a "positive and significant relationship between university research and innovation activity," both directly, as well as indirectly through its impact on private sector R&D.[60] Further, Hausman, in analyzing Census data around universities after the passage of the Bayh-Dole Act in 1980 (an act allowing universities and other researchers the ability to commercialize research funded by federal dollars), found both long-term employment and worker income to rise "in industries more closely related to local university innovative strengths."[61] In short, universities are particularly helpful drivers for growing districts; for this reason, many districts that did not originally include universities (such as the "re-imagined urban areas" model) have convinced universities to build satellite campuses.

Third, entrepreneurs are another asset worth highlighting. While Edward Glaeser's research convincingly affirms the role of entrepreneurs in driving city employment growth, interviews with practitioners reveal that entrepreneurs are equally valued at the district-scale.[62] All innovation districts aspire to support entrepreneurs. Boston's innovation district, for example, includes an "innovation component" for new office and retail developments, where 15 percent of the space is earmarked for entrepreneurs and start-ups.[63]

Fourth, while many districts are focused on the cultivation of entrepreneurs, they alone cannot be a growth strategy for districts. Research conducted by Agrawal, Cockburn, Galasso, and others found that a mixing of firms creates the optimal environment for innovation. Larger laboratories, for example, may stimulate spin-offs considered irrelevant to the lab's overall business objectives, while smaller labs can create demand for specialized services that lower the entry costs for others in the market.[64]

Innovation cultivators are the companies, organizations, or groups that support the growth of individuals, firms, and their ideas. They include incubators, accelerators, proof-of-concept centers, tech transfer offices, shared working spaces (with programs to support idea and firm development), and local high schools, job training firms, and community colleges advancing specific skill sets for the innovation-driven economy. In a small number of districts, legal counsel, patent attorneys, and venture capital firms are scrubbing project concepts to identify their value in moving forward. The rise of technology-driven industries in general is creating demand for supportive industries that employ highly-educated workers, such as advanced business services.[65]

The aggregation of innovation cultivators in districts distinguishes them from standard business and research parks. While cities and suburban areas have cultivators sprinkled across their landscape, district leaders are assembling a critical mass of cultivators within a discrete geographic area. Equally

important, district leaders are "planning for the continuum" by building a range of cultivators to support entrepreneurs and start-ups at each stage of development, keeping them in the district as they mature. There appears to be a tipping point, however, when too many cultivators become counterproductive. "Too many incubators run the risk of spoon-feeding entrepreneurs too much. They need to work hard at achieving success," shared Ylva Williams of the Stockholm Science City Foundation.[66]

Neighborhood-building amenities provide important services to residents and workers in the district. This includes medical offices, grocery stores, restaurants, coffee bars, small hotels, and local retail (such as bookstores, clothing stores, and sports shops). In his analysis of the "new economy" clusters in the urban core, which include innovation-oriented clusters, Thomas Hutton found restaurants, coffee shops, and bars to "reflect not only contemporary urban consumption patterns but also a distinctive 'geography of amenity,' which complements the intensive social interactions of the new economy."[68]

Amenities activate district streets and public spaces, inviting a mix of people to shop, browse, and mingle. Many cities understand this well, and have heavily invested in corridor or neighborhood revitalization initiatives, often providing tax relief and other incentives for local businesses. District strategies build off these efforts, seeking to not only create a critical mass of amenities but to encourage a compelling design of storefronts and signage.

B. Physical Assets

There are three categories of physical assets, all of which are uniquely applied in each district: physical assets in the public realm, physical assets in the private realm, and physical assets that knit the district together and/or tie it to the broader metro area. Similar to economic assets, physical assets are in the process of being re-imagined to advance an innovation imperative—a process that is transforming the physical landscape into a laboratory of creativity, ingenuity, and invention. Experts in the fields of urban design, architecture, landscape architecture, and planning are experimenting with new concepts that facilitate collaboration and connectivity. This story of testing, trying and evolving was observed by MIT researchers, who in their global work on "New Century Cities" found districts to be "messy, with activities and uses all mixed up and things in a constant state of adjustment and change."[69]

Physical assets in the public realm are the spaces accessible to the public, such as parks, plazas, and streets that become locales of energy and activity.

In innovation districts, public places are created or re-configured to be digitally-accessible (with high speed internet, wireless networks, computers, and digital displays embedded into spaces) and to encourage networking (where spaces encourage "people to crash into one another").[70] "Digital places," as defined by MIT's New Century Cities work, are the culmination of ambient technology, digital systems, and the physical form, creating venues for training and education, cultural events, and entertainment.[71]

Streets can also be transformed into living labs to flexibly test new innovations. In Boston, Barcelona, Eindhoven, Helsinki, and Seoul, streetscapes and public spaces are testing new innovations in street lighting, waste collection, traffic management solutions, and new digital technologies. Living labs are what 22@Barcelona calls "open innovation at the city-scale."[72]

The re-make of physical assets extend far beyond technology-infused places however, as the design and programming of public spaces is equally valued. Small-scale parks and plazas programmed with concerts, innovation expositions, and eateries give reason for people to congregate and mix. District leaders are designing and programming such spaces strategically across their districts in an effort to facilitate the building of networks.

Physical assets in the private realm are privately-owned buildings and spaces that stimulate innovation in new and creative ways. Building from a solid base of traditional assets, such as mixed-income housing, neighborhood-serving retail, and research and office complexes, new assets are designed to support the innovation-driven demographic. Office developments, for example, are increasingly configured with flex work spaces, lab spaces, and smaller, more affordable areas for start-ups.

Micro-housing is another example of a new physical asset. These units offer smaller private spaces (typically 300 to 600 square feet) and access to larger public spaces such as co-working spaces, entertainment spaces, and common eating areas. Often marketed for migrating workers in innovation sectors, local residents, and younger single workers, micro-housing is now found in the districts

of Boston, Barcelona, and Philadelphia (under construction). St. Louis is also planning micro-housing units in their district.

Physical assets that knit the district together and/or tie it to the broader metro area are specific investments aimed to eliminate barriers that hinder relationship-building and connectivity.

Practitioner interviews suggest there is considerable work to be done within districts, particularly in linking anchor institutions (commonly oriented within their own campuses) with the rest of the district. For some districts, knitting together the physical fabric requires remaking the campuses of advanced research institutions to remove fences, walls and other barriers and replace them with connecting elements such as bike paths, sidewalks, pedestrian-oriented streets and activated public spaces. For other districts, strengthening connections requires changes at a much larger-scale, such as entirely re-structuring large areas with smaller, more walkable blocks and pedestrian-scale streets.

Strategies to strengthen connectivity between the district and the broader metro aim to ensure innovation districts do not become islands unto themselves. Investments in infrastructure, such as broadband, transit, bike, and pedestrian paths are natural connectors to be considered. Extending broadband into adjacent, often low-income neighborhoods, for instance, is a valuable strategy in reducing the digital divide. Investments in public transportation—including the Silver Line in Boston, the Red Line in Houston, the future M-1 in Detroit—have been essential, for instance, in increasing accessibility between districts and their surrounding metro areas.

C. Networking Assets

The inclusion of networking as its own asset category is supported by a growing body of research that reveals how networks are increasingly valuable and prolific within innovation-driven economic clusters. Scholars cite numerous advantages of networks: they are important sources of new or critical information for new discoveries; they encourage experimentation and are a testing ground for ideas; they help firms acquire resources; they strengthen trust and collaboration within and across sectors; and they help firms enter new markets including global markets.[73]

The most famous success story of networking is Silicon Valley, where dense social networks were found to drive both experimentation and entrepreneurship. In her analysis of Silicon Valley, Saxenian observed, "Companies compete intensely while at the same time learning from one another about changing markets and technologies through informal communication and collaborative practices." She argues that while proximity—in this case, a regional agglomeration—contributes to the development of dense networks, a collaborative culture appears to play a more significant role.[74]

While countless numbers of science parks and tech parks were built on the hopes that Silicon Valley could be easily copied, Bert-Jan Woertman, an enthusiastic connector and creative communicator for High Tech Campus Eindhoven, reflects that "Networks cannot be copied nor can they be easily established."[75] A recent *Harvard Business Review* article similarly presented the difficulties in establishing networks, finding that even start-ups and their parent companies "cannot leave knowledge spillovers to chance."[76]

Districts attempting to cultivate networks are driven by experimentation, creativity, and even a sociological understanding of how networks function. A leading scholar on networks, Granovetter, differentiates networks as either having "strong ties" or "weak ties," which are determined by factors such as the frequency of contact, the emotional intensity of the relationship, and the reciprocity of commitments between the actors.[77]

Strong ties occur between people or firms with a working or professional history, higher levels of trust, willing to share more detailed information, and more apt to participate in joint problem solving. Weak ties occur between people or firms working within a different economic cluster or context where there is infrequent contact. Weak ties provide access to new information, even novel industry information, new contacts, and new information on business leads that are outside of existing networks.[78] While it may seem obvious that a dense network of strong ties is the optimal condition for a highly innovation-driven environment, research indicates that both strong ties and weak ties are fundamental to firm success.[79] Two primary categories of networking assets emerge from this research:

Networking assets that build strong ties focus on strengthening relationships within similar fields. These types of assets include: "tech regulars" (such as Eindhoven's Tech Regulars, where "techies" discuss problems or advances in their work as a collective), workshops and training sessions for

specific fields or technicians (daily activities along Boston's waterfront), cluster-specific meetings (22@Barcelona), industry-specific conferences and monthly meetings (found in several districts), and industry-specific blogs for local firms and entrepreneurs.

Networking assets that build weak ties focus on building new, often cross-sector, relationships. Examples include: networking breakfasts (such as 22@Barcelona's breakfast where experts and star innovators offer new insights in their fields followed by open time to network), innovation centers (such as Boston's newly constructed 12,000 square foot District Hall), hack-a-thons across industry clusters such as life sciences and tech (Stockholm), tech-jam start-up classes (found in Boston), and even the choreographed open spaces between highly programmed buildings (St. Louis). In this last example, St Louis will be clustering five innovation centers, with the purpose of generating "collision points" between smart people.[80]

Reflections from Practitioners

As innovation districts take hold, the real challenge is how each community marshals resources in a deliberate and customized way to capitalize on advantages and realize the promise of productive, inclusive, and sustainable growth. To that end, this section summarizes reflections from practitioners spearheading efforts to drive and develop districts. We found their experiences to vary considerably, in part due to the types of local actors, the level of resources at their disposal, and the distinct economic, physical, and networking challenges they set out to address. Even with these and other variations at play, practitioners for the most part offered similar reflections from their work so far.

This section is not meant to be a how-to guide for future districts but is instead intended to illustrate how these practitioners have come to understand and organize the complexities inherent in their work. It draws from interviews with practitioners and researchers working in leading edge innovation districts including University City in Philadelphia, Cortex in St. Louis, Kendall Square in Cambridge, the South Boston Waterfront, downtown and midtown in Detroit, South Lake Union in Seattle, the Texas Medical Center in Houston, 22@Barcelona, two innovation districts in Stockholm (Stockholm Life and Kista Science City), and Eindhoven in the Netherlands.[81]

We have consolidated their reflections into the following five strategies, each of which will be discussed in turn:

- Build a collaborative leadership network
- Set a vision for growth
- Pursue talent and technology
- Enhance access to capital
- Promote inclusive growth

1. Build a collaborative leadership network

A collaborative leadership network is a collection of leaders from key institutions, firms, and sectors who regularly and formally cooperate on the design, delivery, marketing, and governance of the district. Practitioners reflected that to bring innovation to scale—i.e. beyond the boundaries of individual organizations and firms—has required leaders from disparate institutions to encourage idea sharing across researchers, firms, universities, and supportive organizations. Likewise, physically remaking a place in the service of innovative growth and expanding employment and educational opportunities for low-income residents has required leaders to think and act in a multi-dimensional fashion, across multiple sectors and communities.

Practitioners in the field underscored the importance of a focused and organized leadership network to super-charge innovation, reshape places, build a culture of trust and collaboration, and steward networks. Interviews identified three key and, in some cases overlapping, models of leadership:

An important share of innovation district leaders found the Triple Helix model of governance to be foundational to their success.[82] The Triple Helix consists of structured interactions between industry, research universities, and government. Collectively, they design long-range visions and create new

vehicles for innovation, such as research centers and incubators. In the case of 22@Barcelona, St. Louis, Kista Science City (Sweden), and Eindhoven (Netherlands), the Triple Helix model established a clear organizational model of collaboration from the start. Further, Eindhoven and St. Louis are finding real success in a leadership model that includes a powerful development agency to execute strategies.

Practitioners also cited the valuable role of one person, a team of people, or designated entity serving as a "catalyst," an "integrator, or a "facilitator" throughout the process. This was found to be true even in cases using the Triple Helix model. Integrators or facilitators were found to stitch together disparate efforts, help conflicted leaders reach consensus, and simply kept the process moving along. In St. Louis, Bill Danforth, chancellor emeritus of Washington University, founded the BioSTL Coalition, a regional organization championing the bioscience cluster, which brought together city and regional leaders to forge a vision for growth and innovation.[83] In other places like Houston, Research Triangle, and Philadelphia, the powers and activities of an existing entity are rediscovered or reconfigured to fit the new purpose.[84] In Seattle, Vulcan Real Estate has played a critical role in including local community groups in discussions around the design and location of housing, infrastructure and amenities.

Finally, and of particular importance in the United States, practitioners cited the instrumental role mayors can play in catalyzing the formation and evolution of innovation districts—a role that will likely grow over time. Former Seattle Mayor Greg Nickels played a critical role in the growth of South Lake Union, making key infrastructure decisions around transit, roads, and energy. Former Boston Mayor Tom Menino's successful effort more recently to designate the South Boston Waterfront as an innovation district and steer its redevelopment in collaboration with a broad network of stakeholders is now being studied by mayors in cities as diverse as Albuquerque, Austin, Chattanooga, Detroit, and Pittsburgh as they seek to build on their strengths.

2. Set a vision for growth

A vision for growth provides actionable guidance for how an innovation district should grow and develop in the short-, medium- and long-term along economic, physical, and social dimensions. 22@ Barcelona, for example, envisioned and articulated in forward-looking documents, a "new model of a compact city," replete with innovation activities, green spaces, advanced industries, a strong industrial heritage, subsidized housing, a new mobility model, and revitalized public spaces.[85] St. Louis and Stockholm Life also devoted the necessary time and resources to develop a highly visual, long-term vision for their districts. Beyond these examples, most practitioners cited the importance of developing a vision to leverage their distinctive strengths—economic clusters, leading local and regional institutions and companies, physical location and design advantages, and other cultural attributes. Innovation districts that may share the same physical geography (e.g., a downtown or waterfront setting) or similar institutional platforms (e.g., an advanced research institution or medical campus) can have radically different opportunities for growth.[86]

Clarify your competitive advantage

Given the distinctive starting points and strengths of disparate places, many district leaders grounded their visions in evidence, developed through the accumulation of relevant data and information, and accompanied by smart analysis, experience and intuition. Some places conducted analyses to guide areas of industry and entrepreneurial growth. Others instead used a bottom-up process driven by entrepreneurs to identify new and emerging areas of growth.

Many practitioners in the United States explained how detailed analysis helped define which clusters and/or research areas to advance. In the early stages of St. Louis' conceptual planning, for instance, Battelle was hired to conduct a thorough analysis of the region's industry clusters in life and plant science. The diagnostic included several areas of study: an assessment of the region's economic strengths (evaluating their range of strengths within life sciences); a benchmarking exercise (against leading and comparable regions); and a SWOT analysis (a quantitative and qualitative analysis of strengths, weaknesses, opportunities, and threats). This work was an important precursor to the formulation of specific plant and life science strategies for St. Louis to consider.[87]

As the St. Louis example demonstrates, a city's or metropolitan area's distinctive economic strengths helped orient actors to the clusters that have the best chance of success rather than rely on a government's attempt to pick industry winners. In fact, St. Louis' strength in plant and life sciences,

Philadelphia's strength in health, computing and informatics, and energy, and Eindhoven's strength in precision machinery are the very clusters promoted in their innovation districts. As these places have evolved, new, emerging clusters grew out of R&D and smart commercialization or through surprising synergies between two or more clusters, creating an even more dynamic network of clusters.

Other practitioners have applied a more bottoms-up approach to identify new and emerging areas of growth. Through a methodology known as "smart specialization," Stockholm and Eindhoven encourage entrepreneurs and other economic actors to enter into a process of "entrepreneurial discovery" to collectively determine new innovation projects or new areas of R&D. Rooted in open innovation, firms and entrepreneurs meet in structured settings to brainstorm, analyze, and ultimately test new ideas. Importantly, this approach aims to move the broader collective of firms into new and emerging areas.[88]

Ylva Williams of the Stockholm Science City Foundation described their intricate process of supporting entrepreneurs, larger companies, universities, and health care providers to collectively identify new market opportunities. One successful example is the convergence between Stockholm's strong sectors of life science, tech and ICT sectors (which also builds bridges between the city's two main innovation districts: Stockholm Life and Kista Science City). In an effort to develop new digital health products and services, entrepreneurs, companies, and other public organizations developed the following process:

- **Ideation workshop.** Patients, healthcare providers, companies and entrepreneurs define challenges or problems and subsequently develop potential solutions. If desired, participants can form teams around a possible solution.
- **HealthHack.** A 48-hour workshop where teams of experts from tech/ICT and life sciences work together to find solutions to the ideas generated in the ideation workshop. Products in this phase range from sketches and prototypes to software ideas.
- **Design workshop.** With the support of sector experts, the teams refine and design their prototypes developed during HealthHack.
- **Pitch workshop.** The teams receive training in how to make successful pitches.
- **Digital Health Days.** The best teams are selected to give a pitch presentation during the international meeting and the audience will vote for the best team.[89]

Smart specialization, such as this above process, aims to "identify new product segments and further strengthen our competitive advantage," said Williams. Perhaps somewhat similar in philosophy, some U.S. districts, including Boston's innovation district, have opted to be silent on clusters, arguing that the selection process derive from entrepreneurs and the market itself.

Imagine a new mix of institutional assets

Practitioners have come to understand that a future vision of a particular district does not begin and end with an assessment of its existing institutional assets. They are keenly aware of the growing trend of leading edge technology and pharmaceutical companies, private and public universities, and even medical campuses to move advanced research and other critical assets to those locations that generate the largest return on investment for the firm or institution. From this understanding, district leaders have become more deliberate in their efforts to lure major innovation assets to their sites (i.e., to "un-anchor anchors") or to form new institutions whole cloth."

The innovation district in downtown Detroit was catalyzed by the decision of Quicken Loans to move its headquarters from suburban to downtown Detroit. Boston's successful enticement to Babson College and the Fraunhofer Institute to open outposts on the South Boston waterfront is another example of this trend as is the University of Washington's decision to locate an advanced medical research campus in Seattle's South Lake Union. Stockholm's largest technical university, KTH, opened a technical branch within Kista Science City. Lastly, 22@Barcelona successfully lured numerous universities to locate within their district, creating a new gravitational pull in the region and a new location for students, researchers and entrepreneurs to innovate jointly.

Re-imagine your physical landscape

Successful practitioners routinely spoke of the need to transform the physical landscape of their districts to create the favored attributes of complexity, density, and mixed uses and activities. This has been particularly challenging in places that bear the indelible markings of 20th century development.

Heavy infrastructure—highways and exposed railroad tracks—often divide natural districts. Euclidian zoning, originally intended to protect health and safety, segregated uses and isolated housing, office, commercial, and manufacturing activities from each other.[90]

A number of innovation districts have therefore required variances from antiquated land use and zoning ordinances and, in some cases, radical changes to existing infrastructure.

In the "anchor plus" model, practitioners have re-drawn existing lines—tearing down walls, fences and other, even more substantial, barriers between anchor institutions and others, creating new mixed-use neighborhoods, making and creating new public spaces, and activating streets to draw people together, and re-designing corridors to make them more pedestrian-friendly. In both Kendall Square near MIT and St. Louis' Cortex district, city governments (or their designated agents) revised land use conventions and zoning ordinances to affect this change. One Stockholm innovation district, Stockholm Life, is in the process of covering over (also known as "decking") two highways that divide their anchor institutions and firms. In doing so, they will have space to build 5,000 units of housing, laboratories, several schools, and open space, effectively stitching the district together.[91]

Practitioners involved in re-imagining urban areas have also undertaken (or benefitted from) pronounced changes to the physical infrastructure. 22@Barcelona, for example, was built on the remains of a 494-acre industrial area, scarred and separated from the rest of the city by railroad tracks. Through extensive public planning and investment, 22@Barcelona buried these tracks, increased access via a new public tram, designed walkable streets, and created new public spaces and housing.[92] Boston's innovation district was enhanced by the Big Dig, the removal (and submerging) of elevated highways that separated the south waterfront from the rest of the city. Equally important, construction of Boston's third harbor tunnel markedly increased the level of access to the innovation district for both cars and transit.[93]

In the few cases of the "urbanized science park," re-imagining land use is the precursor to realizing any aims of urbanization—density, a mixing of uses, and a concentration of activities. This counters the original design of science and research parks, as exemplified by North Carolina's Research Triangle Park, which were intended to ensure seclusion, isolation, and the protection of intellectual property, often on their own "research estates," as the RTP Master Plan puts it.[94] Today, an outsized portion of RTP's master plan focuses on its physical redevelopment: specific urban nodes allowing greater density and amenities, the development of a vibrant central district with more retail, and building up to 1,400 multifamily housing units.

Innovation districts relied on a variety of planning tools as they engaged in this work. 22@Barcelona, Cortex in St. Louis, and Cambridge (MA), for example, developed master plans to address the complexity in physically redeveloping their districts. Under existing state statute, the city of St. Louis designated Cortex West Redevelopment Corporation the master developer of the innovation district. Cortex is also responsible for master planning, oversees development, issues tax abatements, and may use eminent domain. MIT experts in their global work on innovation districts found tremendous success using strategic visions, which are more nimble in scope than traditional master plans. Boston, instead, developed design guidelines and development standards to guide changes incrementally as new developments come on-line.

Lastly, a number of district leaders spoke of efforts to physically brand their area in effort to create a clear, undeniable experience when people enter a district. Dennis Frenchman from MIT describes branding as "narrative design" where the physical landscape is enhanced "so they more clearly communicate a particular set of images and stories."[95] District branding has included the strategic use of urban design elements (such as building massing, street design, public spaces, materials, and plantings); gateway development (where entrances into the district are pronounced or marked in some unique way); communicative digital displays, lighting, signage and banners (all carrying the district logo) along key corridors, at district gateways, and in public spaces.

3. Pursue talent and technology

Talent and technology appear to be the twin drivers of innovation in these districts. Talent commonly refers to those workers with the specialized education and skills necessary to generate new discoveries, commercialize ideas, design new products or production methods (or tinker with existing ones), and manage, brand, and package the ultimate result for the marketplace. Technology refers to the

tools, machines, infrastructure, and systems that help talented workers engineer industrial breakthroughs, disentangle big data and complex problems, and facilitate the production processes that follow. Both fields of work, practitioners shared, have required systematic planning and execution.

Dedicate efforts to attract, retain and grow talent

Practitioners argue that their ability to attract, retain, and grow talent plays a valuable role in differentiating seemingly identical clusters across U.S. and global cities and regions. Similar to businesses and leaders at the regional- and city-scale, district leaders have developed their own campaigns to lure individuals trained or educated in specific niches and specializations.

Practitioners explained that efforts to attract talent—which includes organized outreach programs, marketing campaigns, and highly tailored scouting techniques—largely target highly educated and skilled workers from other parts of the country, if not other global regions. Barcelona's aim to become a global hub of innovation required both a local and global workforce, driving efforts to target international professionals as stimulants for local economic activity.[96] Eindhoven, in their drive to be the "smartest region in the world," found this necessitated a pooling of talent from across Europe and around the globe.[97] South Lake Union's most successful attraction strategy was to entice Amazon to move to the area. As one entrepreneur said: "We love being next to Amazon" They are to South Lake Union and Seattle what Microsoft was to Redmond and the Eastside in the 1990s. They attract a lot of talent. Talent begets talent."[98]

Efforts to retain talent were found to be similarly critical. Years of growing and assembling a strong pool of talent can quickly lead to paralyzing setbacks with the loss of key researchers and faculty. Eindhoven, for example, has dedicated staff focused on talent retention, offering a pipeline of support including cultivating dual career opportunities, and cultural training for international workers on "how to deal with the Dutch."[99] The retention of recent university graduates is equally important, a renewing source of human capital.

Growing talent, while the most time- and resource-intensive of these three categories, is described by practitioners as the very heart of a district's core mission. On one hand, growing talent means growing entrepreneurial capacity and catalyzing start-ups and spin-offs dedicated to commercializing ideas. All practitioners interviewed underscored the extent to which they designed programs, and even often constructed new buildings, to support the growth process of entrepreneurs. "It's all about programming: choreographing 'spontaneous' opportunities for smart people to interact with each other. This is what separates us from traditional science parks," shared Dennis Lower of Cortex in St. Louis.[100] On another level, growing talent means developing a feeder system of STEM workers with the general and customized skills necessary for participation in innovative sectors. Recent work and experiences will be highlighted in the section on promoting inclusive growth.

Seamlessly integrate technologies into the landscape

Practitioners emphasized that technology plays two roles across the district landscape.

First, advanced technology provides the platform upon which innovation is conceptualized, advanced in R&D, and developed during prototyping and product formulation. Specializations such as artificial intelligence, next-generation genomics, and software development, rely heavily on advanced technologies, such as robotics, nanotechnology, and sophisticated computer systems.

The extent to which technologies now drive advancements in science and other fields is what propels districts to invest in technology enhanced facilities. A 2012 survey of university research parks in North America—one example of the "anchor plus" typology—reveals that 75 percent of these districts now contain specialized laboratory facilities.[101] Innovation districts in Cambridge, St. Louis, and Eindhoven have found real success in sharing many of these cost-prohibitive technologies with firms and entrepreneurs through shared workspaces, shared laboratories, and technology centers. As Johannes Fruehauf, the head of Lab Central in Cambridge says, researchers should focus on "perfecting their science" rather than making substantial capital expenditures and assuming large early risks and liabilities.[102]

Second, practitioners have observed the salutary effect of embedding technology in standard public infrastructure to create a platform for innovation. Installations of fiber optics to create a high quality internet environment are now considered an investment in "the basics." St. Louis, for instance,

is making substantial upgrades in internet connectivity by adding fiber to the existing sub-street infrastructure, further enhancing the computing power around big data and the potential for the commercialization of innovation.[103] 22@Barcelona constructed separate tunnels to lay fiber to ensure that upgrades to the system would be easier to meet growing demand.[104] As described in the section describing physical assets, some districts are attempting to reduce the digital divide by extending fiber optics into adjacent, often low-income, neighborhoods. In their global work, MIT researchers focused on New Century Cities observed real growth in the development of digital systems (display and interactive communication systems designed into objects such as bus stop walls and café table tops) and digital places (the nexus of technology, the physical form, and activity creating new ways to teach/train and to entertain). These digital models are particularly pronounced in newer cities and districts in Asia (such as Seoul's Digital Media City) and the United Arab Emirates (Masdar City in Abu Dhabi).[105]

4. Promote inclusive growth

Promoting inclusive growth means using innovation districts as a platform to regenerate adjoining distressed neighborhoods as well as creating educational, employment, and other opportunities for low-income residents of the city.

Given broader trends around economic restructuring, anemic job growth, and wage stagnation, many cities and metropolitan areas have experienced substantial increases in the number of people living in poverty and near poverty over the past decade. As described below, innovation districts offer multiple opportunities for neighborhood revitalization, quality employment, and poverty alleviation. Pursuing these opportunities will lessen the tensions between innovative and inclusive growth, which have emerged in many communities.

Pursue comprehensive neighborhood revitalization

As a recent survey of urban-oriented research parks highlights, 45 percent of these parks are adjacent to, or located within, distressed communities.[106] For this very reason, anchor institutions, like the University of Pennsylvania and Drexel University are pursuing the regeneration of adjoining neighborhoods through multiple strategies to improve public safety, provide quality education, enhance digital literacy and connectivity and expand affordable housing and retail opportunities.

As one practitioner explained, quality public schools are central to this multi-layered effort. To that end, several innovation districts are placing their considerable academic, real estate, and tech talent in the service of broader education reforms. This includes creating or adopting area schools, such as STEM charter schools or magnet schools, developing STEM-oriented curriculum, offering teaching assistance, and providing internship opportunities. In Philadelphia, for example, a consortium of institutions led by Drexel University is working with the city to create a K-8 school near its campus in an underserved neighborhood. The middle school program will be created and overseen by such esteemed institutions as the Science Leadership Academy high school in partnership with the Franklin Institute and the Academy of Natural Sciences of Drexel University. The development of the larger site would include a commercial component to yield capital dollars to help fund this school.[107]

Increase labor market participation

Innovation districts are likely to grow jobs in multiple sectors such as housing, construction, medical, tech, services, and retail. The districts, therefore, offer ample opportunities to connect residents in high unemployment areas (particularly young residents) to occupations that require disparate sets of skills and work experience. Practitioners noted the need to be purposeful in hiring, training, and supporting local talent, with the ultimate goal of giving lowÐincome workers economicallyÐmobile career paths with familyÐsustaining wages. Further, by redirecting capital and jobs back into urban cores and urbanizing suburban parks, jobs become increasingly accessible, particularly by transit.

A number of practitioners emphasized the potential for equipping workers with the skills they need to participate in the innovation economy. Tom Andersson of Kista Science City in Stockholm, explained how they view this as their responsibility "in addressing the competence issue for the long-term."[108] One strategy a few practitioners are applying is to focus on the many innovation jobs (e.g., lab technicians) that require customized technical training in high schools or community colleges, rather than a four-year or advanced college degree. In fact, in mature science and research parks, the conventional

wisdom is that 40 percent of the jobs require high school diplomas or associate degrees, 40 percent require bachelor degrees, and only 20 percent require masters and Ph.Ds.[109] This dovetails with Brookings research, which found that half of all STEM occupations are available to workers without a four-year college degree, arguing for an expanded definition of talent.[110] The St. Louis and Barcelona districts are particularly focused on this potential, experimenting with school-to-work programs, apprenticeships that teach career-building skills and on-the-job training programs.

The challenges associated with linking low income residents to innovation-oriented jobs should not be underestimated given vast educational disparities. In Philadelphia, district leaders are also looking to connect area residents to job opportunities in the secondary and tertiary sectors (e.g., services, retail) that the innovation district catalyzes.[111]

Stimulate local entrepreneurship

Innovation districts, finally, also offer rich opportunities for local entrepreneurial growth. In some cases, specific programs have been designed to grow or support entrepreneurs from pools of less educated residents and workers. The district in Medellin, Colombia, for example, is growing talent through its fabrication lab (known as Fablab), cultivating innovations developed by people living in informal settlements.[112] Free to the public, the Fablab offers state-of-the-art high technology equipment, including the latest in 3-D, digital production.[113] Drexel University and other area anchors in Philadelphia are pursuing entrepreneurial opportunities presented through local procurement.[114] As shown by a recent report released by the Philadelphia city controller, purchases made by anchor institutions form a substantial potential market for local firms.[115] These anchors are now coordinating efforts to hire local (including minority-, and women-owned) businesses to provide these products and services—essentially creating their own local supply chain. As Lucy Kerman of Drexel observed, "Local businesses tend to hire locally so anchors can effectively partner with local businesses, creating new jobs and new opportunities."[116]

5. Ensure Access to Capital

Capital is a necessary ingredient to fuel district growth and expansion. Financing in many forms and from a variety of sources is needed to support basic science and applied research; the commercialization of innovation; entrepreneurial start-ups and expansion (including business incubators and accelerators); urban residential, industrial, and commercial real estate (including new collaborative spaces); place-based infrastructure (e.g., energy, utilities, broadband, and transportation); education and training facilities; and intermediaries to steward the innovation ecosystem. A district-wide integrated strategy, as opposed to compartmentalized efforts, enhances the likelihood that different sources of capital will value the potential of this new form of development, ultimately supporting different kinds of firms, institutions, and activities.

Redeploy and leverage local capital

Many practitioners understand the importance of garnering local capital from disparate public, private, and civic sources to spur innovation district growth, particularly in the early stages. The provision of local capital, particularly at-risk capital, is a market validator and shows that local investors are willing to back the effort. To accomplish these goals, practitioners have been intently focused on redirecting local resources to new innovative purposes and smartly leveraging these resources so that they have full impact.

Practitioners point to early signs that the mixing and leveraging of different sources of local capital is already underway. City governments, for example, are smartly redirecting scarce public resources in ways that garner large private and civic investments. In St. Louis, the city government is using tax increment financing to support infrastructure improvements. The city has also designated Cortex as the master developer for the area, delegating an ample suite of redevelopment powers including the right to exercise eminent domain, abate taxes, and enter into parcel agreements with developers; those decisions have likewise leveraged hundreds of millions of dollars in private and civic sector investment.[117] In 2003, for example, the Danforth Foundation announced that St. Louis-based plant and life sciences would be a predominant focus of its grant-making.[118] In tandem with the McDonnell Foundation and private corporations, the Danforth Foundation led efforts to establish

the BioGenerator, a sophisticated accelerator with a non-profit seed fund. In the last five years, the BioGenerator helped close the funding gaps challenging many local startups, aiding in the successful launch of over 40 new life science enterprises. Further, this accelerator set its eyes on drawing national and regional capital, with its parent organization BioSTL hiring a dedicated person to increase access to national VCs, angel investors, and others.[119]

Local institutional capital is also being unlocked to spur urban regeneration. MIT, for example, has used its extensive land holdings in Cambridge to spur the development of research, entrepreneurial, commercial, office and residential space.[120] In Detroit, meanwhile, philanthropic investments have been a main catalytic force. The Kresge Foundation alone recently committed $150 million over five years to implement the recommendations and strategies outlined in the Detroit Future City report, doubling down on the investments it has already made along the riverfront, in M1 Rail, in the planning for the Detroit Future City effort, and as part of both the New Economy Initiative and Living Cities.[121] These investments have provided a platform for large-scale federal investments (via FHA, DOT, SBA, HUD, and other sources) as well as other state and private sector commitments.

Provide a roadmap for broader private, civic and public sector investment

Practitioners understand that innovation districts will only reach their full potential when companies and investors outside the city and metropolis either decide to locate facilities in the district or otherwise deploy capital. Practitioners recognize further that innovation districts, by providing both a geographic, economic, and entrepreneurial focus, can bring together, in a disciplined and market-oriented way, the disparate elements required to accelerate city regeneration and metropolitan growth.

The practical implications of these insights: innovation districts must make a compelling case for investment and even create special investment vehicles tailored to disparate kinds of activities. Some innovation districts are experimenting in this regard as an avenue to raise capital. The emerging innovation district in Detroit, for example, is considering an investment prospectus that presents the vision and goals of the district, shows the market momentum to date (including a profile of major investors and investments), and describes current and future market opportunities. The prospectus would both make a general case for investment in the district but also target discrete classes of investors and institutions (real estate developers, equity investors, large firms, venture capital, and others).

The Detroit investment prospectus would cleverly build upon existing activities that have already attracted disparate kinds of investors to distinct opportunities. Invest Detroit, for example, has established a series of funds (e.g., a Predevelopment Loan Fund, an Urban Retail Fund, a Lower Woodward Housing Fund, a New Markets Tax Credit Fund) that try to match the expectations of private and civic investors with the financing needs of small- and medium-sized firms that serve different market functions in the downtown and midtown area.[122] It is expected that the Detroit investment prospectus and the subsequent hosting of investor forums would educate the investment community about the market momentum in the innovation district and attract more capital to the specialized funds administered by an institution with a proven track record.

Scaling Innovation Districts

The rise of innovation districts—in all three typologies—has, to date, been a local phenomenon. Mayors and corporate, university, and philanthropic leaders, local developers, and intermediaries have largely driven their growth and development in most cities. A few national and global institutions have established a presence, with capital and facilities, in the leading edge districts, but most major companies and institutional investors have yet to acknowledge or adapt to this trend. The federal government has been an important but silent investor. With a few notable exceptions, states have largely acted without focus or purpose. To date, networks of innovation district practitioners and leaders remain nascent and isolated.

If current trends are any indication, innovation districts will continue to grow in size and scale, fuelled by market and demographic dynamics, open innovation, local leadership, and the place based investments of large anchor institutions. But if innovation districts are to realize their full potential across the country, then asset-rich companies, civic entities and financial institutions—with expertise

honed from global experience—need to invest at scale. Higher levels of government also need to act with more predictability and purpose.

A. Scaling Private and Civic Investment

As described previously, local institutions and investors have, to date, played the primary role in powering growth and innovation district development forward, leveraging local institutional assets and sharpening their case for broader investment. A few institutions of national scope—tech giants like Microsoft and Google, big pharmaceutical companies like Pfizer and Novartis, large urban development firms like Forest City Enterprises and life science focused real estate investment trusts like Alexandria Equities—have spotted the emerging trend and moved facilities and capital to the leading edge innovation districts. But, for the most part, large national and global institutions have not participated at scale.

Several things are necessary if that is to happen.

First, innovation districts need to be recognized as a separate sub-metropolitan/sub-urban geography worthy of focused data collection and analysis by companies that follow urban real estate and innovation trends.

Markets are created when risks and returns are made transparent, so that investors can invest in an informed way. Tracking economic trends in innovation districts (e.g., residential growth, real estate value appreciation, business formation and growth, tech transfer activity) will give investors the confidence to enter the market at scale. Companies that invest in innovative firms and start-ups will look at a broader set of cities and metropolitan areas for their investments. Companies with expertise in delivering mixed-use development and urban-oriented retail (e.g., Post Properties, Whole Foods) will see innovation districts as fertile geography for their products and services and locate accordingly. Firms that either provide innovative products and services (or provide legal, accounting, marketing, and other advice to such firms) will shift locations as well.[123]

Given the potential for job creation in the districts, philanthropies, corporate as well as civic, will see the wisdom of supporting efforts to make innovation more inclusive. And given the entrepreneurial spirit of these new communities, demand for crowd-funding for creative and community projects will grow exponentially. Innovation districts represent, in short, a form of market creation, which will grow in size and scale as data and analytics are sharpened, first mover firms show decent returns on their initial investments and standards and models for more routinized investment are established.

Second, and more aspirational, innovation districts ultimately need to be treated as a unified asset class that recognizes the synergistic effect of disparate investments that strengthen and reinforce each other's value, rather than as a collection of separate and unrelated investments. This is a major challenge to the status quo. Financial institutions, governmental agencies, and philanthropies compartmentalize all aspects of financing (equity investments, debt lending, and grant making just to name a few) even though the focus of these investments (e.g., housing, infrastructure, small business) are physically located in small geographies and interact in a way that enhances value for each of the disparate elements.

Innovation districts, by contrast, offer a possible vehicle for "thinking horizontally across industries and sectors" and overcoming the propensity of investments in cities to come from fragmented sources in "vertical silos."[124] As innovation districts evolve, the hope is that this insight will spur new financial innovations and unleash new flows of capital. Large commercial banks might establish special initiatives to bring spatial coherence to their current array of aspatial products and financing vehicles. Other large financial institutions might invest directly in firms and intermediaries at the cutting edge of design, execution, and management of this new development form (Blackstone's investment in the mixed use developer Eden Communities is an early example of this kind of capital shift). The end result of this: an ample supply of early stage venture capital and commercial lending becomes available in innovation districts to support the building and expansion of innovation-related firms, reinforced by real estate, small business, and community lending to create the housing and mixed-use buildings these firms and their workforce need to thrive.

B. Smart Feds, Smart States

The federal government and states, to date, have not intentionally driven the rise of innovation districts and, for the most part, have not even been cognizant of the trend. Their active engagement and involvement could accelerate the growth of districts, provided it respects the organic and differentiated nature of this nascent trend. They have three important roles to play: spurring innovation and entrepreneurial growth, financing land and infrastructure improvements, and boosting human capital.

Spurring Innovation and Entrepreneurial Growth

It is simply impossible to imagine the late 20th century rise of "cities of knowledge" in Silicon Valley, the Research Triangle, or the Boston megalopolis without recognizing the foundational role played by federal investments in basic and applied science and state investments in public universities.[125] The federal and state governments, in short, have provided the institutional platform for innovation, the base for the generation and commercialization of ideas and the creation and expansion of companies.[126]

The federal and state governments do, however, play disparate roles. For example, the federal government dominates in research funding, with federal actual outlays for R&D in FY 2011 of $125.7 billion, compared to state (and local) governments which account for only 1 percent of national R&D expenditures, with $3.8 billion in 2011, most of which is for academic R&D at colleges and universities.[127] The federal government also supports the start-up, expansion, and trading activity of firms through the lending activity of the Small Business Administration and the Export-Import Bank. The states, by contrast, are major direct investors in public universities, advanced research aligned with state economic clusters and competitive advantages, and tax and spending investments in sophisticated building and equipment.

The general message to both the federal and state governments is to stay the course and continue to provide consistent platform funding and support for innovation. At a time of increasing fiscal austerity, maintaining the status quo would be victory enough. Yet there are several more targeted roles that the federal government and particularly the states should consider.

- ***The smart location of advanced research institutions:*** Given the shifting spatial geography of innovation, the federal government and states should consider locating new or existing advanced research facilities (or providing incentives for the location of such facilities) in innovation districts. The federal government achieved this when it located the first National Manufacturing Innovation Institute, focused on additive manufacturing, in the downtown of Youngstown, Ohio, close to the existing base of small and medium-size manufacturing firms.[128] The state of California achieved this when it located the Institute for Regenerative Medicine in the Mission Bay district of San Francisco.[129] As described earlier, the shifting of public university advanced research facilities to innovation districts (e.g., the location of UW Medicine in the South Lake Union district of Seattle) has become a recognized trend. In the next decade, states in particular would be wise to rethink the location of the research arms of institutions of higher learning to spur market creation and radically increase the return on state investment during a period of fiscal challenges.
- ***Targeted research funding:*** As federal funds for advanced research become scarcer, states would be wise to dedicate focused capital to advanced research efforts that builds on their special sector niches and competitive advantages. A recent Brookings paper noted the increased use of ballot box referendums for these purposes in California, Massachusetts, New Jersey, New York, and Texas.[130]
- ***Catalytic funding:*** States are often involved in particular tax and spending transactions that help grow the institutional platform for innovation in cities and metropolitan areas. The state of New York, for example, recently allocated $45 million to Buffalo to facilitate the expansion of the Columbus, Ohio-based Edison Welding Institute, one of the most advanced shared infrastructure facilities in the United States.[131] The state of Massachusetts, meanwhile, recently made a $5 million grant to facilitate the building of the LabCentral facility in Cambridge.[132] These kinds of targeted investments for capital projects complement the more routine funding that is available for basic science and applied research and, if located in strategic places, can promote synergy and rapid commercialization.

Financing/Regulating Land and Infrastructure

The federal government and states have traditionally played a large role in the financing and regulation of the physical realm of cities. To varied degrees, both levels of higher government make direct or indirect investments in transit, roads, other infrastructure, parks, housing, and other capital improvements. States also determine building codes and standards of construction, establish how tax delinquent properties can be foreclosed, and dictate the ground rules for using eminent domain.

As with innovation funding, federal and state funding for major physical assets have been unreliable in recent years, either due to revenue shortfalls in dedicated funds (e.g., the federal Highway Trust Fund) or partisan gridlock (e.g., the failure to reauthorize federal transportation laws on a timely basis). Thus, the first order of business is to make funding more reliable and predictable, and more flexible so that cities and metropolitan areas can apply the funding to the special needs of innovation districts.

But, several other focused engagements should be considered.

- ***Smart removal of infrastructure barriers:*** Many innovation districts, particularly those located near waterfronts and downtowns, still bear the scars of mid-20th century freeway construction that often divided communities and disrupted the organic street grid and connectivity of urban places. The removal and reconstruction of such infrastructure provides a means to spur innovative markets. The rise of the innovation district in the Boston Waterfront is, in many respects, a consequence of the Big Dig project to tear down and bury key highways, thereby re-connecting the waterfront to the broader city and metropolis. Similar efforts are underway in cities as diverse as Akron, Detroit, and Syracuse and will have enormous impact on investment and jobs once concluded.
- ***Smart use of tax incentives***: Innovation districts often house properties of historic value, which, if renovated and repurposed, could be a critical component of a district's brand and growth. They also tend to contain land parcels that are still contaminated by prior industrial use and require remediation that costs more than market value can bear. Targeted tax incentives for historic preservation, brownfield remediation, and land assembly have a high return on investment when applied in emerging innovation districts and should be encouraged and expanded. The Cortex district in St. Louis has already taken smart advantage of Missouri tax incentives and is a model in this regard.[133]
- ***Smart mortgage standards:*** Innovation districts thrive when housing, retail, and small-scale innovative activities are co-designed and co-located near transit stops and anchor institutions. In the past, federal government sponsored entities and other federal and state agencies disfavored such mixed- use developments, setting a platform instead for large scale financing of single family homes. As housing reforms take hold in the aftermath of the Great Recession, sensible standards around mixed-use development and multifamily housing would benefit the smart, fiscally prudent growth of innovation districts.

Boosting Human Capital

The federal government and states heavily influence the delivery of basic education and skills training in cities and metropolitan areas. The U.S. Department of Education spent some $68 billion in FY 2011, on both K-12 and higher education, plus another $29 billion in tax expenditures related to education. States spent $261 billion of their own funds for the same purpose, while local governments spent nearly $600 billion on education.[134] Relatedly, the U.S. Department of Labor spent $9.7 billion on employment and training programs in FY 2011.[135]

Innovation districts benefit when these large scale federal and state resources are applied in a way that can be customized to their special education and skills needs. To this end, several models are worth considering:

- **Apprenticeship Carolina** helps South Carolina firms in a handful of key industry clusters establish apprenticeship programs that provide effective on-the-job training opportunities for prospective employees. It is based out of the South Carolina Technical College System. Consultants from Apprenticeship Carolina provide assistance throughout the development process, working with firms to create apprenticeships that meet the requirements of the national Registered Apprenticeship system.[136]

- **Oregon's Career Pathways** initiative is focused on increasing the number of Oregonians with post-secondary certificates and degrees to prepare them for employment for jobs requiring more than a high school diploma but less than a Bachelor's degree. It is offered through the state's 17 community colleges and is designed to provide "stackable credentials" of academic certificates (12-44 credits) that can lead either to immediate employment or to the next academic credential within the career pathway, potentially leading to an associate's degree. At Portland Community College, the Career Pathways initiative includes courses and certificates in fields such as accounting, manufacturing, and medical coding.[137]
- **New York State Pathways in Technology Early College High School** (NYS P-TECH) initiative is an effort to prepare thousands of disadvantaged students for jobs in such sectors as technology, manufacturing, healthcare and finance. The model is a six year, "9-14" program that combines high school, college, and career training and involves close partnerships with core industries.[138]

The Path Forward

The potential for innovation district growth in the United States is exceptionally strong. Virtually every major city in the United States has an "anchor plus" play given the confluence of a strong central business district (mostly for the congregation of government and corporate headquarters, entertainment venues, and cultural functions), a strong midtown area (where advanced research institutions and medical campuses tend to concentrate), and a state-of-the-art transit corridor connecting the two.

Many cities and older suburban communities are also making progress on "re-imagined urban areas," repositioning underutilized sections of their community through investments in infrastructure (or infrastructure removal), brownfield remediation, waterfront reclamation, and transit-oriented development.

Lastly, a handful of "urbanized science parks" (and their adjacent suburban communities) are clustering development, encouraging density, and creating spaces to allow individuals and firms to network openly.

The rise of innovation districts seem perfectly aligned with the disruptive dynamics of our era: "crowd sourced rather than close sourced, entrepreneurial rather than bureaucratic, networked rather than hierarchical."[139] They also intensify the very essence of cities: an aggregation of talented, driven people assembled in close quarters, who exchange ideas and knowledge in what urban historian Sir Peter Hall calls a "dynamic process of innovation, imitation, and improvement."[140]

Innovation districts, in short, represent a clear path forward for cities and metropolitan areas. Local decision makers—elected officials and heads of large and small companies, local universities, philanthropies, community colleges, neighborhood councils and business chambers—would be wise to unleash them. Global companies and capital would be smart to embrace them. States and federal government should support and accelerate them. The result: a step toward building a stronger, more sustainable and more inclusive economy in the early decades of this young century.

Endnotes

1. Anchor institutions are research universities and research-oriented medical hospitals with extensive R&D.

2. Select excerpts in this and future sections came from the recent book, *The Metropolitan Revolution: How Cities and Metros are Fixing our Broken Politics and Economy,* Innovation Districts chapter, co-authored by Bruce Katz and Jennifer Bradley.

3. Pete Engardio, "Research Parks for the Knowledge Economy," *Bloomberg Businessweek*, June 1, 2009.

4. The term 'innovation ecosystem' is commonly defined and described in technology and business development magazines, newspapers, and on blogs. Brookings developed this expanded definition to incorporate a more extensive list of variables observed to contribute to the innovation ecosystem at the district scale.

5. Our observations are based on extensive interviews with practitioners and leaders on-the-ground, visits to more than a dozen districts in both the United States and Europe, reviews of other scholarly research on this trend and specific fields of study (such as the growing field of networking and the changing nature of physical planning), and a roundtable discussion held at the Brookings Institution in April 2013 with nationally-recognized urban development experts.

6. To learn more about 22@Barcelona, refer to the website: www.22barcelona.com. Another source was co-authored by the CEO of 22@Barcelona, Josep Miquel Pique'. Refer to Montserrat Pareja-Eastaway and Josep Miquel Pique', "Urban Regeneration and the Creative Knowledge Economy: the Case of 22@ in Barcelona," *Journal of Urban Regeneration and Renewal* 4 (4) (2011): 1-9.

7. Research Triangle Foundation of North Carolina, "Research Triangle Park: Master Plan" (2011).

8. Brookings research, supported by supplemental research by Wexford Science and Technology, identified three other "urbanized science park" examples: University Research Park at the University of Wisconsin-Madison, available at www.universityresearchpark.org/property/urp2/ (April 11, 2014); the University of Virginia Research Park, available at www.uvaresearchpark.com/the-park/park-map/ (April 11 2014); and the University of Arizona Tech, available at www. techparks.arizona.edu/parks /ua-tech-park/planning-development (April 11, 2014).

9. Mark Muro and Alec Friedhoff, "Metropolitan Jobs Recovery? Not Yet." Brookings, The Avenue, April 2014.

10. Brookings analysis of Census data.

11. For more, see Bruce Katz and Jennifer Bradley, *The Metropolitan Revolution: How Cities and Metros are Fixing our Broken Politics and Economy* (Washington: Brookings, 2014).

12. Lydia DePillis, "Dinosaur Makeover: Can Research Triangle Park Pull Itself Out of the 1950s?" *New Republic,* October 12, 2012. Available at www.newrepublic.com/article/108527/can-research-triangle-park-pull-itself-out-1950s (April 19, 2014).

13. Edward K. Muller and Paul A. Groves, "The Emergence of Industrial Districts in Mid-Nineteenth Century Baltimore" *Geographical Review* 69 (2) (1979): 159-178.

14. Ibid.

15. Ibid.

16. Asa Lindholm Dahlstrand and Helen Lawton Smith, "Science Parks and Economic Development." In Prasada Reddy, ed., *Globalization Of Technology: Issues In Technology Transfer And Technological Capability Building* (UNESCO-EOLSS).

17. Thomas Hutton, "The New Economy of the Inner City," *Cities* 21 (2)(2004): 89-108, p. 90.

18. Michael Jaroff, Dennis Frenchman, Francisca Rojas, "New Century City Developments Creating Extraordinary Value" (Cambridge: Massachusetts Institute of Technology, 2009).

19. George Bugliarello, "Urban Knowledge Parks Knowledge Cities and Urban Sustainability," *International Journal Technology Management* 28 (3) (2004): 388-394.

20. American Institute of Architects, "Cities as a Lab: The Innovation Economy" (2013), p. 2.

21. Richard Florida, "Startup City: The Urban Shift in Venture Capital and High Technology" (Toronto: Martin Prosperity Institute, 2014).

22. Personal communication from Dennis Lower, President and CEO of Cortex, April 16, 2014. See also, Innovation District Boston, "Boston's Innovation District: 3 years and counting," February 13 2013, available at, http://www.innovationdistrict.org/wp-content/uploads/2013/03

/InnovationDistrict_NewJobsReport-_2013-03-01_FINAL2_contact.pdf ;

23. Recent economic analysis conducted in the cities of Pittsburgh, New York and San Francisco gives further evidence to this shift into the urban landscape. For New York, the report was written by the Center for an Urban Future, "New Tech City" (2012). For Pittsburgh, the paper was written by Ernst & Young LLP and Innovation Works, Inc. "Building Momentum: Investing in Pittsburgh's Technology Sector" (2014). For San Francisco, the report was written by South Mountain Economics, LLC "A Balanced and Growing Economy: How San Francisco is Making the Transition to a Digital City" (2014).

24. Jonathan Rothwell, "The Hidden STEM Economy" (Washington: Brookings Institution, 2013).

25. Mark Muro, Kenan Fikri, and Scott Andes, "Powering Advanced Industries State by State" (Washington: Brookings Institution, 2014).

26. Her Majesty's Treasury and the Office of the Deputy Prime Minister, "Devolving Decision Making: Meeting the Regional Economic Challenge; The Importance of Cities to Regional Growth" (London: Office of the Deputy Prime Minister, 2006).

27. Gerald Carlino and Robert Hunt, "The Agglomeration of R&D Labs" (Philadelphia: Federal Reserve Bank of Philadelphia, 2012). Carlino's work is part of a much broader base of literature that exists pertaining to proximity and innovation. Stuart Rosenthal and William Strange, for example, have found that the intellectual spillovers that drive innovation and employment drop off dramatically as firms and people move further apart. Refer to Stuart S. Rosenthal and William C. Strange, "Evidence on the Nature and Sources of Agglomeration Economies," in Handbook of Urban and Regional Economics, edited by J. V. Henderson and J. F. Thisse (New York: Elsevier, 2004).

28. Kyungjoon Lee and others, "Does Collocation Inform the Impact of Collaboration?," PLoS One 5 (12) (2010), available at www.plosone.org/article/info:doi/10.1371/journal.pone.0014279 (April 10, 2014). Also refer to Katie DuBoff, "Close Proximity Leads to Better Science," Harvard Medical School at hms.harvard.edu/news/close-proximity-leads-better-science-12-15-10 (April 11, 2014).

29. Joe Cortright, "Making Sense of Clusters: Regional Competitiveness and Economic Development" (Washington: Brookings Institution, 2006).

30. Antonio Ciccone and Robert Hall, "Productivity and the Density of Economic Activity," *American Economic Review* 86 (1) (1996): 54-70.

31. William Hoffman, "The Shifting Currents of Bioscience Innovation," *Global Policy* 5 (1) (2014): 76-83.

32. South Mountain Economics, LLC, "A Balanced and Growing Economy: How San Francisco is Making the Transition to a Digital City" (2014), p. 4.

33. Ibid, p. 12.

34. Center for an Urban Future, "New Tech City" (2012), p. 9

35. Ibid, p. 10.

36. Henry Chesbrough, "The Era of Open Innovation," *MIT Sloan Management Review* 44 (3) (2003): 35-41.

37. Daniel Pacthod and Michael Park, "How can the US advanced-industries sector maintain its competitiveness?" (New York: McKinsey & Company, 2012), p. 2.

38. Suzanne Berger, *Making In America: From Innovation to Market* (Cambridge: MIT Press, 2013).

39. The increased emphasis on collaboration may even extend to the important interplay of innovation and production as the economy evolves and 3-D printing and other disruptive technology accelerate prototyping and enable small-scale and customized manufacturing. The first National Manufacturing Innovation Institute, which focused on additive manufacturing, is located in the downtown of Youngstown, Ohio, close to the existing base of small and medium-size manufacturing firms. The midtown Detroit location of the watch- and bicycle-making firm Shinola, close to the College for Creative Studies (known for industrial design), is further evidence of this trend.

40. Karen Weintraub, "Biotech Players Lead Boom in Cambridge" *The New York Times*, January 2, 2013. This reference reminds us that an economy driven by knowledge bestows new importance on institutions of knowledge such as universities, medical research centers, private research institutions and innovation institutes. These institutions tend to be disproportionately located in cities and other urban places. Over 1,900 colleges and universities, more than half the nation's total, are located in the urban core of metropolitan areas and account for roughly 74 percent of all research expenditures at U.S. research universities. Coalition of Urban Serving Universities, "Urban Universities: Anchors Generating

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51. Richard Florida, *The Rise of the Creative Class And How It's Transforming Work, Leisure and Everyday Life* (New York: Basic Books, 2002).

52. Joseph Cortright, "Young and the Restless 2011" (Washington: CEO for Cities, 2011).

53. Urban Land Institute, "America in 2013" (2014).

54. Michael Kimmelman, "Building a Better City" *New York Times*, October 16, 2013. For shift in housing/location preferences for a particular metro, see Kinder Houston Area Study, conducted by Kinder Institute for Urban Research at Rice University.

55. During our research, some innovation districts were found to organize their assets into two categories: hard factors and soft factors. Hard factors are defined colloquially as the "hard stuff," such as the infrastructure and the physical structure of buildings that create the compact, urban form. Soft factors are the "soft stuff," such as firms, people, and the important connections between them. We broke these two factors apart into economic, physical, and networking assets to enunciate the range of disciplines at play.

56. In this paper, assets are neatly bucketed under one of these three categories although several important assets can actually fit under more than one category. Shared workspace provides the best illustration of this interchangeability. While clearly a physical asset, it is also an economic asset (as economic activity is generated there), and a networking asset (as networking with adjacent start-ups often occurs there).

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71. Ibid.

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82. Professor Etzkowitz, previously with Newcastle University in the UK, developed the Triple Helix after observing that innovation has shifted from a "hands off" linear model of innovation, which is an internal process within and among firms, to an "assisted" model of innovation that involves a coalition of three types of actors: industry, university and government. Its foundation was built on groundbreaking laws, such as the US Bayh-Dole Act of 1980 that permits universities, small businesses or non-profit institutions to pursue ownership of an invention funded by federal R&D dollars. This opened up the viability of universities transforming from a pure teaching institution to one of research and ultimately entrepreneurialism, an important shift that led to the Triple Helix. Sweden, developed a similar policy called "Teachers Exemption," which allows teachers/professors to own the right to their own patentable inventions even if they are made during working hours.

83. Personal communications from Donn Rubin, President & CEO, BioSTL, March 24, 2014.

84. In Houston, for example, the Texas Medical Center had for decades the primary purpose of managing the parking and facilities of the nation's most extensive medical campus. In recent years, under new leadership, the Center has expanded its role to include promoting collaboration on data and research across key member institutions.

85. Ajuntament de Barcelona, "22@Barcelona, the Innovation District," presentation to the Brookings Institution, 2011.

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88. Dominique Foray and Xabier Goenaga, "The Goals of Smart Specialisation," Policy Brief Series 01/2013 (European Commission, 2013).

89. Personal communications from Ylva Williams, Chief Executive Officer, Stockholm Science City Foundation, April 11, 2014. For more information on this event, which will take place in August 2014, refer to www.digitalhealthdays.se (April 14, 2014).

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91. Personal communications from Ylva Williams, Chief Executive Officer, Stockholm Science City Foundation, April 2, 2014.

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93. Personal communications from Dennis Frenchman, Leventhal Professor of Urban Design and Planning, MIT, March 21, 2014.

94. Research Triangle Foundation of North Carolina, "Research Triangle Park: Master Plan," p.11.

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98. Sasha Pasulka, "A Glympse of the future in Seattle's South Lake Union" *Geek Wire*, April 20, 2012. Refer to www.geekwire.com/2012/glympse-future-seattles-south-lake-union/ (April 17 2014).

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101. Battelle Technology Partnership Practice, "Driving Regional Innovation and Growth: The 2012 Survey of North American University Research Parks" (2013).

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104. Personal communications from Josep Pique', CEO of 22@ Barcelona, 22@Barcelona, March 27, 2013.

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112. The OECD defines informal settlements as "areas where groups of housing units have been constructed on land that the occupants have no legal claim to, or occupy illegally."

113. Personal communications from Jenni Young, Carlo Ratti Associati, Srl, October 16, 2013.

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121. John Gallagher, "Kresge Foundation pledges $150 million toward Detroit Future City plan" *Detroit Free Press*, January 9, 2013.

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123. Some innovation district service companies are likely to initiate in one district and then expand to others. The Cambridge Innovation Center, a technology and life sciences business incubator that has helped launch over 1,200 companies near MIT since 1999, recently announced that it will expand its operations and start-up support services in Baltimore and St. Louis. See Michael B. Farrell, "Cambridge Innovation Center branches out: Kendall-based operation looks beyond Massachusetts," *Boston.com*, February 17, 2013. University Park at MIT, for example, is now a model for other Forest City developments including the Science + Technology Park at Johns Hopkins in East Baltimore, the Translational Research Lab at the University of Pennsylvania in Philadelphia and the Colorado Science + Technology Park adjacent to the Fitzsimons Life Science District in Aurora, Colorado. Refer to www.forestcity.net/properties/work/science_technology (January 2013).

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125. The phrase "cities of knowledge" comes from Margaret Pugh O'Mara's excellent book of the same name. Her book is a careful exposition of the role of the federal government in creating Silicon Valley, and of the efforts of other places to create their own comparable centers of knowledge and economic development.

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About the Authors

Bruce Katz is a vice president at the Brookings Institution and founding director of its Metropolitan Policy Program.
Julie Wagner is a nonresident senior fellow with the program.

For More Information

Alex Jones
Policy/Research Assistant
Brookings Metropolitan Policy Program
acjones@brookings.edu

For General Information:

Metropolitan Policy Program at Brookings
202.797.6139
www.brookings.edu/metro

1775 Massachusetts Avenue NW
Washington D.C. 20036-2188
telephone 202.797.6139
fax 202.797.2965

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